Exploring Stress Resilience and Physical Activity Amongst Australian Nursing Populations During Coronavirus 2019

Samantha J. Armstrong

Bachelor of Arts (Psychology) (Deakin University)

Bachelor of Psychological Science (Honours) (Federation University)

Thesis submitted for the fulfilment of the requirements for the degree of

Doctor of Philosophy

Victoria University, Australia

Institute for Health and Sport

September 2023

Abstract

Research investigating physical activity and stress resilience is emerging yet burgeoning. The current dissertation aimed to further ascertain the relationship between physical activity and stress resilience and to investigate the use of physical activity as a facilitator of stress resilience amongst Australian nurses during a pandemic. Further, the project focused on different nursing populations and their psychological wellbeing during Coronavirus 2019 (COVID-19). Three independent but interconnecting studies are included in the dissertation to investigate these aims.

The primary purpose of Study 1 (Chapter 3) was to investigate stress resilience, stress, and burnout of hospital staff (predominately nurses) via monthly cross-sectional surveys from August 2020 to March 2021 during the COVID-19 pandemic. Results from 558 surveys revealed an increase in burnout over time, coupled with negative relationships observed between stress resilience and burnout and between stress resilience and stress. Study 1 indicated declining psychological wellbeing of hospital staff due to COVID-19. Study 1 prospected the impact of COVID-19 on mental health and created a baseline for the relevant psychological variables, yet an understanding of positive health-related behaviours, such as physical activity that may improve stress resilience was warranted.

The purpose of Study 2 (Chapter 4) was to determine the strength of the relationship between physical activity and stress resilience, burnout, and distress amongst emergency department nurses across two cross-sectional surveys that were conducted prior to and during COVID-19. Overall, the nursing population showed little engagement in physical activity; therefore, no relationships were found between stress resilience and physical activity parameters both before and during the pandemic. The sample also showed poorer psychological health outcomes during, in comparison to before, the pandemic. Study 2 could not indicate a potential relationship between physical activity and resilience due to limited engagement in physical activity overall; therefore, a physical activity intervention study was required to further understand the relationship between the relevant variables.

The purpose of Study 3 (Chapter 5) was to conduct an eight-week feasibility intervention, with a mixed-method design to compare the effectiveness of an online, high-intensity physical activity intervention (conducted via YouTube) and an online, mindfulness intervention (using The Resilience Project application) on 12 student-nurses to improve stress resilience during COVID-19. Stress resilience was measured by questionnaires and cardiovascular parameters during a stress test conducted at pre- and post-intervention. Quantitative results indicated improvements in physiological parameters after eight weeks for both the physical activity and mindfulness intervention, yet no changes were apparent for psychological parameters across the intervention. Qualitative analysis indicated improvements in both physiological and psychological stress resilience and emerging themes included personal growth and coping skills. The study provides evidence that physical activity may optimise stress resilience and also highlights the potential for mindfulness practice to promote stress resilience.

Overall, this dissertation provides evidence that there is a weak relationship between stress resilience and physical activity, yet the impact of COVID-19 may have heavily influenced results and weakened the stress resilience-physical activity relationship. Further, it was apparent that COVID-19 negatively affected the mental health of various nursing populations. A comparison of the current findings and the research on stress resilience during and outside of COVID-19 are discussed, as well as practical implications, limitations, and proposals for future research.

Statement of Authorship and Originality

I, Samantha Armstrong, declare that the PhD thesis entitled ‘Exploring Stress Resilience and Physical Activity amongst Australian Nursing Populations during Coronavirus 2019’ is no more than 80,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references, and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own word.

I have conducted my research in alignment with the Australian Code for the Responsible Conduct of Research and Victoria University’s Higher Degree by Research Policy and Procedures.

Ethics Declaration

All research procedures reported in the thesis were approved by Federation University Human Research Ethics Committee (A17-114, A18-116, A20-126, E20-011) and Latrobe Regional Hospital Human Research Ethics Committee (2020-16). This project also received a Reciprocal (Mirror) Approval from Victoria University Human Research Ethics Committee (see Appendix AF for official memo).

Signed: [redacted] Date: 11/09/2023

Acknowledgments

Firstly, I would like to thank my supervisor and friend, Dr. Christopher Mesagno. To write a PhD can be a gruelling yet fulfilling task, and within this dissertation there were multiple trials and hoops to jump through and I can honestly say that I would not have pulled through this mountainous task without your help and guidance. You have been by my side, coaching me to be my best 'academic' self, and coincidentally you have become my mentor both on and off the court. Your dedication to your students is truly an incredible gift and for this I owe an incredible gratitude. We have become great friends and I look forward to many more collaborations together in the future.

Secondly, to my associate supervisor, Professor Joanne Porter. Your unfailing support and positivity throughout this journey has brought me to tears on occasion. You constantly astound me with your 'can do' attitude, your dedication to the field and to your students and my admiration for you is paramount. I will be forever grateful for your help, and I cherish our friendship beyond words.

Thirdly, to my supervisory teammates, Dr. Jo-Ann Larkins, Associate Professor Brendan O'Brien, Dr. Wendy O'Brien, and Professor Fabio Serpiello. Thank you for your advice, support, and contribution to the project. Jo, I will always attribute my newfound love of statistics to you, an incredible feat in itself. Bob, you were a wonderful support and have a kind nature that is endearing to all that have the pleasure to work with you. Wendy, my support across the ditch that kindled a wonderful friendship- thank you for your help with the RPAQ. Fabio, thank you for your enthusiasm and for lending your ear when I was in at the last tether of confusion.

Fourthly, to the participants in my study. Without your generosity, my PhD would not have been possible. To all of the nurses who presented at the front line during the pandemic-the whole of Australia owes you a wealth of gratitude. No words can describe how much your dedication meant to the people around you and you are the heroes of 2020/2021.

Lastly, to my family. Zane, this PhD has taken more time than anticipated and I truly appreciate your patience and constant support. You were the person that pushed me to the end with endless cups of tea and conversations when I needed a sounding board. You mean the world to me, and I am so lucky to have you in my corner. Mum, you helped me with of my other endeavours to make sure that writing this PhD was actually possible- I can never thank you enough for your generosity and time. To my smallest human, Linc, being pregnant with you whilst writing the last sections of my PhD gave me the final push I needed to make sure that it was complete.

Samantha Armstrong was also supported by the Australia Government Research Training Program (RTP) Stipend through Victoria University and Federation University, Australia.

Publications

Armstrong, S. J., Porter, J. E., Larkins, J.-A., & Mesagno, C. (2022). Burnout, stress and resilience of an Australian regional hospital during COVID-19: A longitudinal study. BMC Health Services Research, 22(1), 1115. doi.org/10.1186/s12913-022-08409-0.

Armstrong, S. J., Porter, J. E., Larkins, J.-A., O'Brien, W. J., O'Donohue, J. S., & Mesagno, C. (In Review). Stress resilience and physical activity amongst Australasian emergency nurses: A cross-sectional, comparative study preceding and during the COVID-19 pandemic. Submitted to BMC Health Services Research.

Chapter	Publication Title	Publication Status	Candidate's Contribution
Three	Burnout, Stress and Resilience of an Australian Regional Hospital during COVID-19: A Longitudinal Study	Published by *BMC Health Services Research* on the 2nd September, 2022.	The candidate was the principal author responsible for conceptualisation, data collection, data analysis and writing of manuscript.
Four	Stress Resilience and Physical Activity Amongst Australasian Emergency Nurses: A Cross-Sectional, Comparative Study Preceding and During the COVID-19 Pandemic	Under Review	The candidate was the principal author responsible for conceptualisation, data collection, data analysis and writing of manuscript.

3. There are no other authors of the publication according to these criteria;

4. Potential conflicts of interest have been disclosed to a) granting bodies, b) the editor or publisher of journals or other publications, and c) the head of the responsible academic unit; and

5. The original data will be held for at least five years from the date indicated below and is stored at the following **location(s)**:

All data will be held on Victoria University's R: drive (research data storage) for five years.

Name(s) of Co-Author(s)	Contribution (%)	Nature of Contribution	Signature	Date
Christopher Mesagno	10%	Conceptualisation and design; Editing	[redacted]	18/09/23
Joanne Porter	10%	Conceptualisation and design; Editing		18/09/23
Jo-Ann Larkins	10%	Analysis and interpretation; Editing		18/09/23

Updated: September 2019

Abbreviations

ANOVA- Analysis of Variance

BP- Blood pressure

BRS- Brief Resilience Scale

CD-RISC- Conner-Davidson Resilience Scale

CENA- College of Emergency Nursing Australasia

CG- Control Group

COVID-19- Coronavirus Disease 2019

CSAH- Cross-Stressor Adaptation Hypothesis

DBP- Diastolic blood pressure

ED- Emergency department

HR- Heart rate

HRV- Heart rate variability

K10- Kessler Psychological Distress Scale

MIND- Mindfulness Group

PA- Physical Activity Group

PSS- Perceived Stress Scale

PSQI- Pittsburgh Sleep Quality Index

RMSSD- Root mean square of successive differences between normal heartbeats

RMPE- Recommended Minimum Effect Size Representing a "Practically" Significant Effect for Social Science Data.

RPAQ- Recent Physical Activity Questionnaire

RPP- Rate pressure product

SBP- Systolic heart rate

SDNN- Standard deviation of NN intervals

SMBQ- Shirom-Melamed Resilience Questionnaire

TSST- Trier Social Stress Test

VAS – Visual Analogue Scale

Table of Contents

List of Tables

List of Figures

Chapter 1

Introduction

The year 2019 saw the rise of the respiratory infection Coronavirus disease (COVID-19), which caused devastation globally and resulted in the mortality of millions, placing strain on medical systems and medical personnel such as clinicians and nurses. Frontline hospital staff (i.e., working in the COVID-19 hospital wards) and emergency department personnel (Eyre et al., 2020; Gómez-Ochoa et al., 2021) were at a higher risk of contracting COVID-19 compared to the general population (Hunter et al., 2020; Keeley et al., 2020; Nguyen et al., 2020). COVID-19 led to changes in procedural and working conditions, mandated lockdowns, fear of contagion, and increased workload. These infection-based changes contributed to increased levels of stress, anxiety, depression, and burnout (Bohlken et al., 2020; Lai et al., 2020; Pappa et al., 2020; Shen et al., 2020; Tiete et al., 2021; Yörük & Güler, 2021) amongst frontline hospital staff (Eyre et al., 2020; Lai et al., 2020), nurses (Chegini et al., 2021; Kakemam et al., 2021; Lai et al., 2020) and student nurses (Gao et al., 2021; Huang et al., 2020; Zhu et al., 2021). Therefore, there was a need to assess the mental well-being and resilience of nursing populations during the pandemic and to implement strategies to improve stress-related mental health outcomes.

Resilience has become a topical, key factor to prevent and/or manage poor psychological health outcomes within the nursing industry and beyond (Brown et al., 2018; Hegney et al., 2015; Jackson et al., 2011; Pierce et al., 2020; Taylor & Reyes, 2012). Whilst the concept of resilience is difficult to define (Richardson, 2002; Windle, 2010), the current thesis focuses on 'stress resilience'. Stress resilience is conceptually grounded within stress literature and originates from an individual's reaction to a stressor, which influences the physiological and psychological stress response (Cowen et al., 1990; O'Donohue et al., 2021; Obbarius et al., 2018; Richardson, 2002). An individual's reaction to stress can lead to either successful adaptation and optimised functioning (a resilience to stress) or a hindered/ inactive response resulting in physical and mental vulnerability (Cowen et al., 1990; O'Donohue et al., 2021; Obbarius et al., 2018; Richardson, 2002). This dissertation's contribution to knowledge focuses on understanding stress resilience as a 'process' that is changeable and can be developed through experience, thus promoting positive adaptation to adversity (Luthar & Cicchetti, 2000).

Another contributing factor that improves mental health and theoretically stress resilience is physical activity. Engaging in physical activity can assist in improving poor stress-related health outcomes (Bentley et al., 2013; Conn et al., 2009; Gerber et al., 2016; Gerber, Lindwall, et al., 2013; Shechter et al., 2020) and may facilitate greater stress resilience and resilient stress responses (Baker et al., 2012; Boutcher et al., 2001; Kelley et al., 2001; Silverman & Deuster, 2014; Sothmann, 2006; Wells et al., 2012). Research on the relationship between physical activity and resilience, including stress resilience, is budding, and the current dissertation aimed to contribute to this knowledge base by investigating stress resilience and physical activity amongst Australian nursing populations during COVID-19. Furthermore, this dissertation aimed to understand the connection between physical activity and stress resilience and the use of physical activity as a facilitator of stress resilience amongst different nursing populations during COVID-19.

Dissertation Aims

The current dissertation focused on four main interconnected aims, which included:

a. To monitor the relationship between stress resilience, stress, and burnout amongst hospital staff (including nurses) during an 8-month period of the COVID-19 pandemic (Chapter 3)
b. To explore the relationship between physical activity and stress resilience amongst emergency department nurses (Chapter 4)

c. To explore the use of physical activity as a facilitator in the promotion of stress resilience within a student nursing population during COVID-19 (Chapter 5)
d. To compare a physical activity program to a mindfulness intervention program in optimising stress resilience during COVID-19 (Chapter 5).

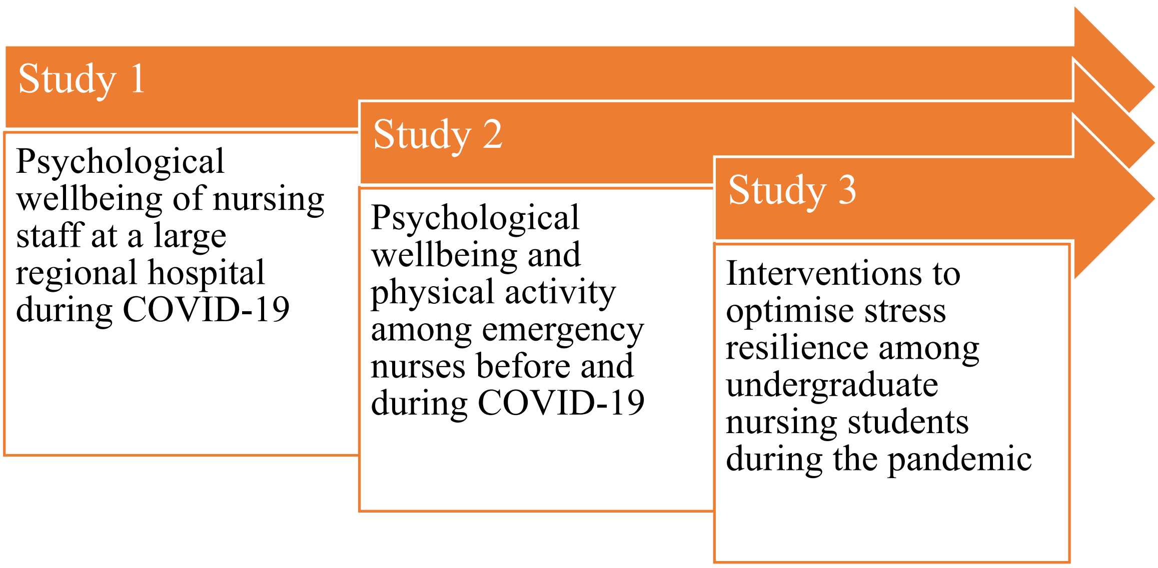
Chapter Organisation

The introduction to this PhD dissertation (Chapter 1) outlines the significance of the project, acknowledges the sample populations used throughout, and briefly explains the unique impact of COVID-19. Set against the pandemic backdrop, a preamble before Chapter 2 elucidates COVID-19's impact and associated challenges upon the three research studies. Chapter 2 provides a review of the literature, including an introduction to key terminology such as stress resilience, stress, physical activity, and its link with stress resilience optimisations. In addition, a review of physiological and psychological resilience interventions is offered. Chapters 3 to 5 are presented as individual, but interconnected, research papers with a focus on testing the aims and hypotheses of the projects within the dissertation. Chapter 6 contains the general discussion, whereby I convey the over-arching findings of the three research studies, relate results to theoretical frameworks, consider real-world implications of the research findings, highlight limitations, and conclude with future research recommendations.

Significance of Project

The significant of this PhD research lies in its focus on the critical intersection between stress resilience and physical activity within the Australian nursing population during the unprecedented challenges of the COVID-19 pandemic. Nursing professionals were placed under immense strain, with stress and burnout symptoms exacerbated during the global crisis, which led to high rates of absenteeism and nurses leaving the profession. By investigating stress resilience and physical activity in different nursing populations, ranging from expert to novice, including emergency department nurses and 3rd year nursing students on clinical placement, this research sheds light on the psychological wellbeing of these vital healthcare providers. Understanding the connection between physical activity and stress resilience, and how physical activity can potentially serve as a facilitator of stress resilience, is crucial in implementing effective interventions to improve nurses' mental health, promote their professional longevity, and ensure the continuity of quality healthcare during and beyond the pandemic. By using physical activity as a psychological wellbeing intervention (Chapter 5) and exploring participants' experiences of the intervention, this research offered nurses a more palatable approach to maintaining their health and wellbeing, which may be more suitable in the long term than traditional classroom learning interventions. Ultimately, the significance of this project lies in the potential to positively influence, not only the nursing workforce but also the wellbeing of those in need of exceptional care. Figure 1 provides a summary of the PhD research studies.

Figure 1. A summary of the PhD research studies



COVID-19 Preamble

COVID-19 had a significant impact on how the current dissertation was conducted. Initially started, and the confirmation of candidature conducted, prior to the COVID-19 pandemic, this PhD project has morphed and adapted to the situation and difficulties that arose from COVID-19, pivoting around the pandemic to create a unique PhD project. Given the unexpected nature of COVID-19, the initial planned research studies were modified accordingly, which produced alternative studies (within COVID-19 restrictions) that contributed to the literature based on the core topics of stress resilience, physical activity and the impact of COVID-19 on nursing populations. Whilst methodological changes brought on by COVID-19 meant deviations from robust face-to-face data collection methods, I was fortunate to continue the project with an alternative approach, despite the somewhat “remote” online methodological procedures. This dissertation, overall, highlights growth, resilience, and tenacity in the production of this dissertation.

Study 1 provided an insight on the effect of COVID-19 on the nursing population of an Australian hospital. There was a prominent awareness of the fatigue plaguing frontline healthcare populations across the globe due to the unexpected longevity of virus prevalence. Based on hospital recommendation, research was restricted to short surveys (due to COVID and survey fatigue) and online data collection procedures, and unfortunately we were advised to exclude questions surrounding physical activity. The first study provided interesting outcomes on the psychological wellbeing of the target sample, further highlighting the need to explore interventions that would build resilience and optimise psychological wellbeing overall.

Study 2 presented an opportunity for comparison between pre- and post-COVID-19 data, which capitalised on pre-pandemic data collection associated with the initial confirmation of candidature proposal. We were unable to create a within-participant design due to anonymity submissions within the first survey, fortunately the comparison data was pulled from the same sample demographic and comparisons yielded interesting results.

During Study 3, the Government rules and restrictions as a consequence of COVID-19 meant that face-to-face interventions were no longer possible due to social distancing requirements. Thus, I reluctantly (for scientific rigour) adapted Study 3 from a face-to-face intervention to an entirely online study. The following aspects moved to a solely online format (Chapter 5): the pre-and post-stress tests using the Trier Social Stress Test, fitness test data collection, physical activity intervention provided through online video workouts accessed through YouTube, and all contact and recruitment of participants was through Zoom, phone or email, with individual interviews conducted over Zoom. The integrity of Study 3 (Chapter 5) was maintained regardless of the imposed restrictions, however, the dissertation, could be seen as a paradigm shift for alternative methodological approaches and further methodological rigour could be built from the research foundations of this dissertation.

Chapter 2

Review of Literature

Overview

This review of the literature delves into the intricate interplay between stress resilience, physical activity, and psychological wellbeing, presenting a comprehensive examination of the current state of knowledge in these domains. Firstly, COVID-19 section explores the multifaceted impact of the COVID-19 pandemic on nursing populations, emphasising the psychological challenges such as stress and burnout. Secondly, the nursing population section provides insights into the distinctive experiences of nurses, highlighting the specific challenges and stressors faced by these professionals during COVID-19. Thirdly, the stress section explores the concept of stress, encompassing both psychological and physiological dimensions. The objective is to provide an explanation of stress, recognising its complexity, and emphasising the various ways individuals react to and manage stress. The physical activity section examines the relationship between physical activity and stress, and reviews extant literature to discern how engaging in physical activity may positively influence both psychological and physiological facets of the stress response. Lastly, stress resilience, characterised by an individual's ability to adaptive positively to adversity, is explored both psychologically and physiologically. In the latter section of the review, the focus is on the dynamic relationship between stress resilience and physical activity. The potential impact of physical activity on both psychological and physiological facets of the stress response is examined, providing a bridge to the subsequent exploration of stress resilience during the COVID-19 pandemic amongst nursing populations in Australia. This review sets the stage for understanding the potential role of physical activity as a facilitator and protective factor in promoting stress resilience.

COVID-19: A Global Pandemic

The year 2020 saw the declaration of the worldwide pandemic Coronavirus disease 2019 (COVID-19). By December 2021, there were 276 million recorded COVID-19 cases; almost 5.3 million deaths recorded across 222 countries and territories since the pandemic began (World Health Organisation, 2021) with Australia reporting over 260,000 cases and over 2000 deaths (Australian Government Department of Health, 2021) and lower morbidity and mortality rates than most countries. The first 425 cases were reported in Wuhan, China (Li et al., 2020) and presented with high transmission rates, whereby on average, one person with COVID-19 infected two additional persons (Fauci et al., 2020). Symptoms of COVID-19 resembled the severe influenza virus but with a fatality rate of 1-2% (de Wit et al., 2016; Guan et al., 2020; World Health Organisation, 2020). Government-mandated lockdowns (i.e., restrictions on personal active transport and socialising), closure of state borders and of non-essential businesses, limited personal contact outside of home, and curfews (Koh, 2020) were all implemented in most Australian states to prevent the spread of COVID-19. In the Australian state of Victoria, the first 'wave' of the COVID-19 pandemic in 2020 was March/April, which was accompanied by the first lockdown period from 31st of March to 31st of May. The second 'wave' appeared in June to September and lockdown was from the 6th of August to the 9th of November and was considered the height of the pandemic for the year 2020. By the end of the year, there were approximately 28,500 cases of COVID-19 (Australian Government Department of Health, 2021). In 2021, long and short infection waves emerged resulting in further mandated lockdowns, with a 5-day lockdown in February, a 15-day lockdown in May to June, a 12-day lockdown in July and the longest lockdown between the 5th of August to the 21st of October (77 days). Researchers have shown that lockdowns have resulted in poorer mental health for individuals worldwide (Baloch et al., 2021; Benke et al., 2020; Bruno et al., 2021; Lee, 2020; Patrick et al., 2020; Pierce et al., 2020; Twenge & Joiner, 2020; Voss et al., 2021; Zacher & Rudolph, 2021). Australian populations have suffered psychologically from the enforced lockdowns (Biddle, 2020; Fisher et al., 2020; Li et al., 2021; Newby et al., 2020; Rossell et al., 2021; Sameer et al., 2020; Stanton et al., 2020; van Agteren et al., 2020), including those within the health care system, such as nurses, physicians, and allied health staff (Pascoe et al., 2022; Smallwood, Karimi, et al., 2021).

Nursing Populations

Prior to COVID-19, nursing populations endured shift work, long working hours, high levels of responsibility, high task orientation, and inflexible rostering (Adeb-Saeedi, 2002; Driscoll, 2008; Healy & Tyrrell, 2011; Ross-Adjie et al., 2007). The unpredictable nature of nursing can lead to poor mental health, high workplace stress, anxiety, burnout, and depression (Badu et al., 2020; Lim et al., 2010; Potter, 2006). A review of Australian nursing staff highlighted moderate to high levels of stress and burnout (Badu et al., 2020) with symptoms of burnout more prevalent in younger populations (Holland et al., 2013).

During COVID-19, nurses were the frontline personnel and their workload significantly increased (Lee et al., 2020). Nurses also dealt with a higher risk of contracting the infection compared to the general population (Eyre et al., 2020; Gómez-Ochoa et al., 2021), which contributed to the fear of virus transmission to their family (Pappa et al., 2020; Shanafelt et al., 2020; Wallace et al., 2020). In Australia, healthcare workers (including nurses) were subjected to three times the risk of infection compared to the general population during the first six months of the pandemic (Quigley et al., 2021). It is unsurprising then, that during the COVID-19 pandemic, nurses were under pressure to prepare and manage the personal and occupational consequences of COVID-19. For both clinical and non-clinical staff, COVID-19 forced changes to procedural and working conditions such as the introduction of retraining programs, which increased staff workload (Lee et al., 2020). The closure of education centres, such as schools and pre-school learning centres, meant nurses with children could no longer work their regular employment hours (Gavin et al., 2020). Similar to other countries, COVID-19 adversely affected the mental health of hospital staff, which resulted in increased levels of stress, anxiety, depression, and burnout (Bohlken et al., 2020; Chegini et al., 2021; Eyre et al., 2020; Gao et al., 2021; Huang et al., 2020; Kakemam et al., 2021; Lai et al., 2020; Pappa et al., 2020; Pascoe et al., 2022; Reverté-Villarroya et al., 2021; Shen et al., 2020; Tiete et al., 2021; Yörük & Güler, 2021; Zhu et al., 2021). Despite the low COVID-19-related mortality and morbidity rates in Australia, nurses showed similar trends on poor psychological health outcomes compared to other nations (McGuinness et al., 2022; Smallwood, Karimi, et al., 2021), indicating greater stress and burnout symptoms compared to pre-pandemic levels (Chor et al., 2020; Woo et al., 2020). Burnout and stress are familiar terms and often used synonymously, especially during COVID-19. Stress, defined within this dissertation, is a dynamic process initiated by the perception of an unpredictable or uncontrollable stimulus (stressor), encompassing measurable psychological and physiological responses (Goodnite, 2014; Koolhaas et al., 2011; Levine, 2005). Burnout, however, is the accumulation of stress over time and is characterised by feelings of mental and physical exhaustion, negative attitude, and feeling like workplace goals are unachievable (Arora et al., 2013; Bianchi et al., 2014; Embriaco et al., 2007). Burnout can lead to high absenteeism rates (Toppinen-Tanner et al., 2005), low self-efficacy (Alarcon et al., 2009), sleep deprivation (Ekstedt et al., 2006), poor cognitive functioning (Deligkaris et al., 2014), depression (Iacovides et al., 1999), and higher risk of developing cardiovascular diseases (Melamed et al., 2006).

Prior to COVID-19, researchers were aware of the poor mental health of nursing populations and interventions were implemented to improve stress-related health issues. These interventions have varied from mindfulness-based interventions (Chesak et al., 2015; Galantino et al., 2005; Lin et al., 2019; Magtibay et al., 2017; Ramachandran et al.; Sampson et al., 2019; Yang et al., 2018), to resilience programs (Chesak et al., 2015; Magtibay et al., 2017) and a physical activity program (Efendy et al., 2021). In light of COVID-19, improving stress-related health outcomes via interventions became imperative.

Stress

Whilst the definition of stress is difficult to define (Goodnite, 2014; Koolhaas et al., 2011), the current dissertation recognises the importance of psychological and physiological dimensions in capturing its multifaceted character and manifestations. Psychological stress refers to an internal response to a perceived stressor, resulting in either inability or ability to cope consequently affecting psychological adaptive processes (Chrousos & Gold, 1992). A stressor, specifically, is determined as the cause of the stress response, rather than the reaction to stress itself (Carver & Connor-Smith, 2010). Further, the term 'stress response' is an individual's non-specific reaction, be that physiological, behavioural, and emotional reaction to the experience of stress (Crum et al., 2020). Psychological stress is typically portrayed in a negative light, however contemporary researchers emphasise the optimising nature of the stress response, whereby the experience of stress can be positively adaptive (Bower et al., 2008; Carver & Connor-Smith, 2010; Crum et al., 2013; Janoff-Bulman, 2014). Depending on the definition of stress, stress may be considered in terms of how one perceives and handles challenges, and not merely the body's attention or arousal towards a stressor, thus stress could be considered a process (Goodnite, 2014; Koolhaas et al., 2011). Koolhaas et al. (2011) and Monroe (2008) propose that the environment in which the stressor occurs, the psychological and biological reactions to a stressor and the duration of the response are the three key domains for stress conceptualisation. Moderate levels of stress can assist with future challenges (Rutter, 2012). Exposure to moderate stress can promote positive growth and adaptation towards future stressors (Rutter, 2012). Depending on the frequency, duration and intensity of the stressor, the stress response process can lead to beneficial psychological adaptations, but only up to a certain point, which is determined by the body's physiological response and recovery to the stressor

(Holmes & Rahe, 1967), similar to the U-shape hypothesis of performance and arousal (Yerkes & Dodson, 1908).

Physiological stress refers to the biological processes of the stress response that are activated in response to a real or imagined stressor (McEwen, 2000, 2004). These biological stress response processes can encourage efficient physiological functioning for the body to meet the demands of the stressor, encourage physiological endurance (Dienstbier, 1989; Epel et al., 1998) and from an evolutionary point of view, promote survival (Sapolsky, 1996). McEwen's (1998) allostasis theory supports the process of physiological adaptation and suggests that the stressor response (rather than the stressor itself) can produce both protective and damaging effects upon physiological stress response systems. Positive physiological adaptation results in superior physiological functioning with enhanced stress reactivity response to a broad array of stressors and not just repeated stressors of the same type. Allostasis refers specifically to the physiological systems that maintain stability through changing environments, like a cause-and-effect process of stress mediators in response to an external stressor (McEwen & Wingfield, 2003). Allostatic processes occur when physiological mechanisms adjust bodily resources to suit the constantly changing demands of the external environment (McEwen, 1998). For example, in response to a stressor, the bodily systems enable secretion of cortisol and via the adrenal gland increase heart rate and blood pressure, thus mobilising the body for action in order to resolve the stressor (McEwen, 1998). If, and when, cessation of the stressor occurs, allostasis allows the body to return to a level of homeostasis. Allostasis is an extension of the homeostasis theory (McEwen, 1998). Homeostasis regulates internal physiological processes despite changes in the external environment, whereas allostasis modifies internal physiological processes directed by external change (e.g., a threatening situation).

Allostasis is a fundamental component within the stress response that can lead to optimised, adaptive functioning (Karatsoreos & McEwen, 2011). The allostatic responses of the hypothalamic-pituitary-adrenal axis and the immune, cardiovascular, metabolic and autonomic nervous systems are responsible for the body-enhancing physiological adaptations towards a stressor (McEwen, 2007). The allostatic process is altered by the hippocampal response to stress; the hippocampus is involved in interpreting and responding to stressors that effect the coordination of allostatic processes, resulting in allostatic load (McEwen, 1998). Allostatic load refers to the accumulative effects of a stressor upon the stress response pathways that can result in wear and tear on the body leading to either optimisation or negative interference of bodily functioning (Frodl & O'Keane, 2013; McEwen & Wingfield, 2003). According to McEwen (1998), there are three types of physiological responses that contribute to allostatic load. Firstly, frequent stress can lead to allostatic load depending on the frequency and intensity of the stressor. The repetitious occurrence of a stressor (regardless of the type of stressor) can have positive or negative consequences upon physiological adaptation. Second, failed shut-down of the stress response mediators (i.e., hormone activation and secretion) occurs when the stressor has been removed, yet the physiological processes have not ceased in mobilising the body for defence. For example, this may occur when an individual has persistent high blood pressure levels that can lead to cardiovascular disease. Third, inadequate response refers to the body's physiological inability to react to a stressor, resulting in higher load as the body's regular defence systems are in deficit. The type of allostatic load, or moderate levels of stress as suggested by Rutter (2012), has a significant impact on bodily functioning and can lead to an optimised physiological adaptation of the stress response, which may assist with upcoming future stressors.

Positive and negative adaptations within the body occur through allostatic load (McEwen et al., 2015). Positive adaptation of allostatic load occurs when there is efficient regulation and recovery of the stress response system (involving mediators such as activation and deactivation of neurotransmitters, cortisol secretion) in response to a stressor (McEwen, 2005). For example, during acute stress the secretion of cortisol and adrenalin enhances memory retainment, which leads to more efficient coping of future stressors (Roozendaal, 2000). When these mediators are switched off and no longer needed (i.e., stressor removed), the body can return to homeostasis. If cessation of these mediators does not occur after the stressor is no longer present (a stress response malfunction), this can lead to allostatic overload resulting in negative adaptation (McEwen et al., 2015). Allostatic overload refers to a prolonged activation of the stress response producing insufficient or excess stimulation of the mediators involved in regulating the stress response, resulting in impaired bodily functioning (McEwen & Wingfield, 2003). Negative adaptation typically occurs when the body endures chronic stress and sustains constant levels of arousal (amongst other prolonged activations), which can cause damage to the body (Juster et al., 2010). For example, if the challenge is not resolved or mediators of the stress response are not switched off, chronic activity of the cardiovascular system can lead to allostatic overload and can result in harmful consequences such as hypertension and stroke (McEwen, 1998; Treiber et al., 2003). However, positive adaptations of the stress response can lead to physiological thriving.

Physiological Thriving in Response to Stress

Positive physiological adaptation denotes similar characteristics to physical thriving or enhanced allostasis whereby stressors have the potential to create physiological changes within the body, enabling the body to become more resilient in the face of stressors , whereby developing an efficient reactivity and recovery to stress (Bower et al., 2008; Epel et al., 1998; Karatsoreos & McEwen, 2011). Physical thriving (or enhanced allostasis; Bower et al., 2008) implies that the body mitigates the stress response by regulating arousal levels based on allostatic load demand, which decreases the likelihood of overload (McEwen & Stellar, 1993).

When physical thriving occurs, the body is at peak physical functioning allowing efficient regulation of bodily systems to occur.

Conditions must be perfect for physiological thriving to occur. Epel et al. (1998) proposed three conditions that promote physical thriving: (1) the stressor must be acute in nature, rather than chronic; (2) physiological 'toughening' occurs through frequent exposure to acute stressors; and (3) adequate recovery and repair period is essential post-stressor. Repetitious, intermittent exposure to acute stressors encourage efficient regulation of restorative processes to bounce back and grow from the previous allostatic load. Toughening occurs when the stress response systems are conditioned to deal with high levels of allostatic load that also includes a sufficient recovery period, therefore becoming more resilient to forthcoming stressors (Epel et al., 1998). The physiological systems of the stress response become more resilient by minimising the possibility of allostatic overload. Efficient reactivity and faster recovery of stress response systems (i.e., shorter allostatic response) following acute, intermittent stressors allows for a continuous cycle of physical thriving. Researchers have highlighted examples of successful adaptation to repeated stressors (Gerra et al., 2001; Kirschbaum et al., 1995; Schommer et al., 2003; Strahler et al., 2015; Thoma et al., 2017) indicating support that stress response systems can be optimised and strengthened.

An important distinction must be made between habituation and adaptation of the stress response. Habituation refers to repeated confrontation of the same stimulus that elicits attenuated or extinguished responses due to a lack of predictability and novelty of the stimulus (Rankin et al., 2009). Habituation towards a stressor typically signifies a diminished response towards a stressor. Whereas adaptation towards a stressor results in similar reactivity of the stress response, accompanied by a swifter, more efficient recovery response, suggesting a positive physiological adaptation process has occurred. Whilst physiological changes are evident for repeated stressors, uncertainty arises about whether the outcome is derived from habituation towards the stressor or adaptation of the stress response, respectively (e.g., De Vente et al., 2003; Schommer et al., 2003). Mason (1968) proposed that habituation could be considered a moderator of the stress response. Other researchers suggest that habituation relates to the anticipation of the stress response that disrupts homeostasis during the stress response and recovery reflects the return to baseline post-stressor correlating to resting homeostasis that is regained post-stressor (Hughes et al., 2018). The current dissertation will focus on an individual's ability to overcome stress via means of adaptation, rather than desensitisation through habituation.

Cardiovascular Adaptations of the Stress Response

The reactivity and recovery of the stress response towards a stressor may have a direct effect on allostatic load and homeostasis. Specifically, cardiovascular reactivity reflects the physiological output that occurs from a baseline level (prior to the stressor) to exposure to the stressor (Huang et al., 2013). Cardiovascular recovery reflects the physiological output that occurs when an individual responds to, and recovers from a stressor (i.e., length of time before homeostasis is regained post-stressor). Cardiovascular reactivity and recovery towards a stressor may indicate an enhanced or vulnerable stress response system; for example, an optimised stress response may exhibit a faster recovery rate compared to a vulnerable stress response system, and the optimised system may have developed through previous positive adaptation.

Physiological measurements used to access physiological adaptation of the stress response for cardiovascular parameters include heart rate variability (HRV). HRV measures the changes in autonomic regulation assisted by the sympathetic and parasympathetic stress response systems and is defined as the difference in intervals between heart beats (Christodoulou et al., 2020; Shaffer & Ginsberg, 2017). HRV is the cardiovascular system's response to environmental and physiological stressors upon the body (Acharya et al., 2006).

Two main indices of HRV are time domain measurements such as standard deviation of normal-to-normal RR intervals (SDNN) and the root mean square of successive differences (RMSSD). Time domain frequencies measure variation in heart rate (HR) over time. Specifically, SDNN measures the standard deviation of normal intervals of HR (i.e., SDNN measures the space between heart beats). Researchers suggest that both the sympathetic nervous system (involved in fight-or-flight reaction of the stress response) and parasympathetic nervous system (involved in maintaining and/or returning the body to homeostasis within the stress response process) contribute to SDNN (Shaffer & Ginsberg, 2017). RMSSD represents the square root of the mean of the sum of squares of differences between adjacent normal-to-normal intervals and is reflective of the automatic control of the vagus nerve or parasympathetic nervous system activity (Stein et al., 1994). A high HRV (either at rest or during a stressful situation) indicates greater cardiovascular flexibility, adaptability, and optimised physiological functioning and low HRV indicates physiological vulnerability of the stress response processes (Dekker et al., 2000; Thayer et al., 2009; Weber et al., 2010). Kim et al. (2018) reviewed 37 studies and concluded that HRV is a reliable indicator of the physiological stress response.

Other cardiovascular parameters that measure physiological adaptations of the stress response include heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP). Heart rate indicates the speed of the heartbeat as measured by the number of contractions per minute (Vogel et al., 2004). SBP reflects the level of pressure that is created by the hearts contractions whilst pumping blood to the arteries, whereas DBP is the level of pressure in the arteries when the heart is at rest or between beats (White, 2002). RPP observes cardiovascular oxygen consumption and indicates the amount of stress placed upon the heart during an activity or stressful situation (Figueroa et al., 2012; Miyai et al., 2002; Segan et al., 2013; Sembulingam et al., 2015). Increases in HR, SBP and DBP indicate activation of the sympathetic nervous system and decreases in these cardiovascular parameters indicate activation of the parasympathetic nervous system. Increased reactivity of cardiovascular parameters in response to a stressor indicates an efficient, adaptive 'fight-or-flight' response (Hughes et al., 2018; McEwen, 1998) indicative of efficient functioning of the stress response. Within the current study, emphasis is placed on the swiftness of the recovery. Researchers have found that a faster recovery from a stressor suggests a more adaptive stress response system (Hughes et al., 2018; Tugade & Fredrickson, 2004). The physiological and psychological adaptations of the stress response, including both negative and positive adaptations, are imitative of the effects of physical activity and exercise upon the body (Silverman & Deuster, 2014).

Physical Activity

Physical activity can be defined as any purposeful movement of the body resulting in the expenditure of bodily resources (Caspersen et al., 1985). Within the general population, physical activity may produce physiological adaptations of the stress response systems, which promote short- and long-term physical and psychological health and wellbeing benefits (Blanchard et al., 2004; Goldberg, 2005; Grant et al., 2009; Hagberg et al., 2000; Heidke et al., 2021; Schindler, 2010; Sui et al., 2010; Thompson et al., 2003; Uusitupa et al., 2000; Wessel et al., 2004; Weuve et al., 2005). Engaging in physical activity has a positive impact on stress-related health outcomes, including burnout (Bentley et al., 2013; Gerber, Lindwall, et al., 2013; Naczenski et al., 2017; Norris et al., 1992; Penedo & Dahn, 2005; Swain & Franklin, 2006).

A small Australian study assessed the effects of a physical activity intervention on psychological wellbeing, stress and burnout. Bretland and Thorsteinsson (2015) allocated 49 sedentary participants to three experimental groups: cardiovascular training, resistance training, and control groups. The physical activity groups' workouts contained high-intensity components, where they completed 3 x 30 minutes exercise sessions per week for four weeks.

The battery of pre- and post-intervention psychological tests included the Perceived Stress Scale (PSS; Cohen et al., 1983) and the Maslach Burnout Inventory (Maslach et al., 1986). Results indicated a statistically significant difference between the physical activity groups and the control group, with greater positive wellbeing and lower levels of psychological distress and burnout for the physical activity groups. Perceived stress was significantly lower in the physical activity groups compared to the control group. Interestingly, both the cardiovascular training group and the resistance training group had comparatively similar results, even over the short 4-week intervention, which has implications for future burnout interventions that could be short in duration. In addition, the type of training has implications for physiological adaptations of the stress response, assuming that both physical activity groups engaged in high-intensity physical activity, unfortunately intensity was not reported. Bretland and Thorsteinsson (2015) study has many methodological drawbacks. The pilot study relied upon subjective data alone; objective fitness measures are essential when conducting physical activity intervention research. Further, Bretland and Thorsteinsson suggested the use of heart rate monitors would have benefited the study by giving more accurate assessments of intensity, and in addition would have given a better perspective on the dose-response relationship of physical activity and mental health. It must be acknowledged that the Bretland and Thorsteinsson study was a preliminary study that provides insight regarding the positive effect of short duration physical activity interventions on psychological adaptations of the stress response.

Positive implications of engaging in physical activity have also been found amongst nursing populations (Bentley et al., 2013; Gerber, Lindwall, et al., 2013; Heidke et al., 2021; Hui, 2002; Klainin-Yobas et al., 2015; Lovell et al., 2015; Schofield et al., 2016; Tyson et al., 2010). Gerber, Lindwall, et al. (2013) examined the relationship between self-perceived stress, burnout and depression and cardiovascular fitness on a random sample (197 participants), mainly healthcare workers. Gerber et al. found that participants with higher levels of fitness presented with less burnout, depression and stress symptoms compared to participants of limited fitness levels. Furthermore, participants with high stress and high fitness levels had lower burnout scores. Though, the reverse could be considered whereby it is possible that individuals who experience burnout or depressive symptoms are less likely to engage in physical activity or maintain food cardiorespiratory fitness levels, thus longitudinal designs and mediation analysis could be employed to address this conundrum. Gerber et al.'s study give evidence that indicates physical activity may have a positive effect on physiological adaptations of the stress response.

Research on nursing populations prior to COVID-19 highlighted that participation in (Ahmad et al., 2015; Jung & Lee, 2015; Naidoo & Coopoo, 2007), and intensity of (Nahm et al., 2012; Tucker et al., 2010), leisure time physical activity was generally low, and there was limited research on occupational physical activity levels to make comparisons (Albert et al., 2014; Nahm et al., 2012; Perry et al., 2015). Therefore, assumedly, nursing populations may not benefit psychologically from physical activity engagement. An Australian study comparing workplace and leisure-time physical activity on physical and psychological wellbeing amongst nurses revealed nurses with high workplace but low leisure-time activity had a higher risk of negative health effects, in contrast to nurses engaging in more leisure-time physical activity outside the workplace (Henwood et al., 2012). Henwood et al. (2012) suggests that when individuals spend a large capacity of energy within the workplace, and less energy directed towards leisure activities, psychological health can falter and may result in an increase in stress and distress. Henwood et al.'s research did not report on the type and intensity of physical activity, which could affect health outcomes. Additionally, Henwood at al.'s research used self-report data only, to enhance this type of research, objective measures of physical activity could be used to provide more accurate data on physical activity levels. However, Henwood et al.

indicated that physical activity may produce positive physiological adaptations of the stress response when engaging in leisure time physical activity, compared to occupational physical activity though further exploration is required.

Since the beginning of COVID-19, Australian adults that indicated a decline in their regular physical activity (as a consequence of government-mandated lockdowns that entailed closure to sporting clubs and travel restrictions) also indicated higher rates of depression, anxiety and stress in comparison to individuals that did not report changes to their exercise routine (Stanton et al., 2020). This was consistent with global research on physical activity and psychological health during COVID-19 amongst the general population (Violant-Holz et al., 2020). It is plausible that individuals who were directly affected by COVID-19 due to their occupation would be more significantly impacted, regarding engagement in physical activity, compared to the general population.

Researchers suggest that the increased workload has significantly reduced frontline healthcare workers ability to engage in regular physical activity (Lee et al., 2020; Magnavita et al., 2021). The increased workload, as a consequence of COVID-19 (Lee et al., 2020), placed significant distress on nursing populations (Lai et al., 2020) and when individuals suffer from psychological distress, they are less likely to engage in moderate to high levels of physical activity (Gucciardi et al., 2020). Some healthcare workers (including nurses), however, suggested that engaging in physical activity was a coping mechanism to combat the significant stress encountered in the workplace (Brown et al., 2021; Shechter et al., 2020; Smallwood, Karimi, et al., 2021). A small study in China on frontline medical staff during COVID-19 found that individuals that exercised according to the national prescription of daily activity also presented with lower stress levels (Wu & Wei, 2020). Nursing populations may have used physical activity as a stress-mitigating resource during COVID-19, though physical activity includes multiple variables, such as type of exercise, duration and intensity that requires specification and exploration.

High-Intensity Physical Activity

Individuals may need higher levels of intensity to promote adaptations of the stress response, compared to moderate levels of intensity (Bernaards et al., 2006; Bouchard et al., 1994; Norris et al., 1992). A review found that people with high fitness and high exercise levels (including high-intensity physical activity) showed fewer stress-related health issues (Gerber & Puhse, 2009), though the dose response, including intensity level is still unknown. Perhaps high-intensity physical activity may have a positive impact on physiological and psychological stress-related outcomes, which may be the result of a more adaptive stress response. Researchers (for example, Cox et al., 2004; Lines et al., 2020) found high-intensity physical activity produced greater optimised psychological well-being (including greater resilience) compared to moderate-intensity physical activity and may indicate that high-intensity exercise is more beneficial psychologically through the promotion of a healthier biological stress response (Berger & Motl, 2000) and high-intensity exercise facilitates a more adaptive stress response (Boutcher et al., 2001; Kelley et al., 2001). When the body engages in high-intensity physical activity, the stress response is activated. The stress response bodily mechanisms are similar whether they are activated by engagement in physical activity or faced with a stressor. Both stressors and physical activity impact allostatic load within the stress response (by activating the sympathetic nervous and immune systems) and upon cessation return to homeostasis in a timely manner. A swift recovery may help facilitate physiological adaptations of the stress response. Silverman & Deuster, 2014 propose that high-intensity physical activity in acute bouts buffer stress-related disorders and the biological mechanisms that may promote this stress safeguarding effect (with neuroendocrine and sympathetic nervous system responses) include inflammatory pathways, neuroplasticity and growth factor expression.

These factors may influence the optimisation of physiological responses to psychosocial stressors. A highly functioning neuroendocrine stress response (resembling a high cardiovascular reactivity response), combined with an increased neuroplasticity (high neurotropic factors) and an efficient anti-inflammatory state (lower inflammatory marker secretion) may facilitate an effective cardiovascular reaction and recovery process within the stress response system. Whilst specific examination and in-depth explanation of these suggested stress biomarkers is beyond the scope of the current dissertation, is it important to understand the underlying mechanisms as to how high-intensity physical activity may drive a more adaptive stress response through the suggested biological pathways. Stress biomarker research and its translation with psychological wellbeing research is nascent. This dissertation will attempt contribute to this area of research by focusing on cardiovascular outcome measures of the stress response, in response to a stressor and provide cross-sectional data on the relationship between physiological and psychological health parameters.

Norris et al. (1992) compared a moderate-intensity to a high-intensity aerobic exercise program in a 10-week intervention study and found participants in the high-intensity group significantly improved stress levels and cardiovascular recovery (HR, SBP and DBP) compared to the moderate-intensity and control groups at post-intervention. Bouchard et al. (1994) suggested for physical activity to have an effect on the stress response, the relative intensity of the activity should exceed 50% of one's maximal oxygen uptake. In order to exceed 50% maximal oxygen uptake, an individual must engage in physical activity with a 60-84% of heart rate reserve or 77% to 93% of maximal heart rate, which is high-intensity physical activity (Bouchard et al., 1994).

Similarly, Gerber, Brand, et al. (2013) provided preliminary evidence that individuals suffering from occupational burnout may benefit from a 12-week prescribed high-intensity exercise program. The pilot study consisted of 12 males that presented with high levels of burnout, based on the Maslach Burnout Inventory (Maslach et al., 1986). Pre- and post-testing evaluated mood, burnout, depression, and stress levels. The exercise intervention was conducted in a natural setting, a local gym and the prescribed programs were conducted under the instruction of a qualified personal trainer, two to three sessions per week at the discretion of the participant. Participants exercised between 60-75% of their maximal heart rate (adopted by high-intensity definitions). Results from pre- and post-intervention were statistically significant with large effect sizes seen for all participants across all assessed variables, suggesting high-intensity exercise may assist with symptoms of occupational burnout. Unfortunately for Gerber at al.'s pilot study, there was no control group to compare whether these changes were due to participation in the intervention. Both Gerber, Brand, et al. (2013) and Norris et al. (1992) indicate that engaging in moderate to high-intensity physical activity may facilitate adaptations of the stress response, specifically cardiovascular changes, though further validation on the relationship between high-intensity physical activity and its effect on stress (Gerber & Puhse, 2009) is necessary.

Cardiovascular Adaptations of Physical Activity (Including High-Intensity)

Physical activity may improve cardiovascular adaptations of the stress response. Engaging in physical activity optimises cardiovascular health and the cardiovascular response (reactivity and recovery) to stress on parameters such as HR (Bond et al., 2000; Moya-Albiol et al., 2001; O'Sullivan & Bell, 2001; Throne et al., 2000), blood pressure (Bond et al., 2000; Forcier et al., 2006; Georgiades et al., 2000) and HRV responses (Buchheit & Gindre, 2006; Hsu et al., 2015; Jurca et al., 2004; Kouidi et al., 2010; Pichot et al., 2005; Rennie et al., 2003; Teisala et al., 2014; Zou et al., 2018). Further, interventional research has indicated that high-intensity physical activity affects cardiovascular reactivity to psychosocial stressors, whereby attenuated reactivity responses were related to greater cognitive clarity and superior decision making (Throne et al., 2000).

Though there was contention regarding whether attenuated cardiovascular reactivity to a stressor is beneficial for the body, some researchers contend a reduced or blunted reactive response is more favourable (Carroll et al., 2009; Carroll et al., 2007; Rimmele et al., 2009; Tugade & Fredrickson, 2004). Limited (but growing) evidence indicates individuals that engage in physical activity are more show greater reactivity to stressors, accompanied by greater recovery (Jackson & Dishman, 2006), which may indicate a healthier cardiovascular stress response. Since researchers have provided limited conclusive evidence to suggest whether a reduced or attenuated reactivity response indicates an optimised stress response, the current dissertation is aligned with an attenuated response. Theoretically, as long as allostatic load is followed by a swift and efficient recovery then there is an optimised stress response process, and if the recovery becomes more efficient over time, this suggests positive physiological adaptations occurred. Bucheit and Gindre's (2006) correlational study showed that individuals with high training loads were more likely to exhibit a faster HR recovery post-exercise compared to individuals with low training loads, regardless of the cardiovascular fitness level. Optimised cardiovascular fitness, when training at a consistent, high frequency and intensity may produce optimised physiological adaptations that assist with greater HR recovery. A more efficient HR recovery indicates a more productive stress response and a return to homeostasis.

Cardiovascular adaptations present differently depending on gender, with HRV parameters (frequencies specifically) being more pronounced in male populations (Rennie et al., 2003). Gender differences for HRV may reflect differences in autonomic functioning, such as different parasympathetic activity, and this may account for why HRV is more distinct for males (Rossy & Thayer, 1998). Alternative presentations (varying frequencies) for cardiovascular activity do not indicate that physiological adaptation has not occurred or is hindered for the female population but may show significantly different results by comparison.

This was relevant given that the nursing workforce in Australia remains female dominant (Australian Institute of Health and Welfare; Nursing and Midwifery Board of Australia, 2020) and the population for the dissertation concerns nurses. Physiological adaptations may occur, though changes may be more attenuated amongst male nursing populations.

Overall, repeated bouts of high-intensity physical activity may lead to an optimised physiological stress response through the allostatic load process (Chrousos & Gold, 1992; Forcier et al., 2006; Huang et al., 2013; McEwen, 1998). If the body can physically adapt to allostatic loads of a stressor (e.g., physical activity), the stress response system becomes more efficient through positive adaptation, therefore a quicker allostatic response occurs, effectively returning the body to homeostasis and recovery from a stressor (Silverman & Deuster, 2014). Engaging in physical activity may encourage the individual to effectively manage activation of the stress response brought upon by a psychosocial or real-world stressor. This has led to the theory of the Cross-Stressor Adaptation Hypothesis (CSAH; Mark S Sothmann et al., 1996). The current dissertation will explore the role of physical activity in producing an optimised physiological response to a psychosocial stressor within nursing populations.

Cross-Stressor Adaptation Hypothesis

The Cross-Stressor Adaptation Hypothesis (CSAH) proposes that adaptations resulting from participation in physical activity leads to adaptations in response to physical activity, and similar adaptations to psychosocial stressors (Salmon, 2001; Mark S Sothmann et al., 1996). Theorists that advocate for the CSAH (Mark S Sothmann et al., 1996) suggest that engaging in physical activity initiates positive physiological adaptations, reducing the allostatic load on the body that occurs as a result of a stressor, thus affecting the overall stress response (Hamer et al., 2006). When adaptation occurs through intermittent exposure of a stressor, the body becomes physiologically more adept in coordinating, responding, and recovering from stress (Gerber et al., 2010; Throne et al., 2000). Forcier et al. (2006) conducted a meta-analysis investigating the effect of physical activity on physiological responses to psychosocial stressors and concluded that physical activity facilitates positive adaptation to the stress response by altering physiological responses (e.g., attenuated blood pressure) to psychosocial stressors, which may be the product of the CSAH.

Current research indicates that physiological and psychological adaptations of the stress response are linked through the CSAH theory, which is facilitated through physical activity producing a cross-stressor tolerance. Repeated physiological challenges produce adaptations that optimise the cardiovascular response towards stressors in general (Mark S Sothmann et al., 1996) creating cross-stressor tolerance. McCarty et al. (1992) suggested that exercise encourages cross-stressor tolerance via non-associative learning. Non-associative learning assumes underlying physiological adaptations occur when presented with repeatedly administered stressors, which may enhance an individual's reactivity and recovery towards stressors in general. As exercise elicits a similarly taxing state on the stress response compared to a state induced from a psychosocial stressor, physical activity could be used to train the body to respond at an optimum physiological level conducive to productive adaptation (McEwen, 1998; Silverman & Deuster, 2014). Short, repetitious exposure to a psychosocial stressor is similar to short, repetitious participation in exercise because they both positively contribute to successful allostasis and adaptations within the stress response (Deuster & Silverman, 2013; Mark S Sothmann et al., 1996). Theoretically, the more physically fit a person is, the more likely one can endure a more taxing fitness task; comparatively, greater exposure to stressors may increase one's ability to cope with the stressor and enhance psychobiological adaptation of the stress response (McEwen, 1998).

In order to test the CSAH theory, von Haaren et al. (2016) conducted a randomised, controlled trial on 61 students to a real life stressor (examination). Pre- (beginning of semester) and post- (two days before examination) testing included: maximal oxygen uptake via exercise testing, a 36hr heart monitor with chest belt used to obtain baseline HRV R-R intervals (root mean square of successive differences between normal heartbeats; RMSSD) and a perceived stress questionnaire. During the intervention, the experimental group participated in 20-weeks of aerobic training, with two sessions per week involving sprint training, with intensity based on their cardiac capacity (measured during pre-testing) with the training sessions gradually increasing in intensity over the intervention period. At post-intervention, experimental group participants indicated greater aerobic capacity and exhibited higher RMSSD during the examination period compared to the control group. Engaging in physical activity led to a swifter cardiovascular recovery to a real-life stressor, supporting the CSAH theory. Unfortunately, the study only measured physiological stress using momentary assessment, which may not have captured all sources of stress within the participants' lives. The current thesis will use multiple methods to assess stress in general, both psychologically and physiologically. Overall, the CSAH presents a theoretical link between physical activity and a superior cardiovascular response to psychosocial stressors. Based on this theory, researchers have proposed that physical activity, which induces psychobiological adaptations of the stress response, is indicative of stress resilience (Lukey & Tepe, 2008; McEwen & Gianaros, 2011).

Stress Resilience

Whilst resilience has become a 'buzzword' in recent years, its importance has never been more pertinent than in a time of a global pandemic. The concept of psychological resilience has witnessed increasing complexity in its conceptualisation (Southwick et al., 2014), resulting in expansive definitions applicable to various levels including genetics, molecular, individual, and community settings (Berkes & Ross, 2013). Different perspectives of what constitutes resilience, whether that be a trait, a process or an outcome has created a multi-dimensional concept, thus developing a broad range of definitions of this concept (Smith et al., 2010; Southwick et al., 2014; Windle, 2010). Researchers have contended that the singular term ‘resilience’ possesses restricted operational usefulness, suggesting that concentrating on distinct types of resilience may enhance scientific uniformity (Southwick et al., 2014). Modern researchers have proposed that the concept of resilience, especially concerning stress and the capacity to adapt to stressful experiences entails a dynamic and continuous process (Richardson, 2002). The evolution of resilience terminology has occurred organically, incorporating phrases like 'resilience to stress' and 'stress resilience' throughout the research. Stress resilience will be the primary focus of the dissertation. Whilst the construct of stress resilience is difficult to define (van der Werff et al., 2013), stress resilience is considered as the capability to revert to normal functioning after experiencing stress, emphasising recovery rather than desensitisation (Norris et al., 2009). Within the literature, researchers describe stress resilience as a resistance to stress (Brachman et al., 2016; O'Leary et al., 2014), a recovery from stress or bouncing back (Thogersen-Ntoumani et al., 2017), the process of adaptation to stress (Feder et al., 2009; Reul et al., 2015; van der Werff et al., 2013) and finally coping with stress (Li et al., 2017). Due to a lack of a clear definition, it is important to note that stress resilience is an active process of adaption when exposed the stressful stimuli or situations.

Researchers have proposed that stress resilience affects both the psychological and physiological stress processes that encourages positive and/or negative adaptations in the face of adversity, which can lead to optimised psychophysiological functioning or psychophysiological vulnerability (Cowen et al., 1990; O’Donohue et al., 2021; Obbarius et al., 2018; Richardson, 2002). An individual’s level of stress resilience is founded upon their adaptability to the current situation and based on what they have learned from previous experience (Fletcher & Sarkar, 2013). The ability to adequately react and recover from stress (albeit actual threat or exercise) and reduce allostatic load may promote innate stress resilience through exposure to adversity followed by attainment of positive adaptation (Dienstbier, 1989; Fletcher & Sarkar, 2013). O’Donohue et al. indicated that stress resilience is a process, which can therefore be considered changeable and with opportunity to be optimised. Thus, the current definition of stress resilience proposes that it can be developed through preparation, training (positive adaptation) and experience (adversity; van der Werff et al., 2013).

In order for an individual to exhibit stress resilience, the core constructs of adversity and positive adaptation must be present. Luthar and Cicchetti (2000) suggested that adversity encompasses difficult life consequences that impose highly taxing stress states and is associated with period/s of adjustment, whereas other researchers (Davis et al., 2009) suggest that adversity is the minor disturbances that occur in everyday life, rather than major tragedies. Rather than focusing on adversity being either a major event or small setback, adversity should be considered on a continuum that contributes to an individual's overall level of stress resilience. Positive adaptation refers to successfully overcoming salient tasks and building confidence in the face of constant stressors (Fletcher & Sarkar, 2013). Thus, positive adaptation may occur continuously to ongoing stressors, or stressors that are common (i.e., work stressors), rather than just major stressors (e.g., death of a loved one) contributing to adaptations of the stress response that promotes stress resilience.

As stress resilience is a relatively new concept, researchers have used terminology such as 'resilience to stress' and 'psychological resilience' synonymously, which makes conclusions about stress resilience research difficult to compare and quantify (Davydov et al., 2010; Hegberg & Tone, 2015; van der Werff et al., 2013). The following discussion will include information on the concepts of resilience that most closely resemble the current dissertation's definition of stress resilience, whilst the term 'resilience' refers to the broader understanding of the term.

Stress Resilience and Physical Activity

Whilst debated within the literature, researchers have suggested that physical activity may assist in the promotion of stress resilience (Deuster & Silverman, 2013; Levone et al., 2015). Animal research better illuminates the positive relationship between stress resilience and physical activity (Hare et al., 2014; Kingston et al., 2018; Kochi et al., 2017; Nasrallah et al., 2019; Pan-Vazquez et al., 2015; Sciolino et al., 2015; Tillage et al., 2020), yet there is limited research examining stress resilience and physical activity in humans.

Researchers (Bergh et al., 2015; Hegberg & Tone, 2015; Ho et al., 2015; Kim, 2015; Matzka et al., 2016; Neumann et al., 2022; Shakoor et al., 2015; Webb et al., 2013; Wells et al., 2012; Wilner, 2014) have tentatively demonstrated that engaging in physical activity can have a positive impact on the psychological facet of the stress response. Likewise, researchers (Arida & Teixeira-Machado, 2020; Collins et al., 2009; Epel et al., 1998; Forcier et al., 2006; Holmes, 2014; McEwen, 2016; Reul et al., 2015; Rimmele et al., 2009; Rimmele et al., 2007; Silverman & Deuster, 2014; Walker et al., 2017), have illustrated that physical activity may promote physiological adaptations of the stress response, indicating improvements in physiological resilience.

Despite its potentially critical role in stress resilience, physical activity remains an understudied yet impactful factor influencing both physiological and psychological aspects of stress. Physical activity activates stress response systems of the body, whereby the hypothalamic-adrenal axis, autonomic nervous system and immune system coordinates the release of cortisol and adrenaline in response to a stressor/physical activity demands, or 'fight or flight', and on cessation of a stressor or physical activity returns the body to homeostasis or normal functioning (Silverman & Deuster, 2014). After engaging in physical activity, biological mechanisms may confer resilience by enhancing neuroplasticity (Hegberg & Tone, 2015), promoting an anti-inflammatory state (Hamer, 2007), optimising neuroendocrine and physiological responses to stressors (Sothmann et al., 1991), and acting as a protective barrier against stress-related mental health disorders and chronic diseases (Blair et al., 2004).

The well-established understanding that aerobic exercise improves cardiovascular responses to stress is evident ((Huang et al., 2013), aligned with the CSAH. According to the CSAH, regular stress response activation through physical activity leads to a more adaptive reaction to stressors (M. S. Sothmann et al., 1996). Although there are conflicting findings, including a meta-analysis showing inconclusive evidence for reduced stress reactivity though quicker recovery in exercise training studies (Jackson & Dishman, 2006), yet a smaller meta-analyses found support when inspecting more physically fit individuals (Forcier et al., 2006). In support of this notion, (de Geus et al., 1993)'s researchers found that individuals with better aerobic fitness had higher cardiovascular reactivity during mental stress but lower resting heart rate and blood pressure, both during rest and recovery. Even though highly fit and untrained individuals initially showed similar cardiovascular and sympathetic nervous system responses to a stress task, those who were more fit displayed reduced responses upon repeated exposure to the stress task indicating their ability to adapt more swiftly to new stressors compared to their unfit counterparts. These findings are similar to the concept of stress tolerance (Dienstbier, 1989) where exposure to a stressor (including exercise) may induce the stress response (increased hypothalamic-adrenal axis response), and repeated exposure may lead to physiological adaptations representative of physiological stress resilience.

There is limited research on the different intensities of physical activity on stress resilience. Generally, it is known that as intensity of physical activity increases, so does the effect on the stress response (Luger et al., 1987), however there can be marked variability among individuals. For example, some individuals show an increase in cortisol secretion in response to moderate to high-intensity levels of physical activity, whereas other individuals display blunted effects for stress response reactivity (Deuster et al., 2000), and this may be due to studied populations including both fit and unfit individuals without categorisation within the study's themselves. As such, the following section of the document will provide an overview of cross-sectional, longitudinal, and interventional research related to physical activity that have induced changes in physiological and psychological parameters linked to stress resilience, including information of intensity level when specified.

Bergh et al. (2015) investigated stress resilience upon cardiovascular health and assessed the mediating role of physical activity. Based on 237,980 males, analysis highlighted higher-level physical fitness was positively associated with stress resilience and less vulnerable cardiovascular health. Physical fitness was objectively measured through an ergometer test, whilst stress resilience was assessed through interviews conducted by a psychologist and measured using a Likert scale. Whilst these studies may indicate a relationship between stress resilience and physical activity, it is difficult to compare when measurement scales differ so widely, therefore conclusions need to be drawn with caution, especially when the stress resilience definition is elusive. Both the present study and future research endeavours will aid in advancing our understanding of stress resilience by exploring various measures and identifying an appropriate tool to accurately assess the primary construct of stress resilience.

Neumann et al. (2022) longitudinal study explored the role of physical activity attributing to an enhanced stress resilience to modern life stressors on 431 healthy adults. Resilience was measured via a life events checklist to create a stress reactivity score; a high reactivity score denoted a low resilience score. The International Physical Activity Questionnaire (IPAQ), cardiovascular fitness assessment (VO_{2max} test) and a muscular assessment (hand grip and long jump) was used to derive a physical activity score. The assessment was conducted three times over a nine-month period. The results indicated that muscular strength and self-perceived fitness were positively associated with stress resilience, whilst cardiovascular fitness was not.

The contrasting findings suggest the importance of integrating objective and subjective measures to predict stress resilience. Further, Neumann and colleagues implied that a high reactivity to life stress is negatively connotated, this may give a false impression as to what constitutes an appropriate stress resilient response. The use of HRV as an objective measure of stress reactivity may firstly, be a more credible measure of stress reactivity, and secondly, a high reactivity towards a stressor may be viewed as an optimised response, if it is followed by an efficient recovery response, and thirdly, stress resilience research has a strong partnership with HRV measurements, thus future research would be advised to explore within these parameters until researchers have a tighter grasp on how to measure stress resilience.

Further longitudinal research on the relationship between physical activity and resilience was conducted during COVID-19. Philippe et al.'s (2021) study explored the influenced of physical activity and meditation on resilience (measured using the CD-RISC) during the first wave of the pandemic in Switzerland. Whilst the authors did not measure stress resilience, their definition of resilience within the study parallels the current dissertation definition of stress resilience. Whereby the authors propose resilience can be optimised by previous experience through adversity, which can negate or allow positive adaptation of homeostatic biopsychospiritual processes to occur. Philippe et al. dispensed two surveys, four to six weeks apart on individuals that were engaged in physical activities or mindfulness activities. In the first phase, 147 participants were engaged in physical activity (with two thirds being female population) and 48 participants involved in mindfulness training (again, population was female dominated). In the second phase, 70 participants were engaged in physical activity and 15 were involved in mindfulness. Results showed in the first phase that individuals that engaged in physical activity had higher resilience scores compared to individuals that engaged in mindfulness. However, in the second phase, both the physical activity and mindfulness groups showed equally high levels of resilience, indicating physical activity maintained a level of resilience, and mindfulness training improved resilience over time. Interestingly, regardless of activity, females indicated lower resilience scores compared to males.

Philippe and colleagues acknowledge that the beneficial effects of physical activity and mindfulness can improve over time with practice (Carmody & Baer, 2008; Deuster & Silverman, 2013). The difference in resilience scores between the physical activity and mindfulness group could be that those involved in physical activity may have done so prior to the COVID-19 pandemic and lockdowns, whereas those involved in mindfulness may have started their practice at the onset of COVID-19. Unfortunately, there was not control group (no activity) for comparison. An additional, obvious limitation of the study being physical activity was measured subjectively and therefore results could have been influenced by social desirability bias. Though given the swift onset of COVID-19, it is understandable that subjective measures were implemented, and not objective measures, as time was of the essence for the longitudinal study. Overall, the research highlights that both engaging in both physical activity and mindfulness may provide protective effects against adverse events and contribute to improved stress resilience.

Measures of Stress Resilience

Regarding various measurement scales assessing psychological indices of stress resilience, The Connor Davidson Resilience Scale (CD-RISC) and Brief Resilience Scale (BRS), belong to a category of resilience measures focusing on protective factors and stable traits associated with improved health outcomes during challenging circumstances (Windle et al., 2011). Theoretically, these instruments align with aspects of resilience, such as the ability to bounce back from stress and return to a normal level of functioning. However, it is crucial to acknowledge the ongoing debate about the conceptualisation of stress resilience. Measures like the CD-RISC and BRS primarily capture stable trait resilience, prompting discussions about their ability to reflect moment-to-moment changes in resilience to stress or stress resilience as a process (Sarkar & Fletcher, 2013; Smith et al., 2010). Despite their limitations, these questionnaires continue to be widely used due to their psychometric robustness and comprehensive coverage of key aspects associated with resilience. For studies exploring stress resilience, researchers face the challenge of selecting questionnaires that align with the evolving conceptualisation of stress resilience as a dynamic process. Whilst existing measures provide valuable insights into stable trait resilience, there is a trade-off between psychometric reliability and capturing the nuanced, process-based nature of stress resilience. However, due to the limitations of questionnaires capturing the specific stress resilience construct, many studies have implemented other self-report resilience-like data in an attempt to ascertain relationships between physical activity and stress resilience.

Whilst there is not gold standard for measuring physiological parameters of stress resilience (Windle et al., 2011), a combination of self-report measures and physiological measures, specifically cardiovascular parameters may provide insight as to whether stress resilience may be conferred via means of physical activity (Southwick et al., 2014). Specifically, physical activity's ability to promote adaptations of the autonomic system (sympathetic and parasympathetic systems), creating a more flexible cardiovascular response to stress.

Conclusion

Physical activity may facilitate a more resilient stress response (Boutcher et al., 2001; Kelley et al., 2001; Silverman & Deuster, 2014; Sothmann, 2006). Based on the CSAH theory, physiological adaptations of the stress response that occur when engaging in high-intensity physical activity may assist in the development of stress resilience. Within the current dissertation, high-intensity physical activity will assume the role of an adverse situation (or stressor), and through repeated administration, may induce positive adaptations of the stress response, such as improved cardiovascular responses to psychosocial stressors (Deuster &

Silverman, 2013; McEwen, 1998, 2016; Silverman & Deuster, 2014). Engaging in high-intensity physical activity may promote physiological and psychological adaptations (by reducing allostatic load) through exposure to highly taxing states (adversity), thus developing a resilience to stress (Silverman & Deuster, 2014). Physical activity may act as a stress building resource (Baker et al., 2012; Wells et al., 2012) that may increase stress resilience. Positive adaptations resemble adaptations that occur through physiological stress resilience pathways (Hegberg & Tone, 2015; Silverman & Deuster, 2014) and emulate the psychobiological characteristics of stress resilience.

Based on the review of the literature, the purpose of the present dissertation was to examine the link between physical activity and stress resilience and to explore the use of physical activity as a facilitator and protective factor in the promotion of stress resilience amongst nursing populations during COVID-19. The literature informed the method and design of Study 1, 2 and 3. Study 1 aimed to explore the psychological wellbeing of nurses in a large regional hospital in Victoria, Australia during the early years of the COVID-19 pandemic.

Chapter 3

Study 1

Burnout, Stress and Resilience of an Australian Regional Hospital during COVID-19: A Longitudinal Study

Chapter 3 is written in publication form. Study 1 provides information on the effects of COVID-19 on resilience, stress and burnout and offers a broader scope of understanding of the psychological wellbeing of the target population during a pandemic. The expansion of the sample to include all staff working at the hospital was fortuitous, as medical roles transformed during COVID-19 to all-encompassing roles in order to prevent the spread of infection and to care for patients with and without the COVID-19 specific virus.

Study 1 examined hospital staff that were working under a single united purpose; whereby previous professional roles became irrelevant, and all staff became frontiers in the fight against the pandemic. Therefore, the hospital population in its entirety, albeit nurses making up the majority of the sample, provided valuable insight on the stress-related health consequences of being on the front-line during a pandemic and whether an intervention to improve psychological wellbeing was needed. Consequently, Study 1 addressed dissertation aim (a): To monitor the relationship between stress resilience and stress and burnout amongst hospital staff, including nurses, during an 8-month period of the COVID-19 pandemic.

A factor analysis was conducted on the first data collection timepoint (August 2020) and was not included in the journal submission, however supplementary results can be found under Appendix A.

Armstrong *et al.*
BMC Health Services Research (2022) 22:1115
https://doi.org/10.1186/s12913-022-08409-0

BMC Health Services Research

RESEARCH

Open Access

Burnout, stress and resilience of an Australian regional hospital during COVID-19: a longitudinal study

Samantha J. Armstrong[1,2*], Joanne E. Porter[2], Jo-Ann Larkins[2] and Christopher Mesagno[1,2]

Abstract

Coronavirus disease 2019 (COVID-19) has placed huge strain on hospital staff around the world. The aim of the current longitudinal study was to investigate the resilience, stress and burnout of hospital staff located at a large, regional hospital in Victoria, Australia during the COVID-19 pandemic over time via cross-sectional surveys. The surveys were disseminated six times from August 2020 to March 2021, with the first three data collection points distributed during a state-wide lockdown. A total of 558 responses from various professional roles within the hospital over the survey period were included in the sample. Analysis of variance indicated significant main effects for the psychological variables across time, age, and workload. Hospital staff reported an increase in burnout levels throughout the eight-months. Significant negative relationships were observed between resilience and burnout, and between resilience and stress. A backward regression highlighted the contribution of resilience, stress, age, and nursing roles on burnout. Hierarchical regression analysis indicated that resilience contributed to the stress-burnout relationship. This study strengthens the evidence between resilience and burnout among healthcare workers and hospital staff and highlights the need for psychological wellbeing programs to be implemented for hospital staff impacted by a prolonged worldwide pandemic.

Keywords: Psychological resilience, Stress resilience, Nursing, Hospital, COVID-19

Background

The year 2020 saw the declaration of the worldwide pandemic Coronavirus disease 2019 (COVID-19). By December 2021, there were 276 million recorded COVID-19 cases; almost 5.3 million deaths recorded across 222 countries and territories since the pandemic began [1] with Australia reporting over 260,000 cases and over 2000 deaths [2]. Worldwide comparisons show Australia's COVID-19 morbidity and mortality rates are relatively low in the first year, however the pandemic placed significant strain on healthcare systems nationwide. Government mandated lockdowns (i.e., restrictions on personal active transport and socialising) to prevent the spread of COVID-19 were implemented in some Australian states. The first 'wave' of the COVID-19 pandemic in 2020 occurred in March/April and was accompanied by the first lockdown period in Victoria from the 31st of March to the 31st of May. The second 'wave' appeared in June to September and lockdown was from the 6th of August to the 9th of November and was considered to be the height of the pandemic for the year 2020 and by the end of the year, there were approximately 28,500 cases of COVID-19 [3]. The following year (2021) fluctuated with COVID-19 waves of infection, though these waves occurred outside the scope of this project. Researchers have shown that lockdowns result in poorer mental health for individuals worldwide [4–12] and also healthcare workers [13]. Australian populations have also

*Correspondence: Samantha.armstrong@vu.edu.au

[1] Victoria University, 70/104 Ballarat Rd, Footscray, VIC 3011, Australia
Full list of author information is available at the end of the article

Abstract

Coronavirus disease 2019 (COVID-19) has placed huge strain on hospital staff around the world. The aim of the current longitudinal study was to investigate the resilience, stress and burnout of hospital staff located at a large, regional hospital in Victoria, Australia during the COVID-19 pandemic over time via cross-sectional surveys. The surveys were disseminated six times from August 2020 to March 2021, with the first three data collection points distributed during a state-wide lockdown. A total of 558 responses from various professional roles within the hospital over the survey period were included in the sample. Analysis of variance indicated significant main effects for the psychological variables across time, age, and workload. Hospital staff reported an increase in burnout levels throughout the eight-months. Significant negative relationships were observed between resilience and burnout, and between resilience and stress. A backward regression highlighted the contribution of resilience, stress, age, and nursing roles on burnout. Hierarchical regression analysis indicated that resilience contributed to the stress-burnout relationship. This study strengthens the evidence between resilience and burnout amongst healthcare workers and hospital staff and highlights the need for psychological wellbeing programs to be implemented for hospital staff being impacted by a prolonged worldwide pandemic.

Introduction

The year 2020 saw the declaration of the worldwide pandemic Coronavirus disease 2019 (COVID-19). By December 2021, there were 276 million recorded COVID-19 cases; almost 5.3 million deaths recorded across 222 countries and territories since the pandemic began (World Health Organisation, 2021) with Australia reporting over 260,000 cases and over 2000 deaths (Australian Government Department of Health, 2021). Worldwide comparisons show Australia's COVID-19 morbidity and mortality rates are relatively low in the first year, however the pandemic placed significant strain on healthcare systems nationwide. Government-mandated lockdowns (i.e., restrictions on personal active transport and socialising) to prevent the spread of COVID-19 were implemented in some Australian states. The first 'wave' of the COVID-19 pandemic in 2020 was March/April and was accompanied by the first lockdown period in Victoria from 31st of March to 31st of May. The second 'wave' appeared in June to September and lockdown was from the 6th of August to the 9thth of November and was considered to be the height of the pandemic for the year 2020 and by the end of the year, there were approximately 28,500 cases of COVID-19 (Australian Government Department of Health, 2021). The following year (2021) fluctuated with COVID-19 waves of infection, thought these waves occurred outside the scope of this project. Researchers have shown that lockdowns result in poorer mental health for individuals worldwide (Baloch et al., 2021; Benke et al., 2020; Bruno et al., 2021; Lee, 2020; Patrick et al., 2020; Pierce et al., 2020; Twenge & Joiner, 2020; Voss et al., 2021; Zacher & Rudolph, 2021) and also healthcare workers (Saraswathi et al., 2020). Australian populations have also suffered psychologically from the enforced lockdowns (Biddle, 2020; Fisher et al., 2020; Li et al., 2021; Newby et al., 2020; Rossell et al., 2021; Sameer et al., 2020; Stanton et al., 2020; van Agteren et al., 2020), including those within the health care system such as nurses, physicians, and allied health staff (Smallwood, Karimi, et al., 2021).

Burnout and stress are familiar terminology and often used synonymously, especially during COVID-19. Stress is defined as any non-specific demand that can affect a person's physiological and psychological bodily processes, resulting in our ability or inability to cope and can lead to psychophysiological vulnerability or thriving (Chrousos & Kino, 2005). Burnout is the accumulation of stress over time and is characterised by feelings of mental and physical exhaustion, negative attitude, and feeling like workplace goals are unachievable (Arora et al., 2013; Bianchi et al., 2014; Embriaco et al., 2007). Before the COVID-19 pandemic, a review of Australian hospital (nursing) staff highlighted moderate to high levels of stress and burnout (Badu et al., 2020), particularly staff working in emergency departments (Potter, 2006; Shanafelt et al., 2012). Burnout is more prominent in younger populations within hospital settings (Holland et al., 2013). Staff in metropolitan hospitals were also more likely to suffer from symptoms of stress and burnout compared to regional hospitals (Clough et al., 2020; Opie et al., 2011).

During the COVID-19 pandemic, hospital staff, including physicians, nurses, administration, and human resources were under pressure to prepare and manage the personal and occupational consequences of COVID-19. Hospital staff, particularly frontline staff (i.e., working in the COVID-19 hospital wards) and emergency department personnel (Eyre et al., 2020; Gómez-Ochoa et al., 2021), were at a higher risk of contracting COVID-19 compared to the general population (Hunter et al., 2020; Keeley et al., 2020; Nguyen et al., 2020). In Australia, healthcare workers were subjected to three times the risk of infection compared to the general population during the first six months of the pandemic (Quigley et al., 2021). Victoria had the highest infection rates when compared to other states during the second wave of the virus (August 2020), which saw 3,500 healthcare worker infections (Buising et al., 2021; Victorian State Government Health and Human Services, 2020). In response to COVID-19, some hospitals within Australia became designated COVID-19 hospitals, with any person suspected of, or confirmed to have, COVID-19 transported to a COVID-19 hospital. As COVID-19 symptoms are similar to many other illnesses (e.g., influenza), the caseload for hospital staff significantly increased for potential COVID-19 infected persons. This contributed to the strain on the healthcare system, and in addition significantly impacted the health and wellbeing of hospital staff.

Multiple factors contributed to poor psychological wellbeing of hospital staff. For both clinical and non-clinical staff, COVID-19 forced changes to procedural and working conditions such as the introduction of retraining programs, which increased staff workload (Lee et al., 2020). Hospital staff contended with the fear of virus transmission to family members (Pappa et al., 2020; Shanafelt et al., 2020; Wallace et al., 2020) and a limited availability of personal protective equipment (Ripp et al., 2020). The closure of education centres, such as schools and pre-school learning centres, meant healthcare workers with children could no longer work their regular employment hours (Gavin et al., 2020). Similar to other countries, the COVID-19 changes adversely affected the mental health of hospital staff resulting in increased levels of stress, anxiety, depression and burnout (Bohlken et al., 2020; Lai et al., 2020; Pappa et al., 2020; Shen et al., 2020; Tiete et al., 2021; Yörük & Güler, 2021), particularly frontline hospital staff (Eyre et al., 2020; Lai et al., 2020) and nurses (Chegini et al., 2021; Kakemam et al., 2021; Lai et al., 2020). Medical/clinical healthcare personnel demonstrated poorer mental health outcomes in comparison to non-medical healthcare personnel during COVID-19 (García-Fernández et al., 2020; Zhang et al., 2020).

Poor mental health as a consequence of the pandemic prompted further government initiatives to promote positive psychological and physiological health and wellbeing within the workplace such as the Healthcare Worker Infection Prevention and Wellbeing Program implemented in November 2020. One of the aims of the health and wellbeing programs was to build personal resilience amongst the workforces. Whilst resilience has become a ‘buzzword’ in recent years, its importance has never been more pertinent in a time of a pandemic. Whilst the operational definition of stress resilience is contentious, researchers propose that stress resilience emphasises both the psychological and physiological stress processes that encourages positive and/or negative adaptations in the face of adversity, which can lead to optimised psychophysiological functioning or psychophysiological vulnerability (O'Donohue et al., 2021; Obbarius et al., 2018; Richardson, 2002). An individual's level of stress resilience is founded upon their adaptability to the current situation and based on what they have learned from previous experience (Fletcher & Sarkar, 2013). An individual's resilience, stress, and burnout levels are practically and theoretically dependent. Researchers found that hospital personnel with high levels of resilience are more able to manage and overcome workplace stress (Beaumont et al., 2016; Dobson et al., 2021; McGowan & Murray, 2016; Watson et al., 2008). Additionally, individuals that indicate lower levels of stress and moderate to high levels of resilience are less likely to suffer from burnout (Guo et al., 2018; Rushton et al., 2015). In addition, individuals that suffer from burnout are more likely to consider job resignation (Jackson et al., 2007) and hospital staff that present with greater resilience show better workplace longevity (Kim & Windsor, 2015; Turner, 2014). Researchers have suggested that older individuals are more resilient to occupational stress (Ang et al., 2018) and COVID-19-related stressors (Smallwood, Karimi, et al., 2021; Tiete et al., 2021). One possible reason for these results might be that greater workplace experience is linked to greater resilience (Gillespie & Allen-Craig, 2009). Thus, as age increases, exposure to workplace stressors increase, which may help develop psychological resilience. Peripherally, age appears to be an optimising factor for resilience. Furthermore, workload can influence stress and burnout; hospital staff that work long hours exhibit higher stress and their feelings of resilience are limited in comparison to staff working less hours (O'Dowd et al., 2018). Workload is positively correlated with burnout (Brown et al., 2018; Watson et al., 2019).

Whilst it is apparent that literature on stress, burnout and resilience amongst hospital-based health care workers (mainly physicians and nurses) is well researched, there appears to be limited investigation conducted on other workplace roles within these hospitals. Quantitative research that aims to contribute to the research lacuna and complement the existing data is warranted. Longitudinal research on COVID-19 is limited (Cabarkapa et al., 2020), with few time-series studies observing the effect of COVID-19 on the psychological wellbeing of healthcare workers (Cai et al., 2020; Lopez Steinmetz et al., 2022; Van Steenkiste et al., 2021), and minimal studies focused on Australian health workers. Therefore, collecting time-series data from hospital staff during a worldwide pandemic working from a regional, designated COVID-19 hospital over time can inform on the mental health of hospital staff for future pandemics. This paper will present findings of an eight-month stress resilience study within a large, regional hospital.

Method

Participants

Participants were recruited from a large, regional hospital in Victoria, Australia and included staff across multiple divisions, including people and culture, clinical services, high acuity services, medical services, mental health services, education and training and information and regional services. A total of 648 responses were submitted across the six surveys and after data cleaning yielded a cumulative total of 558 hospital staff submissions that gave usable responses in the surveys. Declining response rates occurred over the six data collection points, with the surveys yielding 137 (August), 141 (September), 95 (October), 68 (November), 54 (December) and 63 (February/March) completed responses. Given an estimated hospital workforce available at time of sampling of 2000 employees, a power analysis suggested sample sizes of between 66 (at 90% confidence with a 10% margin of error) to 323 (at 95% confidence with a 5 % margin of error). The number of responses for each sampling event are compatible with this range of estimates.

Overall, the sample across all surveys was female dominant (453), with 98 males, and seven participants that preferred to not say. Staff over the age of 40 made up 59.3% of the sample. For analysis, the participants that indicated their professional position within their workplace were split into three groups: nursing (emergency, midwifery), medical (physicians, anaesthetists), and other (all non-medical and non-nursing staff). Based on aggregated participant categories, data showed there were mostly nurses completing the surveys (243), although the other groups were relatively evenly spread (medical = 132, other = 152). The sample were mainly full-time hospital staff (407, 72.9%) with the remainder of participants working part-time or casually employed (27.1%). The clinical services and mental health departments were the most engaged throughout data collection (299 submissions). Professional longevity within the workforce showed staff that had six or more years' experience in the field (46.9%) had the greatest engagement across the surveys, compared to staff who had two to six years' experience (25.3%), and less than two years' experience (27.5%) within their profession.

Measures

Basic demographic information included information of participants such as gender, age, professional role within the workplace, workload, and workplace longevity at the current hospital.

Resilience

The Brief Resilience Scale (BRS; Smith et al., 2008) is a 6-item questionnaire designed to assess an individual's ability to recover from stressful circumstances (Rodriguez-Rey et al., 2016). Questions include *I tend to bounce back quickly after hard times,* and *I usually come through difficult times with little trouble*. Answers are provided on a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 *(strongly agree*). Since the total is divided by the total number of items, the combined scores range from 1 to 5, with scores from 1.00-2.99 indicating low resilience, 3.00-4.30 moderate resilience, and 4.31-5.00 high resilience (Smith et al., 2013). The scale displays acceptable internal consistency (α = .80 -.91; Smith et al., 2008) and has been used internationally with psychometric support (Rodriguez-Rey et al., 2016). Test-retest reliability is adequate with an intraclass correlation of .69 over 4 weeks with 48 participants and .62 for 12 weeks with 61 participants (Smith et al., 2008). Reliability analyses for the current sample were acceptable with a Cronbach's α score of .86. See Appendix B for questionnaire.

Stress

Stress was assessed with the PSS (Cohen et al., 1983), which is a 10-item questionnaire assessing an individual's level of stress within their current situation and feelings of control, including daily stressors to major events over the past month. An example question is, *In the last week, how often have you been upset because of something that happened unexpectedly?* Answers are provided on a five-point Likert scale ranging from 0 (*never*) to 4 *(very often*). Items four, five, seven and eight are reverse scored, and the 10 items are summed for a total score. Scores range from 0 to 40 with higher scores indicating higher stress. Scores from 0-13 indicating low stress, 14-26 moderate stress, and 27-40 high stress levels. The PSS has good psychometric properties showing strong test-retest reliability (r = .90 for a two-week interval; Almadi et al., 2012), good internal consistency (Sheldon et al., 1983), and adequate convergent and discriminant validity with other stress inventories (Mitchell et al., 2008). Reliability analyses for the current sample were acceptable with a Cronbach's alpha score of .87. See Appendix C for questionnaire.

Burnout

The 14-item Shirom-Melamed Burnout Measure (SMBM; Lerman et al., 1999), a shortened version of the Shirom-Melamed Burnout Questionnaire (Melamed et al., 1992), was used to assess symptoms of occupational burnout. Burnout is measured on three subscales: physical fatigue, emotional exhaustion, and cognitive weariness. Questions include *I am physically drained*, and *my thinking process is slow*. Minor changes were made to four questions on the SMBM. SMBM 4 wording was changed from 'dead' to 'flat' since consideration was given for emergency personnel managing hospital mortality. SMBM wording for questions 12, 13 and 14 was changed from "customers" to "patients" since using patients is better aligned with their workplace interactions. Items were measured on a Likert scale from 1 (*almost never*) to 7 (*almost always*). The SMBM scores were represented as the average of the 14 total items with higher scores reflecting high symptoms of burnout. The SMBM shows adequate internal consistency with majority of studies scoring $\alpha = >0.70$ (Glise et al., 2010; Johansson et al., 2005; Shirom & Melamed, 2006). Regarding construct validity, the SMBM is well correlated with other reliable burnout measures, such as the Maslach Burnout Inventory and the Shirom-Melamed Burnout Questionnaire (Melamed et al., 1992; Shirom & Melamed, 2006). Reliability analyses for the current sample were acceptable with a Cronbach's alpha score of .96. See Appendix D for questionnaire.

Procedure

Emails to participate in the study were facilitated by the Education and Research facility at the regional hospital. The email contained an electronic link to the online survey. The survey comprised of a plain language information statement and by agreeing to complete and submit the survey, the participant agreed to full consent. Once the participant's survey was submitted, the data was unable to be withdrawn since all data collected was anonymous. The survey took 10 minutes to complete. See Appendix E and F for ethical approval and plain language information statement.

The surveys were disseminated by the director of research at the regional hospital to all staff members each month from August 2020 to March 2021 (with the exception of January). Each survey was accompanied by one reminder email before the closure date. There were six data extraction points over an eight-month period. The participants that chose to participate in each of the monthly surveys were submitted anonymously, and therefore participants could not be 'tracked' throughout the six data collection time-points. The months of February and March were combined due to low response rates in those months. Each survey was open for one week, with the exception of the last survey, which was open for two weeks across February and March. The first, second and third surveys were disseminated during the second government-mandated lockdown period in Victoria, Australia. Subsequent surveys were conducted outside of the lockdown period. The beginning of 2021 suggested that the contagion level of COVID-19 within Australia was declining and therefore the study concluded survey distribution after the sixth survey (see Figure 1.1, Appendix G, for survey dissemination timeline).

Data Analysis

Descriptive analysis was conducted to understand demographical trends on the main variables. A one-way, between groups Analysis of Variance (ANOVA) was conducted to examine the changes in resilience, stress, and burnout over time (between groups variable). A multifactorial ANOVA was used to determine the impact of age, gender, workload, professional longevity, and work role within the hospital upon the dependent variables of resilience, stress, burnout and time. Spearman's correlation coefficients were calculated to examine the relationships between variables. Backward multiple regression was used to assess significant factors that contributed to burnout. Finally, a hierarchical multiple regression was conducted to observe the mediating role of resilience on burnout. All statistical analyses were computed using SPSS (Version 26.0). Alpha was set at $p < .05$ significance for all analyses and where applicable partial eta squared (partial η^2) was used to measure effect sizes.

Results

Data Cleaning

To manage missing data, a modified listwise deletion method was implemented, deleting completely random cases with more than one questionnaire incomplete, rather than one or more missing value. Whilst Miettinen (1985) suggested the latter method is the only approach to assure no bias has been introduced, Vach (1994) postulates the draconian rules of listwise deletion limit the scope of the data and the method should be more reasoned and fluid, hence resulting in a modified data cleaning method. Cases removed (by data time point) from the total sample of 648 included: 25 (August), 31 (September), 9 (October), 15 (November), 1 (December), and 7 (February/March). Mean replacement was not used for missing values as the missing item guidelines were exceeded on those occasions.

Analysis of Variance

Time

Table 1.1 (Appendix H) presents the means and standard deviations for resilience, stress, and burnout over the six time points. For each of the six surveys, resilience and burnout scores indicate moderate levels that are comparable to general population norms (Shirom & Melamed, 2006; Smith et al., 2008). Stress scores for the sample indicate moderate to high levels of stress (Cohen et al., 1983). Figure 1.2 shows the mean scores over time with corresponding lockdown periods, Appendix I.

The ANOVA showed a main effect for time and resilience, F (5, 505) = 4.09, $p < .001$, with a small Cohen (1988) effect size (partial $\eta^2 = .04$). Post-hoc comparisons using Tukey HSD indicated significant differences for August, indicating significantly lower resilience compared to all other data collection times. A significant main effect was evident for time and stress, F (5, 502) = 4.34, $p < .001$, partial $\eta^2 = .04$. The month of November saw the highest stress scores compared to other data collection months with Tukey HSD identifying November significantly different from all months except February/March. A significant main effect was also found for burnout and time, F (5, 509) = 2.50, p < .05, partial η^2 = .03. Hospital staff exhibited significantly higher scores for burnout for September compared to December data collection period, but no other significant differences were found.

Age

Table 1.2 (Appendix J) shows the means and standard deviations for age across resilience, stress and burnout parameters. The ANOVA showed a main effect for age and resilience, F (6, 505) = 3.12, p < .005, partial η2 =.04. Significant differences on resilience scores were found for the 26-30 age bracket in comparison to the 31-35 age bracket, the 36-50 age bracket, the 41-50 age bracket and the 61-70 age bracket, but not the 21-25 age bracket or 51-60 age bracket showing the lower age group exhibiting lower resilience scores. A main effect was found for age and stress, F (6, 502) = 3.12, p < .005, partial η2 =.04, whereby hospital staff in their low 30s (31-35) showed significantly higher scores on stress compared to staff aged 36 and above. A significant age main effect was found for age and burnout, F (6, 509) = 6.35, p < .001, partial η2 =.07, highlighting that staff aged 31-35 showed greater burnout scores compared to the 26-30 age bracket, the 36-40 age bracket, the 41-50 age bracket, the 51-60 age bracket and the 61-70 age bracket, although not the 21-25 age bracket.

Workload

The ANOVA showed a main effect for workload and resilience, F (5, 505) = 5.02, p < .001, partial η^2=.05, with higher resilience scores for hospital staff at a higher workload capacity. Whilst all staff indicated a moderate level of resilience across different workloads, a significant difference was evident between full-time staff (M = 3.65, SD = 0.71) and staff working .4 EFT (M =3.27, SD = 0.64), .6EFT (M = 3.33, SD = 0.72) and .8EFT (M = 3.53, SD = 0.66), respectively. No significant results were found for stress, F (5, 502) = .87, p > .05, or burnout, F (5, 490) = .95, p > .05, across workload.

Workplace position

The ANOVA indicated no main effects for workplace position for resilience, F (2, 505) = .04, $p > .05$, stress, F (2, 502) = 1.27, $p > .05$, or burnout, F (2, 490) = .30, $p > .05$.

Correlations

A Spearman's bivariate correlational analysis was conducted to explore the relationships between age, workload, resilience, stress, and burnout (Table 1.3; Appendix K). There was a small, significant positive relationship between age and resilience, *rho* = .14, n = 556, $p < .01$. Significant negative relationships were found for age and stress, *rho* = .14, n = 553, $p < .01$., and age and burnout, *rho* = .19, n = 539, $p < .01$, although both relationships indicated weak associations according to Cohen (1988). Significant, weak positive relationships were prevalent for workload and resilience, *rho* = .20, n = 556, $p < .01$. Moderate, negative associations were observed between resilience and stress, *rho* = -.30, n = 555, $p < .01$ and resilience and burnout, *rho* = -.36, n = 541, $p = .01$. The strongest, positive relationship was evident between stress and burnout, *rho* = .58, n = 541, $p < .01$.

Regressions

A backward multiple regression analysis was conducted to determine which variables significantly contributed to burnout (Table 1.4; Appendix L). The variables age, gender, workload, position within the hospital (medical and nursing dummy variables), stress, and resilience were entered into the model and explained 38.3% of the variance toward burnout, R^2 = 383, adjusted R^2 = .374, F (7, 485) = 42.95, $p < .001$. Step 2 removed gender from the model, and Step 3 removed medical position from the model with both steps explaining the same variance percentage as Step 1. Step 4 removed workload explaining 38.1% of the variance towards burnout, R^2 = 381, adjusted R^2 = .376, F (4, 488) = 75.01, $p < .001$. Unstandardised (B) and standardised (β) regression coefficients, and square semi-partial or 'part' correlations (sr^2) for each predictor are reported in Table 1.4.

Discussion

The purpose of this study was to observe the psychological wellbeing of Australian regional hospital staff across six data time points over eight months of the COVID-19 pandemic. The primary aims were to examine psychological parameters of hospital staff and to provide insight on the health-related consequences of COVID-19 over time related to resilience, stress and burnout and the contribution of resilience and stress on burnout.

Burnout's Crescendo

Based on the unprecedented chronic nature of COVID-19, it is not surprising that hospital staff burnout rates increased during this longitudinal study. Despite the low mortality rates in Australia compared to other countries, the psychological wellbeing of hospital staff is in peril. The increasing rates of burnout symptoms may be attributed to fear of contagion (Du et al., 2020), perception of workplace support (Smallwood, Pascoe, et al., 2021), or prolonged anticipation of a disaster in a constantly changing environment (Sotomayor-Castillo et al., 2021), suggesting a constant state of psychological alertness and fear of the high mortality rates amongst healthcare workers globally (Ehrlich et al., 2020). Since these attributions are largely speculative, more research is necessary to determine the most accurate cause.

Associations with COVID-19 Lockdown

It was presumed that high stress and burnout symptoms would parallel with the COVID-19 lockdown time periods. This was partially supported. Firstly, burnout scores were similar across the three and a half months of lockdown, with September (middle of lockdown) showing the highest scores for burnout of hospital staff. There were differences in burnout scores between September and December, providing a comparison between lockdown and non-lockdown periods. These results are similar to Smallwood et al.'s (2021) cross-sectional study on 9518 Australian healthcare workers that coincided with the second Melbourne lockdown (September to October) who found participants with high scores in resilience still experienced high burnout. Yet the current study's burnout scores were less severe. Smallwood et al. suggested that resilience may not assist in protecting individuals from psychological vulnerability during COVID-19, which corresponds with the current results that resilience had a small but worthy contribution towards burnout compared to stress. November burnout scores were similar to scores during lockdown period. Unexpectedly, the highest burnout scores were seen during the months of February/March, at the end of the data collection period. When this study was initially developed, the extended duration of this pandemic was not considered, and emphasis was on lockdown periods having the greatest impact on stress and burnout. In hindsight, the prolonged duration of the pandemic has meant healthcare workers are enduring chronic states of workplace burnout. Speculatively, that may be why burnout scores were high during the last survey. Smallwood et al. concluded that the moderate to severe burnout rates across healthcare workers in Australia are not surprising considering the prolonged duration of the pandemic coupled with the multiple, enforced lockdown restrictions. Secondly, for stress, significant differences were seen between lockdown and non-lockdown periods, with November (a non-lockdown period) indicating the highest, whilst August and October (during lockdown) showing lower stress scores. Two small cross-sectional studies conducted outside of lockdown in metropolitan Melbourne hospital staff during COVID-19 (from April to June 2020) indicated low to moderate levels of stress (Holton et al., 2021) and burnout (Dobson et al., 2021). Based on the timeline of the aforementioned studies, and the current study's data collection timeline, an accumulative effect upon stress levels for hospital staff and healthcare workers may have occurred; as the pandemic duration increases, stress increases potentially contributing to an increased rate of burnout.

Correlations

It was hypothesised that there would be a negative correlation between resilience and stress and resilience and burnout. As expected, there were significant moderate, negative associations between resilience and stress, and resilience and burnout. The observed relationships and strength between variables are consistent with previous findings on nursing populations (Ding et al., 2015; Guo et al., 2017; Rushton et al., 2015; Zhou et al., 2017). Furthermore, as age increased, resilience also increased across the time points, complementing past research (Ang et al., 2018; Smallwood, Karimi, et al., 2021; Tiete et al., 2021). Although, no significant findings were exhibited for age on stress and burnout for the current study. This is contradictory to past research which highlights a significantly higher prevalence of burnout for younger nursing staff under 30 years of age (Garrosa et al., 2008). A meta-analysis by Brewer and Shapard (2004) showed a strong positive correlation between age and burnout which was not evident in our current results.

Staff Workload During a Pandemic

It was presumed that hospital staff with a greater workload would indicate higher stress and burnout with corresponding lower resilience levels. Contradictorily, hospital staff with a higher workload showed significantly greater resilience than staff working part-time. This finding is inconsistent with other research (O'Dowd et al., 2018) that found long hours and shift work negatively impacted their personal resilience, although this research was not conducted during a pandemic. Further correlational analyses indicated age and level of experience were evenly distributed across workload classifications and therefore did not contribute valuable information as to why the hypothesis was not supported. A cross-sectional study on the experiences of Australian nurses during COVID-19 indicated that there was a decrease in work hours and clinical tasks during the height of COVID-19 (Halcomb et al., 2020). This may account for the current study results, whereby full-time staff may have experienced a reduced workload, indicating why greater resilience was apparent for full-time workers. Part-time staff are more likely to have young families (Jamieson et al., 2007) and the closure of schools led to children completing their schoolwork from home. Home schooling may have increased the workload for part-time hospital staff and may also suggest why their resilience levels were significantly lower than their full-time colleagues. In addition, individuals working part-time may have normally used their spare time to engage in leisure and social activities, which has been shown to improve psychological wellbeing (Deuster & Silverman, 2013; Öksüz et al., 2019), but since these activities were limited during lockdown, this may have affected part-time staff resilience levels.

Clinical Versus Non-Clinical

It was expected that clinical hospital staff (nurses and physicians) would indicate greater stress and burnout compared to other hospital staff members. Contrary to the hypothesis, there were no statistically significant differences amongst hospital staff for resilience, stress and burnout. A recent study on healthcare workers during COVID-19 found no differences between physician or nurses levels of stress (or depression) and in addition, no associations were identified between poor mental health outcomes and staff involved in treatment of COVID-19 patients in comparison to staff involved in other non-COVID-19-related hospital duties (Tiete et al., 2021). This is consistent with additional research on professional roles of hospital staff (clinical or other) during COVID-19 (Dobson et al., 2021). The current results suggest that regardless of position within the hospital, and despite direct involvement with COVID-19 patients, hospital staff as a group experience similar rates of stress and burnout. All staff may interact with a COVID-19 patient, have a fear of contagion, and the limitation of social support due to implemented lockdowns may contribute to stress and burnout, regardless of their professional role within the hospital workplace.

Limitations

Whilst the current findings present a snapshot of hospital staff during COVID-19, there are limitations that must be considered when drawing conclusions. Firstly, the study was cross-sectional therefore difficult to interpret the data changes ‘across time’ since we could not track within-subjects data throughout the six data collection points. Ideally, a repeated-measures within-subjects design across six time-points would have generated more informative data sets regarding interpretation over time. Though this was not possible with the current sample. Secondly, the declining, modest response rates throughout the data collection time points temper conclusions regarding the representativeness of the current findings. Lower response rates may have been due to survey fatigue. Lastly, due to the unexpected nature of a healthcare disaster, we were unable to obtain baseline data to compare before COVID-19 began, but instead, data could be collected post-COVID-19 to determine the resilience, stress, and burnout levels when the COVID-19 threat subsides (when vaccination rates increase).

Implications

The findings of this study present additional avenues for further research. Because stress resilience is a multidimensional construct, it is important to determine the core components of stress resilience and how it is then reflected and measured within the research. In addition, the current study assessed the contributory effect of resilience on burnout using time-point cross-sectional data, thus future research should consider a within-subjects longitudinal study as this will strengthen the assumptions of resilience contributing to psychological optimisation. Research during a pandemic should also obtain further personal participant information to better inform further contributory factors that may impact psychological wellbeing such as, family situation, financial distress, and any pre-existing mental health conditions. In addition, a more extensive examination of workplace roles during a pandemic (compared to regular professional roles before a pandemic) would provide further insight on the impact of a pandemic on individuals working within the hospitals. Within a pandemic situation, it would be useful to compare a designated COVID-19 hospital with a non-COVID-19, creating a potential control group for comparison.

Conclusion

Whilst mindful of the cross-sectional design of the current study, hospital staff showed a moderate level of burnout throughout the six data collection points of this study, though data shows symptoms of burnout are steadily increasing. Due to a lack of longitudinal research, it is unknown whether the psychological health of Australian healthcare workers is worsening, yet it can be assumed that the healthcare population will follow similar global trends presenting poor mental health outcomes as time progresses. Hospital staff showed high stress during the month of November, yet thankfully other data collection time-points showed moderate levels of stress. Additionally, the current data contends younger hospital staff are at a greater risk of burnout which is concerning as younger hospital staff in the current study showed lower resilience compared to older staff working a part-time load. Hospital staff would benefit from supportive interventions for the current pandemic and during future healthcare crises and strategies attempting to improve the psychological health of hospital staff could target younger populations. Resilience training programs may assist in the prevention of workplace burnout and psychosocial interventions may assist with halting the decline of burnout of hospital workers during COVID-19. Further longitudinal data during and post-COVID-19 is required to ascertain the effect of a pandemic on the psychological health of our sorely needed healthcare professionals and hospital staff.

Chapter 4

Study 2: Stress Resilience and Physical Activity amongst Australasian Emergency Nurses: A Cross-Sectional, Comparative Study Preceding and During the COVID-19 Pandemic

Study 1 (Chapter 3) explored the effect of COVID-19 on the resilience, stress, and burnout of hospital staff, including nurses and found that COVID-19 had a negative impact on psychological health over time, resulting in high stress and burnout and a decline in stress resilience. It became clear that a further understanding of the negative impact of COVID-19 on specific roles within the hospital was needed. Thus, Study 2 (Chapter 4) examined a specific nursing population, emergency department (ED) nurses, who are considered the frontline staff during the pandemic. Study 2 presents findings of a comparison study as a follow up of the 2018 cross-sectional study examining resilience, stress, burnout, distress, and physical activity among emergency department nurses across Australasia. Study 2 addressed dissertation aim (b): To explore the relationship between physical activity and stress resilience amongst emergency department nurses. Study 2 is written in publication form. T-tests were conducted on individual items of questionnaires but was not included in the journal submission, however supplementary results can be found under Appendix M.

Abstract

This cross-sectional study aimed to compare stress resilience, physical activity, and the psychological wellbeing of Australasian emergency department (ED) staff before and during the Coronaviris-2019 (COVID-19) pandemic. Two identical, cross-sectional online surveys were administered to ED nurses across Australasia measuring resilience, stress, burnout, distress, and physical activity in April 2018 (108 responses), and in February 2021 (86 responses). The 2018 data indicated main effects for age category, professional role, professional longevity, and qualification. Older ED nurses with greater workplace experience, higher professional roles, and higher education showed higher resilience and lower engagement in physical activity compared to younger ED nurses. Correlational analysis of 2018 data showed significant strong, positive relationships between distress and stress, a moderate, positive relationship between stress and burnout and a moderate, negative relationship between distress and resilience and between stress and resilience. Resilience was higher whilst stress and distress significantly lower in 2018 than in 2021. Few participants indicated engagement in physical activity for both survey collections, thus encouraging physical activity programs could enhance ED staff wellbeing, especially during pandemics.

Introduction

Emergency department (ED) nurses deal with highly-stressful and unpredictable situations on a daily basis, whilst providing medical treatment and care to those in need (Lim et al., 2010). Prior to COVID-19, ED nursing staff were more susceptible to high levels of stress and burnout compared to nursing staff working in other departments (Potter, 2006; Shanafelt et al., 2012). Within this study, stress is defined as a dynamic process sparked by the perception of an uncontrollable and unpredictable stressor (stimulus) that affects physiological and psychological aspects of the stress response (Goodnite, 2014; Koolhaas et al., 2011; Levine, 2005). Burnout is the accumulation of stress over time and is characterised by feelings of mental and physical exhaustion, negative attitude, and feeling like workplace goals are unachievable (Arora et al., 2013; Bianchi et al., 2014; Embriaco et al., 2007). High stress and burnout could be attributed to shift work, long working hours, high levels of responsibility, and high task orientation (Driscoll, 2008; Healy & Tyrrell, 2011; Ross-Adjie et al., 2007).

During COVID-19, ED nurses were the frontline personnel and their workload increased considerably (Lee et al., 2020), which was also accompanied by greater stress and burnout symptoms (Chor et al., 2020; Woo et al., 2020). ED nurses were at a higher risk of contracting the infection compared to the general population (Eyre et al., 2020; Gómez-Ochoa et al., 2021) and contributed to the fear of virus transmission to family members (Pappa et al., 2020; Shanafelt et al., 2020; Wallace et al., 2020). Two cross-sectional surveys conducted before (January, 2020), and during (April, 2020), COVID-19 on ED nurses in Belgium found the prevalence of burnout was high and was not statistically significant between data points (Butera et al., 2021). Whilst this signifies the poor mental health of ED nurses generally, Butera et al.'s (2021) surveys were conducted four and a half months apart and the debilitating consequences of COVID-19 had not reached fruition, and therefore burnout rates may present differently one year further into the pandemic and also in normal "non-COVID-19" times.

Overall, COVID-19 affected ED nurses mental health across the globe resulting in increased levels of stress, anxiety, depression, distress and burnout (Bohlken et al., 2020; Labrague, 2021; Lai et al., 2020; Pappa et al., 2020; Shen et al., 2020; Tiete et al., 2021; Yörük & Güler, 2021).

Stress resilience mediates the effects of stress, distress, and burnout (Brown et al., 2018; Harker et al., 2016; Yu et al., 2019; Zou et al., 2016). Stress resilience is the ability to successfully adapt to a stressful situation; the physiological and psychological stress processes encourage or hinder adaptations in response to adversity, which can lead to optimised or vulnerable psychophysiological functioning (O'Donohue et al., 2021; Obbarius et al., 2018; Richardson, 2002). An individual's level of stress resilience is founded upon their adaptability to a stressful situation and from learned past experience (Fletcher & Sarkar, 2013). Ultimately, stress resilience is considered as the capability to revert to normal functioning after experiencing stress, emphasising recovery rather than desensitisation (Norris et al., 2009). Researchers suggest that hospital personnel with higher resilience are likely to cope with workplace stress (Beaumont et al., 2016; McGowan & Murray, 2016) and have lower stress and burnout levels (Arrogante & Aparicio-Zaldivar, 2017; Guo et al., 2018; Hegney et al., 2015; Rushton et al., 2015). During COVID-19, cross-sectional research on ED nurses showed moderate to severe levels of burnout (Eyre et al., 2020; Lai et al., 2020), and resilience appeared to mediate symptoms of burnout (Jose et al., 2020).

Physical activity positively influences symptoms of stress and burnout (Bentley et al., 2013; Gerber, Lindwall, et al., 2013; Naczenski et al., 2017; Penedo & Dahn, 2005). A study (2013) examined the relationship between self-perceived stress, burnout and depression and cardiovascular fitness on a random sample (197 participants) of mainly healthcare workers. Gerber et al. (2013b) found that participants with higher levels of fitness presented with less burnout, depression and stress symptoms compared to participants of lower fitness. Since the beginning of COVID-19, Australian adults that indicated a decline in regular physical activity (as a consequence of government-mandated lockdowns that entailed closure to sporting clubs and travel restrictions) also had higher rates of depression, anxiety and stress in comparison to individuals that did not report changes to physical activity (Stanton et al., 2020). This is consistent with global research on physical activity and psychological health (Violant-Holz et al., 2020).

Researchers suggest that the increased workload during COVID-19 significantly reduced frontline healthcare workers’ ability to engage in regular physical activity (Magnavita et al., 2021), although healthcare workers (including nurses) that engaged in physical activity suggested it was a coping mechanism to combat the significant stress encountered in the workplace (Brown et al., 2021; Shechter et al., 2020). A small study in China on frontline medical staff during COVID-19 found individuals that exercised according to the national prescription of daily activity presented with lower stress levels (Wu & Wei, 2020). Whilst there is a plethora of research on the mediating effects of physical activity on stress and burnout (Gerber et al., 2020; Naczenski et al., 2017), there is limited research on the contributory effects of physical activity on stress and burnout within Australian ED nursing populations prior to and during a pandemic.

Stress is a pivotal factor for causality of burnout (Ayala & Christina, 1978) and high stress resilience levels and participation in physical activity have indicated a positive influence on stress and burnout symptoms (Naczenski et al., 2017; Rushton et al., 2015). Engaging in physical activity can induce physiological and psychological adaptations upon the stress response through exposure to highly taxing states (adversity) thus developing a resilience to stress (Deuster & Silverman, 2013; Luger et al., 1988; McEwen, 1998, 2016; Silverman & Deuster, 2014). Therefore, based on the relationship between stress resilience and physical activity (Epel et al., 1998; Hegberg & Tone, 2015; Silverman & Deuster, 2014), it is proposed that physical activity should be strongly, positively correlated with resilience, and in turn, negatively related to stress and burnout.

It is hypothesised that there will be: (a) a positive relationship between psychological health and the onset of COVID-19, compared to before the pandemic (b) a negative relationship between resilience and stress, burnout, and distress both before and during COVID-19, (c) a negative correlation between engagement in physical activity and stress, burnout and distress of ED nurses, and lastly, (d) a positive relationship between physical activity and stress resilience. As the sample focuses on an ED nursing population, it is imperative to consider the hypotheses in relation to specific demographic differences (e.g., age, experience) as the literature indicates these factors play a significant role in the psychological wellbeing of these populations.

Method

Participants

All members of the College of Emergency Nurses Australasia (CENA) were invited to participate in the surveys (see Participants Characteristics section in the Results for more detail about participants, see page 70). The first survey was administered in April 2018 and elicited 196 responses. After data cleaning (containing missing data), 108 responses were included in the analysis. The second survey, conducted in February 2021 received 108 surveys, and after data cleaning, 86 responses were included in the analysis. To manage missing data, a modified listwise deletion method was implemented, deleting completely random cases with more than one questionnaire incomplete, rather than one or more missing value. Mean replacement was used for missing values.

Measures

The survey included 14 demographic items on professional role within the workplace, qualification level and workplace longevity.

Resilience

The Brief Resilience Scale (BRS; Smith et al., 2008) is a 6-item questionnaire designed to measure an individual's ability to recover from stressful circumstances (Rodriguez-Rey et al., 2016). Responses are recorded on a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 *(strongly agree*). Total scores are calculated by dividing the sum of responses by the number of items, yielding scores between one and five. Scores from 1.00-2.99 indicating low resilience, 3.00-4.30 moderate resilience, and 4.31-5.00 high resilience (Smith et al., 2013). The scale demonstrates acceptable internal consistency (α = .80 -.91) and has been used internationally with psychometric support (Rodriguez-Rey et al., 2016). Test-retest reliability was evaluated over four weeks with 48 participants (intraclass correlation of .69) and over 12 weeks with 61 participants (intraclass correlation of .62; (Smith et al., 2008). In the current sample, reliability analyses were acceptable with a Cronbach's α score of .87.

Stress

Stress was assessed with the Perceived Stress Scale (PSS; Cohen et al., 1983), which is a 10-item questionnaire assessing an individual's current stress levels and feelings of control, encompassing daily stressors to major events over the past month. Responses are recorded on a five-point Likert scale ranging from 0 (*never*) to 4 *(very often*). Items four, five, seven and eight are reverse scored, and the 10 items are summed for a total score. Scores range from 0 to 40 with higher scores indicating higher stress. Interpretation of scores categorise individuals into low stress (0-13), moderate stress (14-26), and high stress (27-40) levels. The PSS demonstrates robust psychometric properties, including strong test-retest reliability (r = .90 for a two-week interval; Almadi et al., 2012), good internal consistency (Sheldon et al., 1983), and adequate convergent and discriminant validity with other stress inventories (Mitchell et al., 2008). In the current study, reliability analyses were acceptable with a Cronbach's alpha score of .85.

Burnout

The study used the 14-item Shirom-Melamed Burnout Measure (SMBM; Lerman et al., 1999), to assess occupational burnout. The SMBM measures burnout on three subscales: physical fatigue, emotional exhaustion, and cognitive weariness. Minor modifications were made to four questions to better align with workplace context. Items were measured on a Likert scale from 1 (*almost never*) to 7 (*almost always*), with higher scores reflecting high symptoms of burnout. The SMBM has demonstrated adequate internal consistency in various studies, α = >0.70 (Glise et al., 2010; Johansson et al., 2005; Lerman et al., 1999; Shirom & Melamed, 2006). Regarding construct validity, the SMBM is well correlated with other reliable burnout measures, such as the Maslach Burnout Inventory and the Shirom-Melamed Burnout Questionnaire (Melamed et al., 1992; Shirom & Melamed, 2006). Reliability analyses for the current sample were excellent with a Cronbach's alpha score of .95.

Distress

The Kessler Psychological Distress Scale (K10; Kessler et al., 2002) was utilised to assess the psychological distress and stability of the sample. The K10 is a self-report inventory that screens for psychological symptoms of distress over the past month. Scores range from 10 to 50 with higher scores indicating greater psychological distress. Interpretation of scores categorises individuals into low distress (10-15), moderate distress (16-21), high distress (22-29), and very high distress (30-50) for Australian samples (Andrews & Slade, 2001). The K10 exhibits good psychometric properties, showing worthy internal consistency for both dimensions (α = .89; Stallman, 2010). The K10 is comparative to other mental health instruments such as the General Health Questionnaire and the Short-Form-12 (Andrews & Slade, 2001). The values of the kappa scores range from 0.42 to 0.74 indicating a moderately reliability instrument (Dal Grande et al., 2002).

Reliability analyses for the current sample of 2018 scores were excellent with a Cronbach's alpha score of .90.

Physical Activity

The Recent Physical Activity Questionnaire (RPAQ; Besson et al., 2010) was included to assess the intensity, frequency, and duration of activity domains: activity at home, occupation, transport, and leisure-time engaged in over the previous month. The RPAQ comprised of 9-items, and yielded sub-variables including sedentary hours per day, light hours per day (light intensity physical activity engagement per day), moderate hours per day (moderate intensity physical activity engagement per day), vigorous hours per day (vigorous intensity physical activity engagement per day), total activity per day (total physical activity energy expenditure per day), total awake METS (metabolic equivalents; total METS per day during waking hours) and total METS (total METS per day including sleeping hours). The RPAQ tool has been validated against objectively and subjectively measured variables across 10 European countries and is a psychometrically superior physical activity questionnaire when delivered electronically compared to other physical activity questionnaires (Golubic et al., 2014). Reliability and validity tests show moderate-to-high reliability, with an intra-class correlation coefficient of 0.76 (p <0.001) for physical activity energy expenditure, and good validity for grading participants according to levels of participating in high-intensity physical activity (Besson et al., 2010).

Procedure

Ethical clearance was approved by the University Human Research Ethics Committee (2018: A17-114 and 2021: A20-126) and distribution approval was granted by CENA (CENA/RC/2020/10). Participant recruitment for both surveys (2018 and 2021) was facilitated by the CENA research committee through email invitations and social media posts on CENA's Facebook and Twitter pages. Regular Facebook/Twitter posts were uploaded at one-week intervals during the data collection period (4-weeks). The survey included a plain language information statement and participants provided informed consent by completing and submitting the survey. The survey completion time was approximately 15 to 20 minutes.

Data analysis

Typically, an apriori analysis to inform statistical power would be implemented, however, given the circumstances, logistically and practically reaching the appropriate numbers for statistically robust results was not likely in the current study, therefore interpretation of results should be viewed with caution. Post-hoc power analysis was undertaken to provide a measure of informativeness of effect sizes achieved for this study. G*Power (Faul et al., 2007) was used to calculate sensitivity analyses producing ranges of required effect sizes given powers of 0.8 and 0.95, alpha of 0.05 and the sample size used. Effect sizes were calculated for bivariate correlations, t-tests and one-way ANOVAs and the results are summarised in Table 2.1 below. Detectable effect sizes reflected the recommended minimum effect for practical significance in social science of 0.41 for group differences and were between the minimum practical effect of 0.2 and moderate effect of 0.5 for correlations (Ferguson, 2016). Effect sizes below these thresholds should be treated with caution.

Table 2.1

*G*Power Analysis for Estimated Effect Sizes*

Type of Statistical Test (Effect Size Estimate)	Estimated Effect Size (Power = 0.8)	Estimated Effect Size (Power = 0.95)	Recommended Minimum Effect Size for Practical Significance (RMPE)
T-test: Difference Between Two Independent Means (Cohen's d)	0.36	0.48	0.41
ANOVA: Fixed Effects- One Way (Partial Eta Squared)	0.35	0.43	0.41
Bivariate Correlation	0.23	0.30	0.20

Note. RMPE - Recommended Minimum Effect Size Representing a "Practically" Significant Effect for Social Science Data.

Analysis included descriptive and inferential statistics. The 2018 data was used as baseline data and a one-way, between-groups Analysis of Variance (ANOVA) was conducted to examine the differences in resilience, stress, burnout, distress and physical activity on age group, professional workplace role, workplace duration, workload and qualification. Pearson correlation coefficients were also calculated. Combining 2018 and 2021 data sets, an ANOVA was conducted to examine the changes in resilience, stress, burnout, distress, and physical activity variables over time (between-groups variable). Spearman correlational coefficients were calculated to examine the relationships between variables over time. Alpha was set at $p < .05$ significance for analyses and where applicable partial eta squared (partial η^2) was used to measure effect sizes.

Results

Participant Characteristics

The sample across the two surveys was female dominant (164) with 93 females and 15 males in the 2018 survey and 71 females and 14 males in the 2021 survey. For qualification, groups were equivalent between 2018 and 2021. Professional longevity within the nursing workforce showed 30.93% of the overall sample had 11-15 years' experience in the field, though this percentage was higher in the 2018 survey. Further, 36.08% of nurses indicated one to five years' experience and this was similar between surveys. There were more participants in the 2021 survey (8.25%) with 16 years or more experience compared to the 2018 survey (3.09%).

Baseline data- 2018

Before conducting the one-way between groups ANOVA for each variable, the data was examined to ensure underlying assumptions were met. Shapiro-Wilk statistics indicated that the assumption of normality was supported (< .05) for each parameter. Levene's test was non-significant across all variables, resilience F (5, 98) = 1.77, p = .127, stress F (5, 98) = .63, p = .68, burnout F (5, 98) = 1.71, p = .14, distress F (5, 98) = 2.80, p = .06, sedentary hours per day F (5, 98) = 2.37, p = .07, light hours per day F (5, 98) = 3.17, p = .11, moderate hours per day F (5, 98) = 4.75, p = .18, vigorous hours per day F (5, 98) = 4.75, p = .06, total activity per day F (5, 98) = 2.87, p = .08, total awake METS per day F (5, 98) = .33, p = .90, and total METS per day F (5, 98) = .33, p = .89, thus the assumption of homogeneity was not violated.

Age

The effect of the age category was statistically significant for resilience, F (5, 98) = 2.35, p < .046, d = 0.35. Tukey's HSD indicated that the difference was between the 26-30 and the 51-60 year old age groups (p = .076) but the effect size was insignificant (partial η^2 = 0.107

with 95% confidence interval [0.000, 0.191]). There were no significant differences for age on stress, burnout, distress, or physical activity ($p > .05$).

Professional Role

The effect of professional role was statistically significant for resilience, F (5, 96) = 5.17, $p < .001$, $d = 0.51$. Tukey's HSD post hoc analysis revealed that registered nurses (M = 3.21, SD = .88) had significantly lower resilience scores than emergency nurse trainers (M = 3.84, SD = .65), associate nurse unit managers (M = 4.40, SD = .45) and nurse practitioners (M = 4.31, SD = .71). No significant differences occurred for the other scales ($p > .05$).

Professional Longevity

Professional longevity was statistically significant for resilience, F (3, 104) = 9.03, $p <$ .001, $d = 0.51$. Tukey's HSD revealed that participants that had worked in the field for one to five years (M = 3.12, SD = .96) had significantly lower resilience than participants that had worked in the field for 11-15 years (M = 4.06, SD = .75). Scores were statistically significant for the physical activity parameter- vigorous hours per day, F (3, 104) = 3.01, $p = .03$, $d = 0.29$ indicating that participants with one to five years' experience (M = .26, SD = .65) exhibited greater engagement in vigorous physical activity compared to participants with 11 to 15 years' experience (M = .06, SD = .11). Scores were also significant for total METS, F (3, 104) = 4.13, $p = .008$, $d = 0.10$, whereby the significant differences existed between six to ten years' experience (M = 35.89, SD = 6.97), 11 to 15 years (M = 31.98, SD = 4.46) and 21 or more years (M = 29.51, SD = 4.06); more workplace experience showed greater total METS expenditure. There were no other significant differences ($p > .05$).

Education

The ANOVA was statistically significant for education and resilience, F (3, 106) = 3.88, $p = .011$, $d = 0.33$. There were differences between a bachelor's degree (M = 3.36, SD =

1.00) and a master's qualification (*M* = 4.09, *SD* = .70), exhibiting a higher education presented with greater resilience scores. The *F* tests were not significant for the other scales ($p > .05$).

Correlations – 2018 Data

There was a significant strong, positive relationship between distress and stress, and a moderate, positive relationship between stress and burnout (see Table 2.2). There were significant moderate, negative relationships between distress and resilience, and stress and resilience. Significant relationships were identified amongst RPAQ variables.

Table 2.2

Pearson correlation coefficients for Resilience, Stress, Burnout, Distress and Physical Activity for 2018 data

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Resilience	-	-.47**	-.27**	-.48**	-.01	.03	-.06	.06	-.09	-.01	-.01
2. Stress		-	.45**	.78**	.17*	-.00	.06	-.08	.15	.04	.05
3. Burnout			-	.16*	.19**	.05	-.17*	.05	.09	-.05	-.05
4. Distress				-	.14	-.02	.15*	-.03	.18*	.14	.15*
5. RPAQ - Sed					-	.04	-.15*	-.05	.79**	.03	.03
6. RPAQ - Light						-	-.56**	-.17*	.21**	-.08	-.08
7. RPAQ - Mod							-	.04	.19**	.52**	.53**

8. RPAQ - Vig	-	.13	.70**	.69**
9. RPAQ - Tot Act		-	.49**	.48**
10. RPAQ - Tot Aw			-	1.00**
11. RPAQ - METS				-

* *p* < .05 *(two-tailed);* ** *p* < .01 *(two-tailed).*

RPAQ - Sed = RPAQ Sedentary Hrs Per Day, RPAQ - Light = RPAQ Light Hrs Per Day, RPAQ - Mod = RPAQ Moderate Hrs Per Day, RPAQ - Vig = RPAQ Vigorous Hrs Per Day, RPAQ - Tot Act = RPAQ Total Activity Per Day, RPAQ - Tot Aw = RPAQ Total Awake METS, RPAQ - METS = RPAQ Total METS.

Combined 2021 (COVID-19) and 2018 Data

Time. Table 2.3 presents the means and standard deviations for resilience, stress, burnout, distress, and physical activity over the two data collection points.

Table 2.3

Means and Standard Deviations for Resilience, Stress, Burnout, Distress and Physical Activity over Time

	2018 (n = 108)		2021 (COVID-19; n = 86)	
Scales	*M*	*SD*	*M*	*SD*
Resilience *	3.66	0.88	2.98	0.31
Stress *	15.26	6.04	30.58	3.73
Burnout	3.25	1.02	3.81	1.19
Distress *	17.41	5.44	39.32	6.73
RPAQ				
Sedentary Hrs Per Day *	4.67	2.65	5.53	2.63
Lights Hrs Per Day	2.13	1.71	2.08	1.75
Moderate Hrs Per Day *	1.72	1.89	2.15	1.87
Vigorous Hrs Per Day	0.24	0.71	0.70	0.43
Total Activity Per Day *	8.81	3.24	9.92	2.61
Total Awake METS *	26.13	5.76	27.27	5.07
Total METS *	33.26	5.51	34.44	5.01

* $p < .05$

Before conducting the ANOVA on the combined 2018 and 2021 data sets, Shapiro-Wilk, Levene’s test statistics and plot inspection showed normal distributions for both data sets. ANOVA’s were used to compare the two cross-sectional surveys and calculate effect sizes for any significant effects.

The ANOVA showed a main effect for resilience (F [1, 153] = 21.04, $p < .001$), with a moderate to large Cohen (1988) effect size (partial η^2 = .67) indicating resilience scores were lower in 2021 than in 2018. A significant main effect was found for stress (F [1, 153] = 194.96, $p < .001$, partial η^2 = .56), with 2021 stress scores significantly higher compared to 2018. A significant main effect was also found for distress (F [1, 153] = 270.45, $p < .001$, partial η^2 = .64), with participants exhibiting higher levels of distress in 2021 compared to 2018.

A significant main effect for sedentary hours per day was found (F [1, 153] = 4.92, $p < .03$, partial η^2 = .03). Data shows participants led more sedentary lifestyles in 2021 compared to 2018. A main effect was found for moderate hours of physical activity per day (F [1, 153] = 4.38, $p < .04$, partial η^2 = .03), whereby participants engaged in moderate levels of physical activity more so in 2021 than 2018. A main effect was found for total activity per day (F [1, 153] = 8.23, $p < .005$, partial η^2 = .05), highlighting that participants engaged in greater overall activity per day in 2021 than 2018. There was a main effect for total awake METS (F [1, 153] = 3.80, $p < .05$, partial η^2 = .02), showing participant METS expenditure during waking hours was higher in 2021 compared to 2018. Finally, a main effect was also found for total MET expenditure over 24 hours (F [1, 153] = 4.62, $p < .03$, partial η^2 = .03) revealing total MET expenditure was higher in 2021 by comparison. The ANOVA indicated no main effects for burnout, light hours of physical activity per day and vigorous hours of physical activity per day (all *p's* > .05).

Correlations

Time. There was a significant strong, positive relationship between stress and time (rho = .83, n = 194, $p < .001$) and distress and time (rho = .83, n = 194, $p < .001$). This highlights an increase in stress and distress levels over time. There was a significant moderate, negative relationship between resilience and time (rho = -.46, n = 194, $p < .001$).

Resilience. There was a significant strong, negative relationship between distress and resilience (rho = -.51, $n = 194$, $p < .001$). There was a significant moderate, negative relationship between resilience and stress (rho = -.46, $n = 194$, $p < .001$). There was a significant moderate, negative relationship between resilience and time, (rho = -.46, $n = 194$, $p < .001$).

Stress. A significant strong positive relationship was found for distress and stress (rho = .76, $n = 194$, $p < .001$). A significant strong positive relationship was found for stress and time (rho = .83, $n = 194$, $p < .001$). A significant moderate, positive relationship was found for burnout and stress (rho = .45, $n = 194$, $p < .001$).

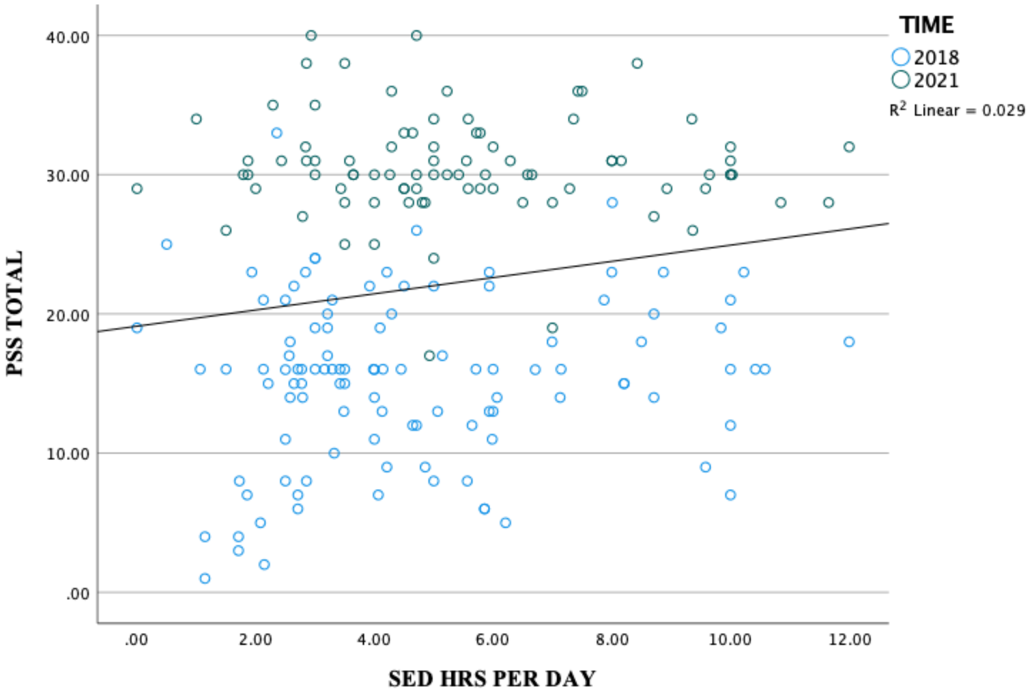
Distress. There was a significant strong, positive relationship between distress and time (rho = .83, $n = 194$, $p < .001$).

Scatterplots

Figure 2.1 shows no obvious relationship between stress and the number of sedentary hours per day. The scatterplot highlights that stress scores were higher in 2021 compared to 2018, yet sedentary hours do not appear to influence stress scores overall. Figure 2.2 highlights no correlation between stress and engaging in vigorous physical activity per day. Though, a very small group of participants participated at a vigorous level of physical activity intensity and may account for the weak correlation. Similar to Figure 2.1, Figure 2.2 shows higher stress scores in 2021 compared to 2018 and similar patterns were observed for each of the four physical activity scale components.

Figure 2.1

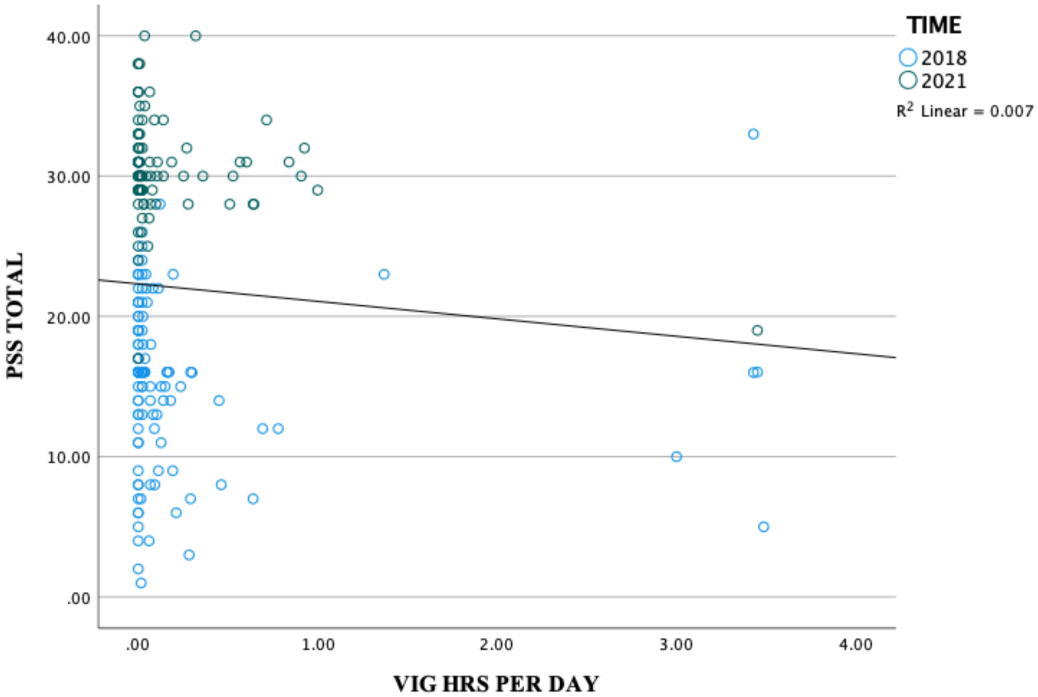
RPAQ variable- sedentary hours per day and stress scores over time



Note. Sed hrs per day = sedentary hours per day, PSS Total = Perceived Stress Scale total.

Figure 2.2

RPAQ variable- vigorous hours of physical activity per day and stress scores over time



Note. Vig hrs per day = vigorous hours per day, PSS Total = Perceived Stress Scale total.

Discussion

This study aimed to compare the psychological wellbeing of two cross-sectional Australasian emergency nursing cohorts prior to and during the COVID-19 pandemic. Additionally, the study aimed to ascertain whether a strong, positive relationship exists between physical activity and resilience. The study revealed that the COVID-19 pandemic significantly impacted the psychological well-being of ED nurses, with lower resilience and higher stress, distress, and sedentary behaviour hours during the pandemic than prior to the pandemic. Burnout levels showed moderate consistency between 2018 and 2021. Contrary to expectations, stress resilience did not positively influence health-related outcomes. Physical activity did not act as a protective factor for psychological health, and limited relationships were observed between physical activity parameters and well-being. Pandemic-induced factors, such as lockdowns and increased workloads, likely contributed to higher stress and distress, lower resilience, and increased sedentary behaviours during COVID-19. The study highlighted the complex interplay of factors affecting the well-being of ED nurses in the pandemic.

COVID-19: The Overarching Effect

Comparison of the 2018 and 2021 data revealed that COVID-19 had a significant negative impact on the psychological wellbeing of ED nurses. Resilience levels were significantly lower, whilst stress, distress, and sedentary hours per day were higher, during COVID-19 compared to before COVID-19. This is consistent with studies that found COVID-19 negatively impacted stress, burnout, and engagement in regular physical activity amongst nursing populations (Lai et al., 2020; Liu et al., 2020; Stanton et al., 2021; Woo et al., 2020). A cross-sectional study on Australian nurses during COVID-19 showed nurses had physiological and psychological health concerns as a result of the pandemic (Halcomb et al., 2020). The study's (Halcomb et al., 2020) results are not surprising given that research on nurses from prior pandemics have indicated heightened anxiety levels derived from the risks of participation in acute care, such as personal safety (Kang et al., 2018; Kohl et al., 2012; Lam & Hung, 2013).

Contradictorily, the results indicated a 'moderate' level of burnout both during 2018 and 2021 and may suggest that burnout levels were similar during the pandemic. In a cross-sectional study comparing ED nurses' burnout before and during COVID-19, minimal changes in symptom severity were observed (Butera et al., 2021). However, the study (2021) reported elevated burnout levels across both time-points, contradicting the present study's findings and differing from other pre-pandemic (Potter, 2006; Shanafelt et al., 2012) and pandemic-related (Cheung et al., 2021; Tiete et al., 2021) findings. Potentially, the ED's unpredictable environment mirrored the pandemic's high stress, fast-paced nature, which may explain why burnout levels were similar before and during COVID-19 (Adriaenssens et al., 2015). Given the cross-sectional design of the current study, limited robust conclusions can be derived because the sample was likely different at each time point. Comparing frontline COVID-19 nurses, possibly akin to ED nurses, with non-COVID-19 nurses revealed lower burnout severity (Wu & Wei, 2020). Aligning with the current study's findings, this may indicate frontline nurses felt greater sense of control within high stress settings, underscoring the need for precise investigations into ED nurse' burnout during and beyond pandemics.

Despite the unprecedented challenges posed by the COVID-19 pandemic, burnout levels among ED nurses appeared to remain consistent with pre-pandemic levels. The nature of the ED environment, characterised by its inherent unpredictability and high-paced demands, has long been acknowledged as a stress-inducing factor (Adriaenssens et al., 2015). However, the pandemic did not significantly exacerbate this stress for emergency nurses as suggested by the burnout measure, as they may have been already accustomed to a high-stress baseline. Their adaptability, crisis response training, and a strong sense of duty might have played crucial roles in sustaining their psychological stress resilience (Alameddine et al., 2021) and may have prevented the exacerbation of burnout symptoms. Additionally, there may have been robust support systems within the workplace for ED nurses specifically, effective communication from leadership within their current hospital, and established coping mechanisms that contributed to the nurses' ability to navigate the challenges posed by the pandemic. This argument suggests, although somewhat speculative, that the unique characteristics of ED nursing, coupled with effective coping strategies and a supportive work environment, collectively acted as a safeguard, preventing a substantial increase in burnout levels during the unprecedented circumstances of the COVID-19 pandemic.

Stress Resilience

The assumption of stress resilience's influence on negative health-related outcomes before and during COVID-19 was not supported. Despite moderate, positive correlations in 2018, neither baseline nor COVID-19 data in 2021 indicated positive effects of resilience on stress, distress, or burnout. Data from 2018 complemented research pre-pandemic on nursing populations (Guo et al., 2018; Hegney et al., 2015). In 2018, older nurses, those with longer workplace longevity, higher workplace status, and advanced education indicated higher resilience than their younger counterparts, consistent with nursing resilience studies (Ang et al., 2018; Smallwood, Pascoe, et al., 2021; Tiete et al., 2021). Younger nurses have cited using their workplace experience to build and cultivate resilience (Reyes et al., 2015), and may account for results favouring increased experience promoting resilience. In 2021, although the age group was older, age, education, and training's impact on resilience was negated during the COVID-19 pandemic. Regardless of these factors, resilience was lower during, than prior to, COVID-19. Elevated stress and distress signified universal pandemic strain amongst nurses, even as they embraced a heightened sense of purpose (Albott et al., 2020; Jassar et al., 2021; Villar et al., 2021).

The absence of age-based distinctions suggests a collective fortitude amongst nurses, challenging the conventional notion that age and experience differentially influence resilience. In this specific rural Australian setting, ED nurses, irrespective of age, have demonstrated cohesion in navigating the adversities of the pandemic. This unexpected homogeneity in resilience levels across age groups could be attributed to several inter-related factors. Firstly, the shared experience of confronting the unprecedented challenges of the pandemic might have fostered a sense of unity and camaraderie amongst nurses, emphasising collective strength over individual differences. Additionally, the rural context, typically characterised by close-knit communitie, may have contributed to the cultivation of a supportive work environment that transcends age-related disparities. The absence of age-based distinctions could also reflect a unique adaptability and resourcefulness ingrained in rural healthcare professionals, allowing them to collectively confront challenges posed by the prolonged pandemic crisis. Ultimately, the cohesive resilience observed among nurses in this rural Australian setting underscores the importance of shared experiences and collaborative environments in fostering collective strength amidst adversity.

Pre-COVID-19 research indicated that greater workplace experience and higher qualifications enhances ED nurse retention (Hogan et al., 2007; Sánchez-Zaballos & Mosteiro-Díaz, 2021). However, Australian studies conducted during the COVID-19 pandemic observed high work resignation intentions amongst ED and healthcare workers regardless of experience or training (Cornish et al., 2021; McGuinness et al., 2022), reflecting international trends (Labrague, 2021). This suggests chronic pandemic stressors, compounded by limited pandemic exposure (especially within Australia), might have overwhelmed ED nurses' psychological wellbeing, leading to high turnover rates post-pandemic. The mitigating effect of resilience on stress levels was limited, regardless of age or experience.

Physical Activity

Our results indicated that physical activity did not serve as a protective facilitator for psychological health before and during the pandemic. Baseline data from 2018 demonstrated limited relationships between physical activity parameters and resilience, stress, burnout, or distress prior to the pandemic. Research prior to COVID-19 highlighted low leisure-time physical activity amongst nursing populations (Ahmad et al., 2015; Jung & Lee, 2015; Naidoo & Coopoo, 2007), along with low intensity levels (Nahm et al., 2012; Tucker et al., 2010). Data from 2018 revealed that participants with less workplace experience (1-10 years) engaged in more vigorous physical activity than participants with 11 years or more experience. Workplace longevity was associated with greater total awake METS per day, accompanied by limited engagement in light, moderate or vigorous physical activity per day. Whilst it is unknown (within the current study) whether more senior occupational roles are related to low engagement in physical activity, as age increases, participation in leisure time physical activity decreases (Hallal et al., 2012). Current results could allude that more senior nursing staff are expending more energy within the workplace environment and engaging in limited leisure-time physical activity outside of the workplace. More senior nurses may experience greater fatigue and time-pressures within the workplace (Buising et al., 2020), and therefore cannot engage in physical activity pursuits. An Australian study comparing leisure-time to workplace physical activity amongst nurses' physical and psychological wellbeing found high workplace activity combined with low leisure-time physical activity led to negative physiological and psychological health compared to individuals that engaged in greater leisure-time outside of the workplace (Henwood et al., 2012). In line with the current study, other research (Henwood et al., 2012) found that nurses allocating energy to work and less to leisure activities may experience compromised psychological health; this could lead to heightened stress, distress, and decreased resilience levels.

COVID-19 data revealed that engaging in physical activity did not influence the effects of stress, burnout, or distress, and highlighted sedentary behaviours were higher during COVID-19. Government-mandated lockdowns (i.e., restrictions on personal active transport and socialising) to prevent the spread of COVID-19 caused psychological distress to Australian nurses (Smallwood, Karimi, et al., 2021). The lockdowns may have contributed to limited physical activity engagement, and partially explain the higher stress and distress, and the lower resilience during the pandemic. Although some individuals engaged in lockdown physical activity regimes (Brown et al., 2021; Smallwood, Karimi, et al., 2021), higher ED nurse workloads (Lee et al., 2020) could have reduced energy levels, making individuals less likely to engage in physical activity outside of the workplace. Moreover, limited pandemic social interactions, known to boost exercise adherence (Dishman et al., 1985), may have further discouraged leisure-time physical activity amongst ED nurses. In the pandemic, leisure-time physical activity was constrained, hindering comparison of 2018 and 2021 data. This pattern might signify pandemic-induced sedentary living due to government restrictions.

Limitations

The study's cross-sectional design over two years hindered tracking longitudinal changes since we did not track within-subjects data. Limited sample sizes and lower response rate during COVID-19 due to workplace pressure and time constraints limits generalisability. As discussed in the data analysis section, the small sample size limited the robustness of the results given the reduced statistical power, therefore results should be interpreted with caution. The one-way between groups ANOVA for age and resilience post-hoc analyses were unfulfilled due to the small sample size within each age group, thus warranting caution. Whilst expected, given the healthcare workforce in Australia is female dominant (Australian Institute of Health and Welfare; Nursing and Midwifery Board of Australia, 2020), 85% of the total sample was female dominant and therefore provides limited insight on the effect of COVID-

19 on the male population. Maintaining methodological similarity between data collection points was crucial, but the survey's occupational focus may have overlooked home stressors during lockdowns, potentially affecting results.

Implications

The current study has implications for hospital educators and suggests the need for leisure-time physical activity programs both within and outside hospital settings to address poor psychological health outcomes. Occupational physical activity along may not suffice for positive health outcomes. Psychological resilience training programs are crucial for staff retention, especially during chronic stressors that occur as a result of pandemics. Whilst resilience wasn't significantly linked to stress or burnout, the absence of resilience-maintaining strategies may have led to negative health consequences in this and other studies during COVID-19. Human resource departments should prioritise physical activity and resilience programs to enhance staff wellbeing and retention.

Conclusions

In the current study, comparison across different years indicated COVID-19 significantly impacted the psychological wellbeing of ED nurses, leading to lower resilience with higher stress and distress. Stress resilience did not affect stress, burnout, and distress. ED nurses reported infrequent engagement in high-intensity physical activity during both surveys, and whilst it appears physical activity did not play a protective role on the sample's psychological wellbeing, COVID-19 restrictions constrained their ability to engage in physical activity. Given the high stress rates and low resilience when faced with a chronic stressor, ED nurses should receive supportive interventions during future healthcare crises, regardless of experience or professional role within the hospital. More post-COVID-19 data is needed to understand its lasting psychological impact on ED nursing populations.

Chapter 5

Study 3: Interventions to Optimise Stress Resilience amongst Australian Nursing Students during a Pandemic: A Feasibility Study

Study 2 (Chapter 4) included a cross-sectional study comparing ED nurses before and during the COVID-19 pandemic, which found that COVID-19 had a negative impact on the mental health of frontline nurses, where resilience declined, and stress and distress increased from 2018 to 2021. Further, Study 2 gave little indication of a positive relationship between physical activity and stress resilience, though it also revealed that nurses have limited engagement in physical activity overall.

To broaden the perspective of the nursing populations during the COVID-19 pandemic, third-year student nursing population completing clinical placement was inspected. Since Study 2 indicated that nurses have low engagement in physical activity, the current study implemented an intervention utilising physical activity to promote the stress resilience of student nurses. Social distancing meant the current study was conducted solely online. Study 3 addressed dissertation aim (c): To explore the use of physical activity as a facilitator in the promotion of stress resilience within a student nursing population during COVID-19, and (d); To compare a physical activity program to a mindfulness intervention program in optimising stress resilience during COVID-19. Further, Study 3 was a feasibility study, whereby, process elements of the intervention were evaluated.

Abstract

This feasibility study aimed to monitor the practicality and viability of implementing a high-intensity physical activity program and a separate mindfulness intervention program to enhance stress resilience among student nurses during the COVID-19 pandemic. Twelve third-year nursing students participated in a mixed-method design (qualitative and quantitative), integrating objective and subjective parameters to evaluate physiological and psychological resilience, stress, and well-being. The study involved one-on-one interviews conducted after the intervention phase. A battery of psychological measures, encompassing resilience, stress, burnout, and distress, was employed, along with objective and subjective fitness assessments and physiological measures, including physical activity levels, heart rate, systolic and diastolic blood pressure, and heart rate variability indices. The Trier Social Stress Test and Rockport 1-mile walk test were administered pre- and post-intervention. Quantitative results indicated improvements in physiological parameters to the stress test over time for the physical activity and mindfulness groups, with no changes in psychological well-being parameters across groups. Although, statistical analysis was conducted on a small sample size with limited power. Qualitative analysis also revealed enhancements in physiological and psychological stress resilience for all experimental groups, particularly the physical activity and mindfulness groups. Qualitative analysis revealed positive participant feedback and robust adherence, underscoring strong feasibility. Notably, the study's flexible online format proved advantageous, especially in navigating the challenges posed by COVID-19. This study contributes further evidence supporting the positive relationship between physical activity and stress resilience. Importantly, it underscores the need for intervention programs to include physical activity components, demonstrating their potential to improve student nurses' reactivity and recovery from stress in the challenging context of the COVID-19 pandemic.

Introduction

Coronavirus disease 2019 (COVID-19) posed extreme demands and prolonged physiological and psychological health consequences on healthcare professionals across the globe. Healthcare workers endured significant workload increments (Lee et al., 2020) and were at a higher risk of COVID-19 contagion compared to the general population (Eyre et al., 2020; Gómez-Ochoa et al., 2021), which spawned fear of viral transmission to family members (Pappa et al., 2020; Shanafelt et al., 2020; Wallace et al., 2020). These workforce issues resulted in a high prevalence of stress and burnout and contributed to poor psychological health of our sorely needed life-saving professionals (Bohlken et al., 2020; Lai et al., 2020; Pappa et al., 2020; Shen et al., 2020; Tiete et al., 2021; Yörük & Güler, 2021).

Stress is based on our reaction to a stressor, which affects the psychological experience and physiological processes that can result in an optimised functioning or vulnerability (Carver & Connor-Smith, 2010; Crum et al., 2020). Within this study, stress is viewed as a dynamic process whereby stress is considered in terms of how an individual may endure a stressor or challenge (Goodnite, 2014; Koolhaas et al., 2011). Stress is also a precursor to burnout. Burnout is characterised by feelings of mental and physical exhaustion, negative attitude, and feeling like workplace goals are unachievable (Arora et al., 2013; Bianchi et al., 2014; Embriaco et al., 2007). Despite the low COVID-19-related mortality and morbidity rates in Australia, physicians, nurses, and allied health staff showed similar trends on psychological health outcomes compared to other nations (Smallwood, Karimi, et al., 2021). There is an abundance of research on the psychological health of healthcare professionals during the pandemic, yet a paucity of research on healthcare students completing their training in the hospitals during COVID-19. Research has shown that younger age groups in the healthcare industry are more susceptible to stress and burnout (Abram & Jacobowitz, 2021; Gómez-

Urquiza et al., 2017; Holland et al., 2013; McGarry et al., 2013; Zeng et al., 2020). Therefore, student populations require further exploration and protection.

Nursing Population

Nursing student populations encounter significant challenges throughout their undergraduate university degree, including attending clinical placements, which can negatively impact their psychological health and wellbeing (Ayaz-Alkaya et al., 2018; da Silva et al., 2014; Watson et al., 2008). In Australia, nursing students must engage in clinical placement to enter the workforce, where nursing students in their final year of university (Rella et al., 2009) are thrust into high-pressure workplace environments contributing to high levels of stress (Chang & Daly, 2016; Milosevic et al., 2012). A review on student nurses showed the most frequently reported stressors were time-management, financial pressures and family management (Andrew et al., 2015; Nayak, 2019) and an Australian study connected these results with academic pressure and physical and psychological health concerns (Lo, 2002). Abram and Jacobowitz (2021) compared registered nurses to healthcare students (including nursing students) and found burnout was more prominent in healthcare students, with similar results found among an Australian sample (Robins et al., 2018). Poor psychological health in tertiary populations can lead to decreased productivity and discontinuation of their university degree (James et al., 2010). Nursing students endure personal, academic and workplace stressors, which contributes to psychological vulnerability.

It was highly likely that COVID-19 negatively exacerbated nursing students' stress-related health outcomes. Nursing students were subjected to unprecedented changes to their education and some nursing students accepted clinical roles that would normally be assumed by graduate nurses in order to ease pressure within the hospitals (Hayter & Jackson, 2020). Previous pandemics (e.g., severe acute respiratory syndrome; SARS) have alluded that student nurses experienced the same risks of developing burnout and workplace stress as their more experienced colleagues (Cao et al., 2020; Kim & Choi, 2016; Savitsky et al., 2020). A cross-sectional study conducted before and during COVID-19 on 305 Spanish final-year nursing students indicated that poor mental health outcomes had increased during COVID-19 (Reverté-Villarroya et al., 2021). Research across the globe indicates nursing students are suffering psychologically as a result of the pandemic (Gao et al., 2021; Huang et al., 2020; Zhu et al., 2021), whilst other researchers found that COVID-19 had little impact on psychological outcomes (Drach-Zahavy et al., 2021; Kochuvilayil et al., 2021). Nevertheless, cross-sectional studies have limited direct pre-pandemic generalisations. Kochuvilayil et al. (2021) recently conducted a small-scale study comparing Australian (n = 99) and Indian (n = 113) undergraduate nursing students during mid-2020 (during government-mandated lockdown) and found moderate anxiety scores were significantly higher in the Australian sample. To date, little is known about the mental health of an Australian student nursing population during COVID-19, and ways in which resilience can be improved during COVID-19.

Stress Resilience

Resilience has been noted as a key factor enabling professional and psychological success within the nursing industry (Jackson et al., 2011; Pierce et al., 2020; Taylor & Reyes, 2012) and correlates with poor psychological health (Brown et al., 2018). Hospital personnel with higher psychological resilience are likely to cope with workplace stress (Beaumont et al., 2016; McGowan & Murray, 2016) and nurses with higher psychological resilience indicate lower stress and burnout (Guo et al., 2018; Hegney et al., 2015; Yu et al., 2019). Whilst the concept of resilience can be difficult to define (Richardson, 2002; Windle, 2010), the current study focuses on ‘stress resilience’, rather than a generalised psychological resilience (Almedom, 2015; Southwick et al., 2014). Stress resilience develops from an individual’s reaction to a stressor and influences the physiological and psychological stress response, which can lead to either successful adaptation and optimised functioning or a hindered/inactive response resulting in physical and mental vulnerability (Cowen et al., 1990; O'Donohue et al., 2021; Obbarius et al., 2018; Richardson, 2002). Stress resilience is considered as the capability to revert to normal functioning after experiencing stress, emphasising recovery rather than desensitisation (Norris et al., 2009). Charney (2004) acknowledges the physiological stress response processes that influence our psychological reaction and recovery towards a stressor, and vice versa Charney's theory manifests the core concepts of stress resilience; the ability to adequately react and recover from stress that may promote innate stress resilience through attainment of positive adaptation and exposure to adversity (Dienstbier, 1989; Fletcher & Sarkar, 2013). Stress resilience literature is in its infancy, therefore literature pertaining to resilience can be defined as either 'psychological resilience', 'physiological resilience' or 'stress resilience' specifically. Thus, Study 3 will draw on all forms of resilience research in order to construct the conceptual landscape that contributes to stress resilience. As the current study includes both psychological and physiological measures of resilience, it is considered better aligned with stress resilience research.

Physiological measurements of stress resilience include cardiovascular parameters such as heart rate variability (HRV). HRV is the cardiovascular system's response to environmental and physiological stressors upon the body (Acharya et al., 2006). Two main indices of HRV are time domain measurements, such as standard deviation of normal-to-normal RR intervals (SDNN) and the root mean square of successive differences (RMSSD). SDNN measures the standard deviation of normal intervals of heart rate (HR) and researchers suggest that both the sympathetic nervous system (involved in fight-or-flight reaction of the stress response) and parasympathetic nervous system (involved in maintaining and/or returning the body to homeostasis within the stress response process) contribute to SDNN (Shaffer & Ginsberg, 2017). RMSSD represents the square root of the mean of the sum of the squares of differences between adjacent normal-to-normal intervals and is reflective of the automatic control of the vagus nerve or parasympathetic nervous system activity (Stein et al., 1994). A high HRV indicates greater cardiovascular flexibility, adaptability, and optimised physiological functioning and low HRV indicates physiological vulnerability of the stress response processes (Dekker et al., 2000; Thayer et al., 2009; Weber et al., 2010). Kim et al. (2018) reviewed 37 studies and concluded that HRV is a reliable indicator of the physiological stress response and a good objective measure of psychological stress resilience.

Other cardiovascular parameters that measure physiological resilience include HR, systolic blood pressure (SBP) and diastolic blood pressure (DBP). Increases in HR, SBP and DBP indicate activation of the sympathetic nervous system and decreases in these cardiovascular parameters indicate activation of the parasympathetic nervous system. Increased reactivity of cardiovascular parameters in response to a stressor indicates an efficient, adaptive 'fight-or-flight' response (Hughes et al., 2018; McEwen, 1998) and are indicative of physiological resilience. Researchers have found that a faster recovery from a stressor suggests a more resilient stress response system (Hughes et al., 2018; Tugade & Fredrickson, 2004).

In student nursing research, the literature generally indicates that a higher resilience can improve psychological health outcomes (Manzanares et al., 2021; Pierce et al., 2020; Ríos-Risquez et al., 2016; Smith & Yang, 2017). A review on student nursing and psychological wellbeing indicated moderate levels of psychological resilience and high levels of stress within the target population before the pandemic (Pierce et al., 2020). Prior to the COVID-19 pandemic, a 13-week pilot intervention (including physical activity and mindfulness training) to improve psychological resilience in 40 student nurses proved effective; resilience scores increased from pre- to post-intervention (Boardman, 2016). During the COVID-19 pandemic, Kerbage et al. (2021) collected qualitative and quantitative data on 121 Australian nursing students and their levels of stress and psychological resilience. Kerbage et al. found low scores on psychological resilience, yet students with employment in nursing-related roles showed higher psychological resilience scores with no statistically significant differences among first, second-, and third-year students. Qualitative thematic analysis identified challenges during the pandemic, including apprehension to maintain or optimise their mental health, fear of contagion, and feeling isolated. Student strategies to overcome challenges were developing or maintaining a daily routine, maintaining social connectedness, and mindfulness and meditation strategies. As Badu et al. (2020) explains, specific interventions to build resilience and improve psychological outcomes amongst nursing populations during prolonged health disasters is warranted.

Mindfulness

Mindfulness training improves stress-related health issues (Galantino et al., 2005; Krasner et al., 2009) and psychological resilience (Boardman, 2016). Mindfulness refers to a mental state where one focuses on the current moment whilst recognising and accepting their thoughts, emotions, and bodily sensations in a calm manner (Khoury et al., 2015). Mindfulness can facilitate greater cognitive flexibility, improved emotional regulation, optimised behavioural responses, and enhanced recovery to stressful situations (Good et al., 2016; Teper et al., 2013). Short (five minute) daily mindfulness-based interventions on healthcare personnel can reduce stress, burnout, and anxiety-related symptoms, and also improve psychological resilience (Gauthier et al., 2014; Gilmartin et al., 2017b). A randomised control trial found mindfulness improved stress resilience over an eight-week period (Chin et al., 2019), though their measurement of stress resilience was based on adaptations of trait mindfulness and acceptance scales and not rooted within stress resilience research. A meta-analysis compared mindfulness-based stress reduction therapies with mindfulness-based cognitive therapy and found that stress reduction techniques improved mental heath for clinical and non-clinical populations, yet cognitive-based therapy showed greater promise for disorder relapse (Fjorback et al., 2011). Mindfulness training for health care workers and student nurses during the pandemic have improved psychological wellbeing (Luberto et al., 2020; Meidiana et al., 2021; Rodriguez-Vega et al., 2020), but has not been investigated among student nursing populations in Australia or during the COVID-19 pandemic.

Mindfulness, as a therapeutic approach, holds unique advantages for the nursing population, justifying its preference over alternative psychotherapies such as Cognitive-Behavioural Therapy. Firstly, the brevity of mindfulness sessions, particularly short daily interventions lasting five minutes, aligns with the demanding schedules of nurses (Gilmartin et al., 2017a). The accessibility and ease of integration into their routine make mindfulness sessions a pragmatic choice for a population with limited time resources. Moreover, mindfulness emphasises present-moment awareness and acceptance of thoughts and emotions, aligning well with the nature of nursing, where rapid decision-making and emotional resilience are paramount (Braun et al., 2019; Xu et al., 2021). The mindfulness practice's focus on cultivating cognitive flexibility and emotional regulation directly addresses the stressors inherent in healthcare settings (Gilmartin et al., 2017a). Additionally, the evidence indicating the effectiveness of mindfulness in improving psychological resilience, a crucial factor for nursing professionals, further supports its application. Unlike some therapeutic modalities, mindfulness does not necessitate prolonged sessions, making it a practical and feasible tool for promoting mental well-being in the context of nursing and practice during the demanding circumstances of the COVID-19 pandemic.

Physical Activity

Physical activity is another strategy that has a significant positive effect on stress-related health outcomes (Bentley et al., 2013; Gerber, Lindwall, et al., 2013; Norris et al., 1992; Swain & Franklin, 2006). Australian nurses who participated in leisure-time physical activity presented greater physical health and better mental wellbeing compared to nurses that solely relied on incidental workplace physical activity (Henwood et al., 2012). Australian and English university students that engage in health-promoting behaviours such as physical activity are less likely to suffer from depression, anxiety and stress (Lovell et al., 2015; Schofield et al., 2016; Tyson et al., 2010). Positive relationships between physical activity and mental health outcomes have been found within student nurse populations (Hui, 2002; Klainin-Yobas et al., 2015). Hawker (2012) found conflicting weak associations between psychological health outcomes and physical activity, though positive, significant correlations were found among the limited third-year nursing students that engaged in moderate to vigorous intensity physical activity. Stanton et al. (2021) conducted a survey on 500 Australian nursing students and found a small percentage (7.9%) of students were meeting the recommended Australian physical activity guidelines and whilst no relationships were found between physical activity and psychological distress scores, significant positive correlations were identified between sedentary behaviours and depression and sedentary behaviours and stress levels. Australian recommendation guidelines indicate that adults should participate in 2.5 to 5 hours of moderate-intensity physical activity or 1.25 to 2.5 hours of vigorous-intensity physical activity per week (Australian Government Department of Health, 2024). COVID-19 has indeed contributed to a negative change in physical activity participation in the student and general population (Karageorghis et al., 2021; Stanton et al., 2021; Talapko et al., 2021). In light of the pandemic, physical activity interventions are needed to improve the psychological wellbeing of student nurses. Physical activity may act as a stress building resource (Baker et al., 2012; Wells et al., 2012) that may increase stress resilience by promoting physiological and psychological adaptations, thus developing a resilience to stress (Silverman & Deuster, 2014).

Theoretically, physical activity facilitates a more resilient stress response (Boutcher et al., 2001; Eriksson et al., 1997; Kelley et al., 2001; Silverman & Deuster, 2014; Sothmann, 2006). When a person engages in high-intensity physical activity, this action places significant strain upon the body and the physiological stress response within the body is activated. The stress response refers to the biological processes that are activated in response to a real or imagined stressor (McEwen, 2000, 2004). The stress response activation mirrors pathways activated when a real-world stressor is encountered (Forcier et al., 2006), also known as cross stress adaptation, whereby habituation of one stressor leads to a tempered stress response in another stressor (Chauhan et al., 2015). These biological stress response processes can develop positive physiological adaptations and can encourage efficient physiological functioning for the body to meet the demands of the stressor and encourage physiological endurance (Dienstbier, 1989; Epel et al., 1998). These positive adaptations may resemble adaptations that occur through physiological stress resilience pathways (Hegberg & Tone, 2015; Silverman & Deuster, 2014). A paucity of evidence indicates that engagement in physical activity can reduce the cardiovascular stress response to psychological stressors (Christodoulou et al., 2020; Forcier et al., 2006; Klaperski et al., 2013; Price, 2006; Rimmele et al., 2009; Rimmele et al., 2007; Throne et al., 2000; Wyss et al., 2016), however other researchers have reported conflicting results (Childs & de Wit, 2014; Jayasinghe et al., 2016). Jackson and Dishman (2006) meta-analysis highlighted physically fitter individuals are likely to recover more swiftly from psychological stressors compared to physically unfit individuals.

Issues with Physical Activity Interventions

The construction of evidence-based physical activity interventions faces challenges due to variations in frequency, intensity, and duration, as well as unclear reporting of intervention standards (Bischoff et al., 2019; Cale & Harris, 2006). The lack of consensus on these parameters, coupled with diverse approaches in promoting physical activity, particularly in terms of intensity, hinders the establishment of clear guidelines for successful interventions, complicating the execution of physical activity studies.

A major issue with physical activity interventions is participant adherence. Numerous interventions exhibit deficiencies in reporting adherence and attrition rates, presenting scenarios of insufficient adherence and elevated dropout rates (Bischoff et al., 2019).Within investigations centred on workplace physical activity, there exists a broad spectrum of dropout rates, ranging from 4% to 85%, and the predominant attrition rate generally falls within the 30% to 50% range (To et al., 2013). This pattern in intervention reporting aligns with a broader trend in physical activity literature, emphasising the significance of strategies that not only enhance adherence but also mitigate attrition rates in workplace-based interventions (To et al., 2013). Addressing these issues becomes particularly relevant in the context of the current intervention study, where a robust understanding of adherence and dropout challenges is crucial for optimising the feasibility and real-world applicability of high-intensity physical activity and mindfulness intervention programs among student nurses on clinical placement. Assessing the feasibility of physical activity and mindfulness interventions for student nurses' stress resilience during COVID-19 involves evaluating the adaptability, acceptability and logistics of the program within hospital settings (Ballew et al., 2010). Evaluating these interventions and aligning them with the specific demands of nursing education settings may indicate their potential influence on real-world effectiveness (Ballew et al., 2010). Given the challenges inherent in physical activity interventions, a thorough examination of feasibility is imperative (Abbott, 2014). Addressing the practical considerations for promoting physical activity in the context of nursing education, exploratory proof-of-concept (POC) studies become a valuable initial step to assess the preliminary efficacy of interventions (Abbott, 2014; Campbell et al., 2019; Thabane et al., 2010). Although POC studies do not offer definitive conclusions about intervention efficacy due to small participant numbers, they guide decisions about proceeding to more extensive, and often more expensive, studies (Campbell et al., 2019; Preskorn, 2014).

Aims of this Study

The primary aim of the study was to compare the effectiveness of a high-intensity physical activity program with a mindfulness intervention program on student nurses' stress resilience during COVID-19 using qualitative and quantitative investigative methods. To the best of my knowledge, this was the first study to implement a physical activity intervention to improve health outcomes of an Australian student nursing population during the COVID-19 pandemic.

It was hypothesised that: (1) both the physical activity program and the mindfulness program will improve psychological and physiological health outcomes from pre- to post-intervention, (2) physiological and psychological health outcomes will show greater improvement from pre- to post-intervention compared to the control group and (3) there will be strong negative relationships between resilience and stress, burnout, and distress, respectively, at post-intervention.

The secondary aim of this study was to access the practicality of viability of implementing a high intensity physical activity program and a mindfulness intervention program for improving stress resilience among student nurses during the COVID-19 pandemic. This study aimed to evaluate the feasibility of the research design and intervention protocols employed with a small sample of twelve third-year nursing students. The focus was on exploring the logistical challenges, acceptability, and adherence to the intervention programs.

The feasibility objectives: what were the participants expectations for recruitment and adherence? How can we enhance the process to improve attrition and adherence to the program? Intervention accessibility-are the protocols flexible for participants and can the intervention be sustainably scaled?

Method

Methodological Approach

This study adopted a pragmatic research design, employing both quantitative and qualitative methods to comprehensively investigate stress resilience among Australian nursing students amid the unique challenges posed by the COVID-19 pandemic. The research aimed to assess the feasibility of physical activity and mindfulness interventions. Whilst the qualitative section followed a constructivist research approach, the integration of both paradigms was crucial to extracting essential data aligned with the overarching thesis question and the specific focus of the study. Informed by pragmatism, the research design was shaped to comprehensively capture psychological and physiological facets of stress resilience in a real-world context. This approach, emphasising practical insights (Maxcy, 2003), guided the formulation of research questions that sought a broader understanding of intervention impacts. Aims and objectives were aligned for a balanced exploration, contributing academically whilst offering practical strategies for nursing student well-being. Embracing pragmatism facilitated the integration of diverse methods, including qualitative interviews and quantitative assessments (Morgan, 2014). This lens ensured our study effectively navigated the intricate dynamics of stress resilience during the COVID-19 pandemic, maintaining both contextual relevance and methodological flexibility.

Study Design

This study used a mixed-method design. Quantitative data encompassed self-report surveys and objective measures for cardiovascular parameters, whilst qualitative data included one-on-one interviews with the participants who completed the intervention. Since this was a feasibility study with small sample size, it was important to extend the breadth and depth of knowledge gained from the physical activity and mindfulness interventions and to strengthen the conclusions via a mixed-method approach (Schoonenboom & Johnson, 2017). These findings may help inform researchers on the types of resilience interventions that could be implemented, not only for nursing populations, but for the general population. Further, evaluating the study's feasibility via qualitative methods ensures the practical implementation of these types of programs that aims to enhance psychological wellbeing.

Participants

A total of 23 participants volunteered to participate in the study. Eligibility for the current study included student nurses in their final year studying at a regional university in Victoria, Australia undertaking clinical placements during the first 6 months of 2021 (during the COVID-19 pandemic). Pre-screening tools ensured eligibility, with individual exclusion criteria being the inability to participate in physical activity, a pre-existing medical condition that posed personal risk, or pregnancy. After pre-screening, 20 participants were eligible, with three participants considered high risk (deemed by the Adult Pre-Exercise Screening System) and were excluded from further participation. The study implemented a matched-groups design whereby participants were allocated to their groups based on their VO_{2max}, Rockport rating, and MET results of the fitness test (for information on these measures, see the Measures section below). At the start of the intervention, there were 16 participants. By the end of the intervention and post-testing, 12 participants completed the entire intervention, with five, four, and three participants in the physical activity, mindfulness, and control groups, respectively. The sample was predominately female, with one male participant, with ages ranging from 19 to 59 (M_{age} = 37.38, *SD* = 12.12).

Measures

Pre-Screening

The Adult Pre-Exercise Screening System (Norton & Norton, 2012) used as a pre-screening tool for physical activity participation and risk assessment (see Appendix S).

Demographics

The pre-intervention survey collected information on workload, specifying details such as full-time equivalents (FTEs). Another aspect covered the number of children, providing insights into participants' family dynamics. Additionally, participants' qualification levels were assessed, encompassing various nursing skill levels, including advanced degrees like Masters and Ph.D.

Battery of Psychological Questionnaires

The psychological survey used at pre- and post-intervention included the Brief Resilience Scale (BRS), a questionnaire comprising of six items assessing an individual's ability to recovery from stressful circumstances (Smith et al., 2008), for further information on the BRS see Chapter 3, page 46. The Perceived Stress Scale (PSS), a 10-item questionnaire assessing an individual's current stress levels and feelings of control (Cohen et al., 1983), for more information on the PSS see Chapter 3, page 47. The Shirom-Melamed Burnout Measure (SMBM) was used to assess occupational burnout (Lerman et al., 1999), for more information on the SMBM see Chapter 3, page 47. The Recent Physical Activity Questionnaire (RPAQ) assessed intensity, frequency and duration of activity domains such as within the home, using transport, within the occupation and during leisure time over the past month (Besson et al., 2010), for more information about the RPAQ see Chapter 4, page 67. Finally, the Kessler Psychological Distress Scale (K10) assessed psychological distress and stability (Kessler et al., 2002), for more information on the K10 see Chapter 4, page 66. Reliability analyses for the current sample were good with a Cronbach's α score of .85 for BRS, an excellent score of .93 for SMBM, a good score of .87 for K10, and the PSS indicated an acceptable Cronbach's α score of .48, so results from the PSS should be interpreted with caution.

Resilience. The survey also included the Connor-Davidson Resilience Scale (CD-RISC; Connor & Davidson, 2003), which is a 10-item questionnaire designed to assess stress coping ability over the past month (see Appendix T). Example questions include *I am able to adapt when changes occur,* and *I tend to bounce back after illness, injury, or other hardships*. Answers are provided on a five-point Likert scale ranging from 0 (*rarely true*) to 4 (*true nearly all of the time*). Total scores range from 0-40, with a higher score indicating higher level of resilience. Some researchers (Miller et al., 2021; Notario-Pacheco et al., 2011) have indicated score quartiles whereby the first quartile indicates low resilience, the second and third quartile indicates moderate resilience, and the fourth quartile indicates high levels of resilience. Campbell-Sills and Stein (2007) found that this short version was well correlated to the original 25-item version (r = .92) and had adequate internal consistency (α = .85). Test-retest reliability is very good with intraclass correlation of 0.87 (Connor & Davidson, 2003; Windle et al., 2011). Reliability analyses for the current sample were excellent with a Cronbach's α score of .90.

Online Diary

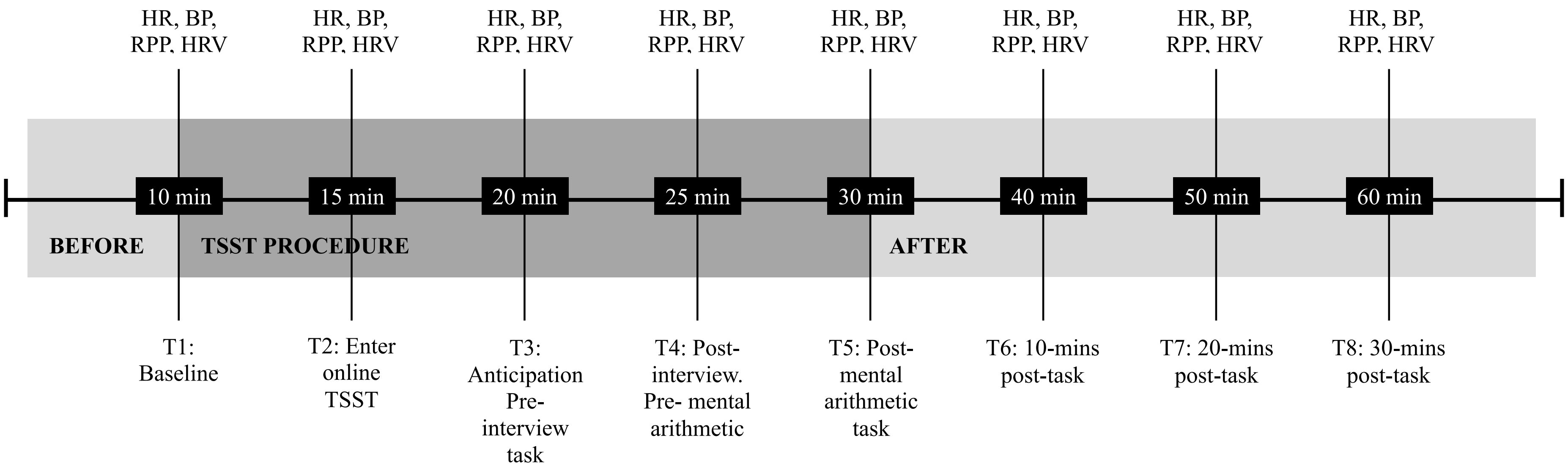
Participants completed a short survey once a week during the intervention (see Appendix U). Questions included adherence to their allocated intervention over the course of the week. Participants also recorded their resting BP, HR and HRV within the survey (this was the same day as completing the survey) via the Suunto wristwatch. Participants were asked about the amount of sleep, levels of stress (Likert scale of 1-10), nutrition (Likert scale of 1-10) and exercise (Likert scale of 1-10) over the previous 24 hr period, with 1 = very poor, 2 = poor, 3 = fair, 4 = below overage, 5 = average, 6 = above average, 7 = good, 8 = very good, 9 = excellent and 10 = outstanding.

The Trier Social Stress Test

The Trier Social Stress Test (TSST) is a biopsychological instrument designed to examine the effects of acute physiological and psychological stress (Kirschbaum et al., 1993). The test comprises of three components; an anticipation stage, a five-minute speech (with topic of dream job application), and a five-minute mental arithmetic test (i.e., counting backwards from 1022 in increments of 13) performed in front of a panel of confederates. The confederates were required to give instructional and negative (verbal and behavioural) feedback throughout both tasks within the TSST. In addition, the lead researcher explained that the most highly convincing speech throughout the study would win a $100 gift voucher. All tasks were video recorded. HR, SBP, DBP and HRV indices were assessed throughout this task (see Figure 3.1 for graphical account of methodological timeline on when cardiovascular parameters were measured). It is difficult to examine test-retest reliability of the TSST due to intra- and inter-individual variability in physiological and psychological responses (Labuschagne et al., 2019), though some authors argue the TSST is not prone to cardiovascular habituation (Mischler et al., 2005; Schommer et al., 2003; von Känel et al., 2006).

Due to COVID-19 social distancing restrictions, the test was conducted online via Zoom. Other studies have conducted the TSST via virtual reality programs and found similar physiological and psychological stress responses were elicited in comparison to the standard TSST (Hawn et al., 2015; Jönsson et al., 2010). A visual analogue scale (VAS) was emailed to participants, and they completed the VAS before and after engaging in the TSST. The VAS asks participants to rate their level of stress, from 1 (*no stress*) to 10 (*very stressed*). This was submitted to the researcher via email after the stress test was completed.

Figure 3.1
TSST Procedure



Note. HR = heart rate, BP = blood pressure, RPP = rate pressure product and HRV = heart rate variability.

Fitness Testing

The Rockport 1-mile walk test (Kline et al., 1987) was developed to predict maximal oxygen uptake (VO_{2max}) and individual fitness. The test involves participants walking a mile as quickly as possible. Participants wore the Suunto wristwatch and chest belt during the Rockport test. Participants were provided with a website link (https://exrx.net/Calculators/Rockport) where they entered the required details such as heart rate (at the conclusion of the walk), walk duration, body weight (used for VO_{2max} calculations), age and sex, and the calculated output included VO_{2max} scores, a Rockport fitness score, and METs based on population averages. The Rockport is a valid and reliable predictor of VO_{2max} and fitness indicator (Weiglein et al., 2011). For physiological testing of HRV indices, the fitness test was compartmented into three sections based on time of the submitted .fit file. The average of three time-points across each of the three sections was analysed for SDNN and RMSSD.

Equipment

SBP and DBP parameters were measured with an automatic blood pressure monitor OMRON HEM-7120, which is a valid and reliable measure (Coleman et al., 2008; Zhang et al., 2021). HRV indices, such as SDNN and RMSSD, and HR were measured via the Suunto Ambit 3 wristwatch and chest belt. The Suunto wrist watches and chest belts are reliable, valid and accurate tools in assessing HR and HRV compared to electrocardiogram data (Bouillod et al., 2015; Schmitt et al., 2013; Weippert et al., 2010). For HRV indices, three measurements were obtained for each time-point within the stress test and a mean result was calculated and used within the main data set. Physiology researchers prefer to use a calculated HRV mean score (Parati et al., 2008; Pickering et al., 2005), however due to the online nature of the intervention, this procedure was not possible for heart rate and blood pressure parameters.

Experimental Group Programs

The three groups are differentiated with the abbreviations PA (physical activity group), MIND (mindfulness group) and CG (control group).

Physical Activity Intervention Group

A high-intensity physical activity program was developed specifically to improve physiological optimisation of bodily functioning. Participants engaged in a high-intensity interval training (HIIT) program, which is defined as small bursts of explosive effort accompanied by short periods of rest or low-intensity physical activity (Gibala & Jones, 2013). A personal trainer and two exercise physiologists collaborated to create 24 workout sessions (videos) for the 8-week program, based on Gibala and Jones' (2013) suggested fitness programs. The program contained three levels of difficulty within each session, in order to cater for different fitness levels of participants. Typically, each 20-min session contained 30-s exercises, with six alternative exercises performed consecutively before a one-minute rest period. These workouts were delivered via Youtube and were password protected. Participants engaged in the program three times per week over the 8-week intervention period. The intensity of the exercise sessions increased over time to compensate for the improvement in participant fitness levels over time.

Mindfulness Intervention Group

The MIND group used the Australian-made phone application by The Resilience Project developed in collaboration with The University of Melbourne research team. The 'app' combines both psychological and physiological exercises that aim to improve psychological resilience. The exercises include gratefulness and empathy reflections, an appreciation journal, and 10-minutes of mindfulness meditation training. Participants engaged in the program for 10 minutes per day over the 8-week intervention period.

Control Group

The waitlist-control group continued their life as normal. Participants did not abstain from engaging in physical activity or mindfulness practices if they participated in these activities prior to the intervention. Though, participants that did not engage in these activities prior to the intervention were asked to refrain from supplementary physical activity and mindfulness practice throughout the intervention period.

Procedure

This study was approved by the University Human Research Ethics Committee (Approval #A18-116, see Appendix V). Recruitment was facilitated through the University nursing staff and school contacts, whereby an email was sent to students enrolled in the third year Bachelor of Nursing program. Potential participants responded to the lead researcher via email regarding their interest in the study. All communication with participants was conducted individually, as to maintain anonymity amongst participants, via email or video conferencing (i.e., Zoom or similar) meetings. All aspects of the data collection and intervention were conducted online due to COVID-19 lockdown restrictions. The lead researcher was available and 'on call' for participants at any time via email, phone, or video conferencing.

Pre-Intervention Phase

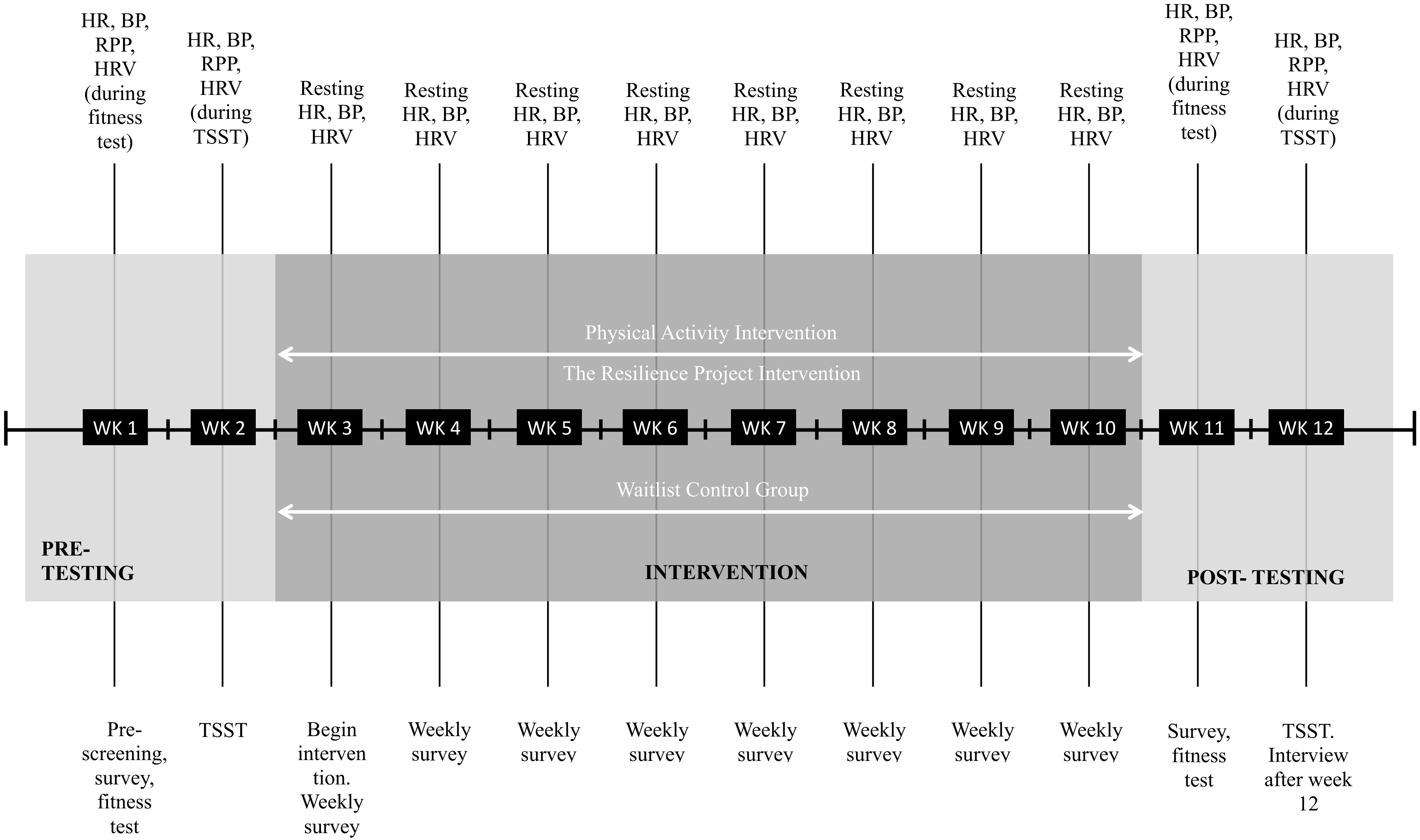
In the pre-intervention phase, an email with a Qualtrics link to the online psychological survey was sent to participants that emailed their interest in the study, with the plain language information statement (see Appendix W) and consent form (see Appendix X) at the beginning of the survey. After the lead researcher reviewed the pre-screening survey, eligible participants were then emailed information about how to complete the fitness test and the TSST. Participants completed the fitness test in their own time, whilst wearing the Suunto watch and chest strap, and within a week of receiving their instructions. Participants submitted their HRV data, and Rockport fitness test results via email to the lead researcher before the pre-intervention TSST, which was conducted one week after the fitness test.

Participants were categorised into low, moderate, or high fitness levels using the Rockport scale. Utilising a matched participant design, individuals were paired and randomly assigned to one of three experimental groups, ensuring homogeneous fitness distributions for the intervention.

Prior to the pre-intervention TSST, participants were requested to abstain from caffeine two hours prior and abstain from exercise, alcohol, and tobacco 24 hours. Abstaining from caffeine prior to the intervention that assesses heart rate variability is recommended to minimise potential confounding effects on autonomic nervous system activity, ensuring a more accurate evaluation of physiological responses (Koenig et al., 2013). Participants also undertook a 10-min relaxation period in order to obtain baseline cardiovascular measures and completed the VAS to indicate their level of stress at that present moment. Abstaining from the above activities and 10-min relaxation period was verbally verified at the beginning of the TSST meeting with the lead researcher.

At an allotted time of the online TSST meeting, participants entered the online space to meet the lead researcher. Cardiovascular measures were taken throughout the task and post-task (see Figure 3.2). After general introductions, two confederates entered the online meeting. Participants were given instructions for the interview task by the lead researcher and given five minutes to prepare. During 5-min preparation time, the lead researcher and the confederate's cameras and audio were turned off, and participants had the option of leaving their camera (and audio) on if they wished. When the lead researcher, the confederates, and participants came back into the virtual room (by turning on their camera and audio), cardiovascular measures were taken, and participants delivered the 5-min presentation (without their preparation notes). At conclusion of the presentation, cardiovascular measures were taken. Then the lead researcher provided instructions for the mental arithmetic task, with the timer set for five minutes. After the mental arithmetic task, cardiovascular measures were taken. The lead researcher then asked the confederates to leave the virtual room, in which they did, leaving only each participant and the lead researcher on the online call.

Figure 3.2
Procedure timeline



Participants then completed a post-task VAS to assess their stress levels at the present time, this was recorded by the participants (noted). Additionally, to obtain recovery cardiovascular measures, participants relaxed in a chair immediately post-task and collected their HR, SBP and DBP at 10-, 20-, and 30-min (i.e., the recovery time). This time was monitored by the lead researcher. After the recovery time, participants emailed the lead researcher their VAS scores.

Intervention Phase

Participants were emailed their group allocation and instructions on how to access and complete the 8-week intervention accompanied by URLs linked to the online diary. Participants could engage in their prescribed group program activities at any time of the day, which was important considering nursing placement contains shift work and needed to be suitable for the participants working hours and to encourage adherence to the program.

During each week of the intervention, the participants recorded their HR, SBP, DBP, and HRV at rest. The HRV was recorded via the Suunto wristwatch and blood pressure and heart rate via the electronic blood pressure monitor. The participants were instructed to sit on the edge of their bed for 10 minutes before recording the measures. Participants completed this task on the same day each week, and completed the recording in the morning. Specific times (example.g., after waking) was not possible with this population given that they completed nightshifts.

Post-Intervention Phase

Participants engaged in the fitness test, the TSST, and completed the post-intervention survey (emailed via a link from lead researcher). Once all post-intervention tasks were completed and data submitted to the lead researcher, participants were contacted via email to organise a mutually convenient data and time for the interview. All interviews were conducted online via Zoom video conferencing software.

Participants were sent a copy of the interview guide that included open-ended questions related to the research topic. The interview guide was developed based on a review of the literature and expert opinions in the field. The guide was designed to elicit details responses and to ensure that all participants were asked the same set of questions. For interview guide see Appendix Y. Each interview was conducted by the lead researcher and lasted between 35 and 55mins. The interviews were recorded via Zoom capabilities with the consent of the participants. At the beginning of the interview, the researcher explained the purpose of the interview and what to expect. The researcher asked general questions to build rapport, such as how is university/placement? before moving into specific questions from the interview guide. During the interview, the researcher used active listening and probing techniques to encourage participants to expand their answers and provide a rich data set. The researcher also clarified any unclear responses or asked follow-up questions as needed. At the end of the interview, the researcher thanked the participant for being involved in the study. All recordings were saved in a password-protected folder on the university's server. Once all interviews were conducted and transcribed verbatim, a member-checking process was employed via email.

Quantitative Data Analysis

Separate 3 (Group) x 2 (Pre- vs. Post-Intervention) mixed model ANOVA's were conducted to examine the changes in resilience, stress, burnout, distress scores, RPAQ sub-variables and Rockport outcome from pre- to post-intervention across the three experimental groups. Pearson's correlation coefficients were calculated to determine the relationships between psychological parameters at pre- and post-intervention across experimental groups. For variables that did not meet normality assumptions, Spearman's Rho was used. Bonferroni post-hoc tests were employed as a means of controlling for multiple comparisons and minimising the type one errors within the analysis. The correlational analysis aimed to explore how the psychological variables were interrelated within each group and whether these relationships changed from pre- to post-intervention. By investigating these interrelationships, the study discerned potential patterns and dynamics in participants' psychological wellbeing and gave a nuanced insight on how the interventions may improve stress resilience. One-way ANOVAs and paired samples t-tests compared groups during the fitness test at pre- and post-intervention and amongst groups upon the dependant cardiovascular parameters HR, SBP, DBP and HRV indices (SDNN and RMSSD). Multiple 3 (Group) x 2 (Pre- vs. Post-Intervention) ANOVAs were conducted on the VAS scores before the stress test and after the stress test at pre- and post-intervention to assess effectiveness of the TSST and to compare groups psychological reactivity to stress at post-intervention. In addition, paired samples t-tests and one-way ANOVAs were conducted for the stress tests to compare experimental groups from pre- to post-intervention upon the cardiovascular variables. For variables that violated Levene's assumption, Welch statistics were used. One-way ANOVAs were conducted to observe changes in physiological parameters at rest, over time from baseline (pre-intervention phase), during week one through to week 8 of the intervention period, and at post-intervention phase amongst groups. Paired samples t-tests were conducted on physiological parameters at rest comparing baseline pre-intervention phase scores to post-intervention phase scores across groups. Alpha was set at $p < .05$ significance for all analyses and where applicable partial eta squared (partial η^2) was used to measure effect sizes.

Qualitative Data Analysis

The constructivist paradigm is a qualitative research approach that emphasises individuals' subjective experiences and meanings. In this paradigm, the aim is to uncover and understand these subjective interpretations through qualitative data collection and analysis. Constructivism emphasises the idea that individuals construct their own realities through personal experiences and subjective meanings (Guba & Lincoln, 1994). To achieve this, the current study will employ a constructivist approach to explore the participants' subjective experiences of their participation in the experiment and their understanding of stress resilience. This approach utilised in-depth interviews and a thematic analysis of the collected data. Braun and Clarke (2019) note that thematic analysis is a commonly used approach within qualitative data. The use of a constructivist paradigm allows for deeper exploration of the participant experiences with the intervention programs and may provide some insight into the effective strategies for developing and optimising stress resilience. Qualitative data analysis was instrumental in addressing questions related to the feasibility dimensions of the study, encompassing logistics, adherence, and intervention accessibility.

Thematic Analysis

The qualitative analysis followed Braun and Clarke (2006) 6-phase thematic analysis to analyse the interview-based data. Firstly, the lead researcher became familiar with the data through transcription of the video-recorded interviews. This involved reading and re-reading the interview transcripts, taking notes and highlighting key points and ideas. Secondly, three experienced qualitative researchers read over the transcripts and coded features (brief descriptions) in the data without using a pre-structured coding set as not to limit researcher's preconceptions of the data. The researchers identified and labelled different ideas, concepts, and patterns within the transcripts in order for potential themes to emerge independently. Thirdly, the researchers collated the coded features into potential themes that were relevant and significant to the research question. Fourthly, the potential themes were then collated to create a visual 'thematic' map in order to review and refine the selected themes and gauge their relationship with the research questions. The themes were reviewed and refined until they accurately reflected the data and research question. Fifthly, a review of the data elicited minor themes relevant to the research questions and contributed to the story. The researchers ensured that the themes were clear and concise, and reflected the data. Lastly, the final phase involved writing up the analysis, including a description of the research question, the approach to the analysis, the themes identified examples to support each theme. The final report was developed, which entailed extracting examples that provided an analytic narrative that corresponds to the main research questions.

Triangulation

Triangulation is the process of implementing a mixed-method design to explore the studied phenomenon from different research perspectives and to ensure the validity and reliability of research findings (Denzin, 2009). In this study, due to the small sample size, it was crucial to obtain an enriched data set. Therefore, three triangulation approaches were employed: data, methodological, and researcher triangulation. Data triangulation (data from different sources) whereby qualitative interview-based data as well as both objective (cardiovascular parameters) and subjective data (psychological questionnaires) were compared. Methodological triangulation (alternative methods of data collection and analysis) where thematic analysis and statistical analysis were implemented and interpreted collectively. Researcher triangulation (team of researchers to analyse data) was used within thematic analysis of transcribed interviews to inform the facilitative nature of physical activity upon stress resilience.

Regarding the use of various data sources, credible researchers have argued the necessity for triangulation (Denzin, 2009), where it provides a more comprehensive understanding of the research topic (Patton, 1999) and helps to overcome the limitations of a single research method (Creswell, 2014). Foss and Ellefsen (2002) advocate the use of triangulation within nursing research, as long as both qualitative and quantitative methods are given equal emphasis when drawing conclusions. Yet, nursing scholar (Shih, 1998), among others (Fielding & Fielding, 1986) suggest that triangulation is used for the purpose of confirmation, providing an answer to a research question with a sense of 'completeness', and warns that multiple data sources should not be used to establish mutual confirmation. Rather, each source adds a unique perspective and provides a diverse insight into a research question, rather than balancing strengths and weaknesses of each data collection method (Shih, 1998). Instead of solely relying on the convergence from multiple sources, the use of triangulation can acquire different viewpoints to create a comprehensive understanding of stress resilience, resulting in a broader and richer view. When used appropriately, triangulation can help capture the complexity and diversity of perspectives within the data.

Member Checking

Member checking or credibility check is a trustworthiness measure used within qualitative data sets. Member checking asks the participant to review the recorded data and to request feedback to ensure that the data are creditable and dependable (Lincoln & Guba, 1985). Culver et al. (2012) note that member checking can add depth and integrity to the data and strengthens the overall credibility of the findings. Some researchers note that member checking can be fraught with limitations such as inaccurate recall and bias (Lincoln & Guba, 1985; Smith & McGannon, 2018). It is evident that generating theory-free knowledge is unattainable, whereby the participant and researcher, regardless of effort, inherently impact the method and any ensuing knowledge claim carries traces of their personal perspective (Braun & Clarke, 2013; Denzin, 2017). Braun and Clarke (2013) highlight that representing peoples' experience necessitates interpretive engagement that is inevitably influenced by assumptions, values and commitments. Whilst it is recognised that complete theory-free knowledge is difficult to achieve, involving participants in the validation process enables a broader perspective in the data and can enrich the researchers understanding of the topic (Levitt, 2015). This holds particular significance when the research topic centres on stress resilience, an area of study that is still emerging and evolving.

In the current study, the lead researcher emailed five participants (two from the PA, two from the MIND and one from the CG) to read the transcribed interview and verified its accuracy. The participants provided additional insights and/or suggested revisions to the interpretations. Not all participants completed the verification because the participants were under undue stress due to government-mandated lockdowns and impending university examinations. After participants clarified they were content with the transcribed data set (no changes were required) regarding authenticity, thematic analysis was conducted.

Results

Fitness Test

To assess baseline physical activity of the participant, Shapiro-Wilk, F_{max} and Levene's test statistics were used on VO_{2max}, Rockport rating scores and METS scores for the groups to assess normality and homogeneity of variance and assumptions were met. There were no groups main effects, and no interaction effects for MET scores, Rockport rating scores or VO_{2max} scores. All groups were found to have equal distribution of scores regarding fitness level.

Data Cleaning

Survey data, concerning the psychological questionnaires were exported from Qualtrics into an excel file and recoded based on individual questionnaire guidelines with cardiovascular measurements manually entered. HRV parameters were downloaded from the Suunto Movescount program and exported as a .fit file. The computer application Kubios was used to split the data file into 'timepoints' within the pre- and post-stress tests, fitness tests, and for the weekly resting HRV, and artifact correction was applied on a case-by-case inspection (Tarvainen et al., 2014). HRV parameters scores were procured based on each artifact corrected segment that corresponded with timepoints within the stress test, fitness test, and resting HRV. These scores were manually entered into the excel file, which was exported to Statistical Package for the Social Sciences (SPSS; Version 26).

Psychological Parameters

Normality tests for ANOVA on the psychological questionnaires (BRS, CD-RISC, PSS, SMBM and K10) were conducted on pre-intervention total scores. Inspection of skewness, kurtosis and Shapiro-Wilk statistics indicated that the assumption of normality was supported for the three groups across all psychological parameters. Levene's statistic was non-significant across the three groups and for all psychological parameters (see Table 3.1).

Pre-intervention scores for BRS were moderate for PA, low for MIND and high for the CG. Pre-intervention scores for the CD-RISC were moderate to high for all groups. Pre-intervention scores for the PSS and SMBM were moderate for all three experimental groups. Pre-intervention scores for K10 revealed all three experimental groups indicated moderate levels of psychological distress.

Post-intervention scores for BRS were moderate for all three experimental groups, whereby the mindfulness group improved their BRS scores from low to moderate from pre- to post-intervention and the CG indicated lower BRS scores from pre- to post-intervention (from high to moderate). CD-RISC scores at post-intervention showed moderate to high resilience for PA and MIND groups, the CG increased their resilience from pre- to post-intervention (moderate to high, to high). Post-intervention PSS scores were moderate for PA and MIND, though the CG indicated low PSS scores, which improved from pre-intervention (was moderate). Post-intervention scores for the SMBM were moderate for PA and MIND, though the CG indicated low SMBM scores (an improvement from pre- to post-intervention, moderate to low). Post-intervention scores for K10 revealed moderate scores for PA and MIND, though the CG improved their psychological distress from pre- to post-intervention (from moderate to low).

Table 3.1

Means and Standard Deviations for Resilience, Stress, Burnout, and Distress Pre- and Post-Intervention Stress Test

Group/ Variable	Pre-Intervention				Post-Intervention			
	M	*SD*	*Min*	*Max*	*M*	*SD*	*Min*	*Max*
PA								
BRS	3.28	0.98	1.67	4.50	3.27	0.75	2.67	4.17
CD-RISC	24.83	9.24	8.00	34.00	25.00	4.53	21.22	36.00
PSS	18.00	11.35	3.00	33.00	19.60	5.98	10.00	27.00
SMBM	2.92	1.30	1.21	4.29	3.57	1.42	2.00	5.14
K10	19.83	9.35	13.00	37.00	19.00	6.16	11.00	27.00
MIND								
BRS	2.75	1.62	0.00	4.67	3.63	0.89	2.67	4.67
CD-RISC	29.33	3.98	23.00	36.00	29.50	5.74	20.00	34.00
PSS	15.67	5.79	7.00	24.00	15.25	5.56	9.00	23.00
SMBM	3.40	0.87	2.07	4.14	3.00	0.53	2.43	3.71
K10	17.50	4.68	14.00	26.00	16.25	2.83	14.00	19.00
CG								
BRS	3.50	0.89	1.83	2.50	4.11	0.19	2.50	4.00
CD-RISC	29.50	4.51	26.00	26.00	34.33	2.52	22.00	37.00
PSS	19.00	6.32	17.00	29.00	11.67	7.63	5.00	22.00
SMBM	3.46	0.92	2.64	4.43	2.29	0.79	1.43	3.00
K10	20.50	5.92	17.00	29.00	13.00	2.65	12.00	19.00

Note. At pre-intervention, PA ($n = 6$), MIND ($n = 6$), and CG ($n = 4$). At post-intervention, PA ($n = 5$), MIND (n =4), and CG ($n = 3$).

Separate 2 (pre- and post-intervention) x 3 (group) mixed-model ANOVAs for each questionnaire indicated no pre- and post-intervention main effects, no significant group main effects, or interaction effects for all questionnaires. For brevity (and because results indicated non-significance for the psychological parameters), the reader is directed to Appendix Z for full written information of results.

Correlations

At pre-intervention, for PA there were strong, negative, significant relationships between PSS and SMBM, BRS and PSS and K10 and BRS. For MIND, there was a strong, negative relationship between PSS and CD-RISC. There were no significant relationships for the CG (see Table 3.2).

Table 3.2

Correlation Matrix (Pearson) for Psychological Parameters at Pre-Intervention amongst Experimental Groups

	BRS	CD-RISC	PSS	SMBM	K10
PA (n = 6)					
BRS	-	.78	-.94**	-.79	-.94**
CD-RISC		-	-.69	-.60	-.91*
PSS			-	.91*	.81
SMBM				-	.66
K10					-
MIND (n = 6)					
BRS	-	.46	-.14	-.34	.43
CD-RISC		-	-.92**	.26	-.26
PSS			-	-.48	.47
SMBM				-	-.46
K10					-
CG (n = 4)					
BRS	-	.93	-.61	-.82	-.79
CD-RISC		-	-.47	-.57	-.51
PSS			-	.84	.46
SMBM				-	.87
K10					-

* $p < .05$ *(two-tailed)*; ** $p < .01$ *(two-tailed)*.

At post-intervention, for PA there were strong, positive relationships between BRS and CD-RISC and PSS and SMBM, strong, negative relationships were found for BRS and PSS, BRS and SMBM, CD-RISC and PSS and CD-RISC and SMBM. For MIND there was a strong, negative relationships between PSS and BRS. There were no significant relationships for the CG (see Table 3.3).

Table 3.3

Correlation Matrix (Pearson) for Psychological Parameters at Post-Intervention amongst Experimental Groups

	BRS	CD-RISC	PSS	SMBM	K10
PA (*n* = 6)					
BRS	-	.93*	-.93*	-.98**	-.85
CD-RISC		-	-.94*	-.94*	-.63
PSS			-	.99**	.77
SMBM				-	.83
K10					-
MIND (*n* = 6)					
BRS	-	.61	-.96*	-.28	-.21
CD-RISC		-	-.45	.59	-.78
PSS			-	.43	.19
SMBM				-	-.71
K10					-
CG (*n* = 4)					
BRS	-	-.12	.95	.78	.98
CD-RISC		-	-.43	.53	.08
PSS			-	.53	.87
SMBM				-	.88
K10					-

** $p < .05$ (two-tailed); ** $p < .01$ (two-tailed).*

Assessment of Physical Activity

RPAQ

Shapiro-Wilk, F_{max} and Levene's test statistics were used to assess normality and homogeneity of variance. All RPAQ variable assumptions for the ANOVA were not violated except Levene's and F_{max} for vigorous hours per day, which was therefore not included in the ANOVA analysis.

A significant Group main effect for light physical activity hours per day, F (2, 9) = 4.43, p = .046, partial η^2 = .50, whereby Bonferroni post-hoc test indicated the PA and the CG were significantly different (*mean difference* = -2.70, *significance* = .05). A significant pre- to post-intervention main effect was obtained, F (1, 9) = 6.19, p = .035, partial η^2 = .41, showing that engagement in moderate physical activity increased from pre- (M = 1.08, SD = 1.18) to post-intervention (M = 2.26, SD = 1.60) for all groups. Apart from the RPAQ variables mentioned above, there were no other significant main effects for the RPAQ. There were no main effects amongst groups nor were there significant interaction effects for all RPAQ variables. For brevity, the reader is directed to Appendix Z for full written information of results.

RPAQ Correlations with Psychological Parameters

A Pearson's bivariate correlational analysis was conducted to explore the relationships between the RPAQ and the psychological parameters of resilience, stress, burnout, and distress across groups for pre- and post-intervention. At pre-intervention, a significant, strong negative relationship was found for MIND between BRS and sedentary hours per day, $r(4) = -.86$, $p < .05$, and a significant strong positive relationship was found between K10 and light physical activity hours per day, $r(4) = .85$, $p < .05$. There were no significant relationships amongst variables for PA or CG. At post- intervention, there were no significant relationships for all variables amongst all groups.

Fitness Test

Multiple, separate paired samples t-tests comparing pre- and post-intervention fitness tests for physiological parameters (HR, SBP, DBP, SDNN and RMSSD) over time showed MIND had a higher HR (T1; start exercise) at the post-intervention fitness test, compared to the T1 HR at pre-intervention fitness test, showing a mean difference of -6.75 HR units, 95% [-13.91, .411] that was statistically significant, $t(3) = -3.00$, $p < .05$, and large, $d = -1.50$ (Cohen, 1988). There were no significant results for the PA or CG for HR, nor were there any other significant results across physiological parameters for fitness tests comparing groups across time.

Psychological Parameters for Stress Test

Multiple 2 x 3 ANOVAs were conducted on the VAS comparing experimental groups before the stress test and after the stress test at both the pre-intervention stress and post-intervention stress phases. At the pre-intervention phase, a pre- vs. post-stress test VAS main effect was found, F (1, 17) = 43.74, p = .001 partial η^2 = .72, with VAS scores increasing before the stress test (M = 3.25, SD = 1.74) to after the stress test (M = 5.85, SD = 2.32), as expected for the TSST. A group main effect was found for VAS scores, F (2, 17) = 3.93, p = .04, partial η^2 = .32. Tukey's post hoc results indicating a significant difference between PA and CG (M_{diff} = 2.44, S_{error} = 0.87, p = .03, 95% [-4.68, -0.20]). There was no significant interaction effect, F (2, 17) = 1.22, p = .348, partial η^2 = .12.

At the post-intervention phase, no group main effect was found for VAS scores, F (2, 10) = 0.07, p = .938, partial η^2 = .01, there was no pre- and post-stress VAS score main effect, F (1, 10) = 0.67, p = .434, partial η^2 = .06, nor was there an interaction effect, F (2, 10) = 1.52, p = .265, partial η^2 = .23.

Physiological Parameters for Stress Test

Normality tests for cardiovascular parameters (HR, SBP, DBP, SDNN and RMSSD) was also conducted on pre-intervention baseline scores of the stress test. Skew and kurtosis scores did not significantly differ from normality for HR and SDNN. There was a deviation in kurtosis scores for both SBP and RMSSD scores for PA and for DBP within MIND, though Shapiro-Wilk tests indicated PA was normally distributed in all cases. Levene's statistic was not significant for HR and DBP where Levene's was violated for parameters SBP, SDNN and RMSSD therefore Welch statistics were used.

Given the small sample sizes in the experimental groups, the results section includes significant results on physiological parameters, though non-significant results can be found in the Appendix section (Appendix AA). Inclusion of both significant and non-significant results is crucial for the exploratory nature of the study, allowing a comprehensive examination of changes and patterns in participants' HRV parameters from pre- to post-intervention and across different groups. Presenting both types of data facilitates a holistic interpretation of the study's findings.

Heart Rate (HR)

Using multiple one-way ANOVAs to analyse the physiological data instead of a 3x2 ANOVA was justified due to small sample sizes within certain groups, which allowed for the avoidance of assumption violations and provided a suitable alternative for analysing the data.

Multiple one-way ANOVA's comparing HR during the pre-intervention phase stress test (based on each time-point within the stress test) did not indicate any significant findings ($p > .05$ in all analyses, see Figure 3.3 and Appendix AB for means and standard deviations).

A significant finding was evident within the post-intervention phase stress test. A one-way ANOVA on HR was statistically significant for T4, F (2, 10) = 4.62, $p < .04$, partial η^2 =

.48, with Tukey's HSD post hoc comparisons indicating significant higher scores for the PA compared to the MIND and CG.

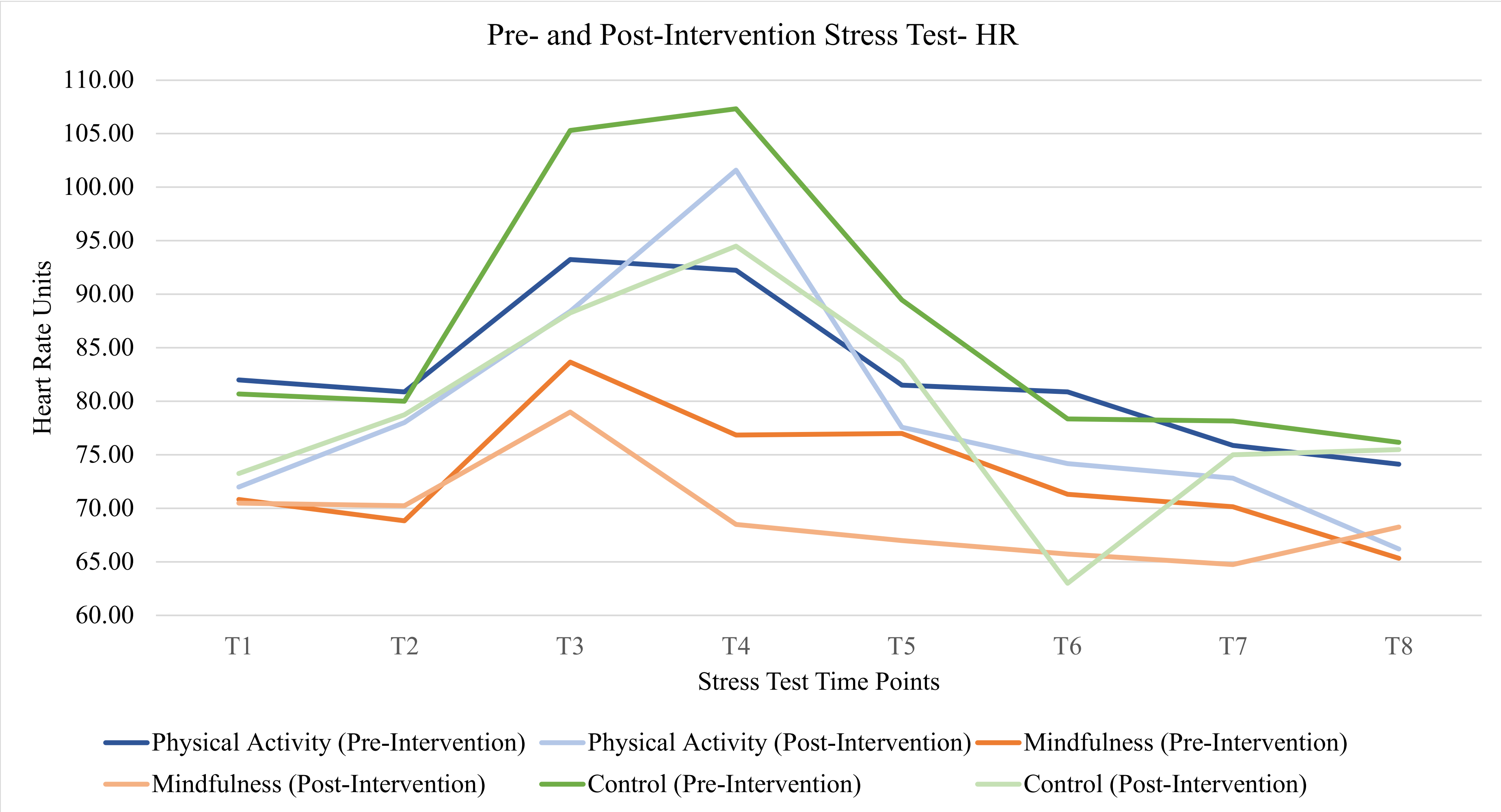
Inspection of HR at the pre- and post-intervention stress test for the PA using paired samples t-tests indicated that participants had a lower HR at T1 during the post-intervention stress test compared to the pre-intervention stress test at T1 with participants indicating an average 9.20 HR unit decline, 95% [.760, 17.640] from pre- to post-intervention. This difference was statistically significant, $t(4) = 3.03$, $p < .04$, and large, $d = 1.35$. observing non-statistically significant data during the post-intervention stress test showed that PA indicated a sharp decline in HR from T4, though this did not occur during the pre-intervention stress test. PA also showed lower HR units during T6, T7 and T8 (recovery periods) at post-intervention.

Inspection of HR at pre- and post-intervention for the mindfulness group using pair-samples t-tests indicated non-significant results ($p > .05$).

Multiple paired sample t-tests at pre- and post-intervention of the CG also highlighted non-significant results concerning HR ($p > .05$).

Figure 3.3

Mean Scores for HR during Pre- and Post-Intervention Stress Tests for Experimental Groups



Systolic Blood Pressure (SBP)

Multiple one-way ANOVA's comparing SBP during the pre-intervention stress test (based on each time-point within the stress test) did not indicate any significant findings (p > .05; see Figure 3.4 and Appendix AC for means and standard deviations).

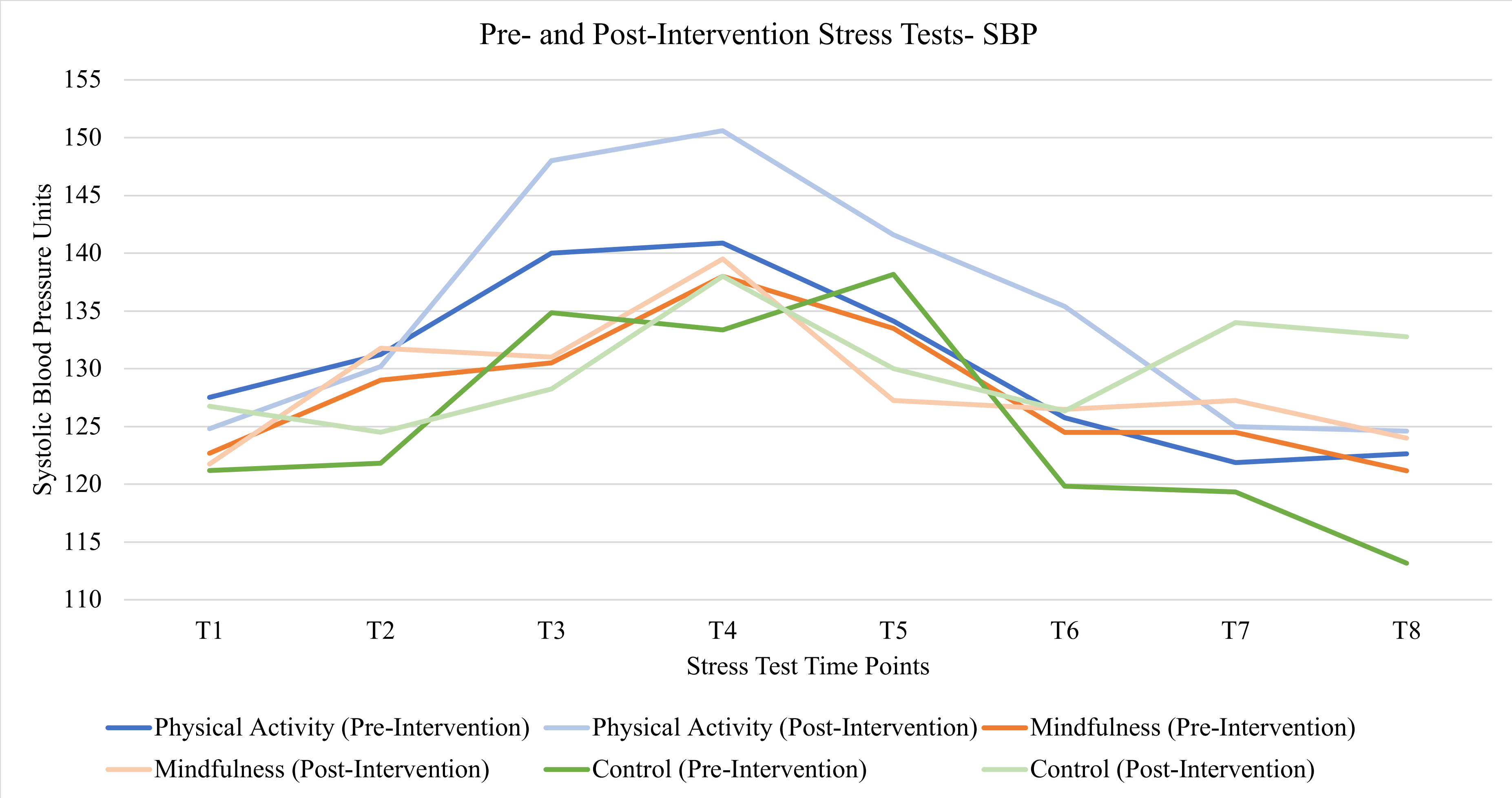
At the post-intervention stress test, there were no significant results for the one-way ANOVAs conducted (p > .05).

Analysis of SBP at the pre- and post-intervention phase stress tests for the physical activity group using paired samples t-tests indicated participants had a statistically significant difference, $t(4) = -2.96$, $p < .04$, and large, $d = -1.33$ (Cohen, 1988) and lower SBP during the post-intervention phase stress test compared to pre-intervention phase, with participants averaging a -3.8 SBP unit decrease, 95% [-7.356, -.244].

Inspection of SBP at pre- and post-intervention for MIND indicated similar data over phases, indicating that the mindfulness intervention SBP did not change (p > .05).

Figure 3.4

Mean Scores for SBP during Pre- and Post-Intervention Stress Tests for Experimental Groups



Diastolic Blood Pressure (DBP)

Multiple one-way ANOVAs comparing DBP during the pre-intervention stress tests (across time points) did not indicate any statistically significant results ($p > .05$). See Figure 3.5 for graphical information and Appendix AD for means and standard deviations.

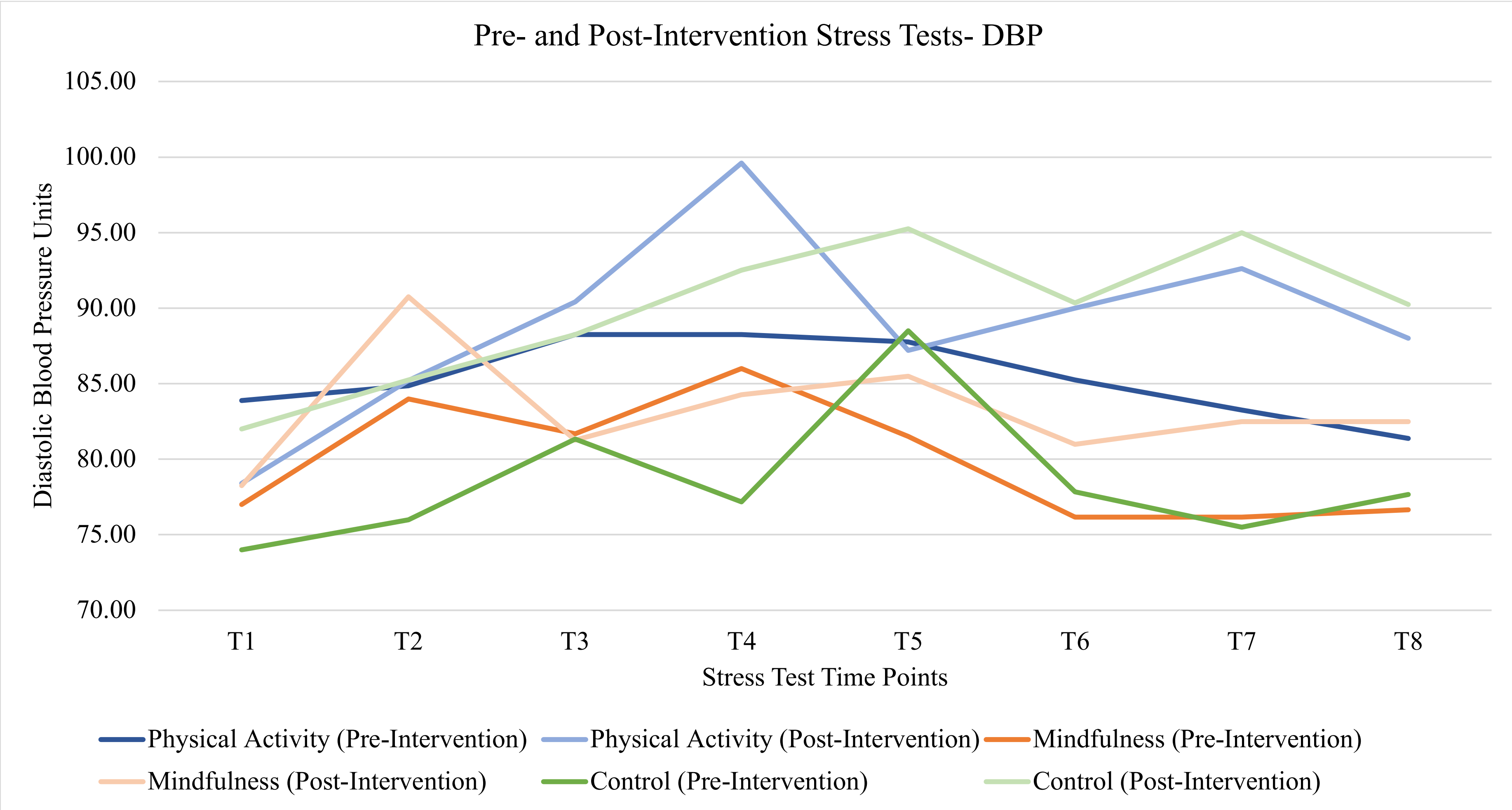
There were no statistically significant one-way ANOVAs for DBP across the post-intervention stress test time points ($p > .05$).

Analysis of DBP at the pre- and post-intervention phase stress tests for the PA using paired samples t-tests indicated a statistically significant difference at T3, PA indicated higher DBP at post-intervention, compared to pre-intervention stress test, $t(4) = -3.20$, $p < .03$, and large, $d = 4.62$ (Cohen, 1988). The PA participants demonstrated an average 6.60 DBP unit increase, 95% [-12.331, -.869] from pre- to post-intervention. During the recovery phase (T6, T7 and T8), participants in PA showed higher DBP during T7, $t(4) = -9.436$, $p < .001$, and large, $d = -4.22$ (Cohen, 1988) and T8, $t(4) = -3.074$, $p < .04$, and large, $d = -1.38$ (Cohen, 1988) compared to the pre-intervention stress test. There was a 12.80 DBP unit increase, 95% [-16.566, -9.034] at T7, and a 11.80 DBP unit increase, 95% [-22.460, -1.140] for T8 from pre- and post-intervention. Non-significant data demonstrates a sharp decline in DBP from T4 to T5.

There were no significant paired sample t-tests when comparing the MIND group from pre- to post-intervention ($p > .05$).

Figure 3.5

Mean Scores for DBP during Pre- and Post-Intervention Stress Tests for Experimental Groups



Standard Deviation of NN Intervals (SNDD)

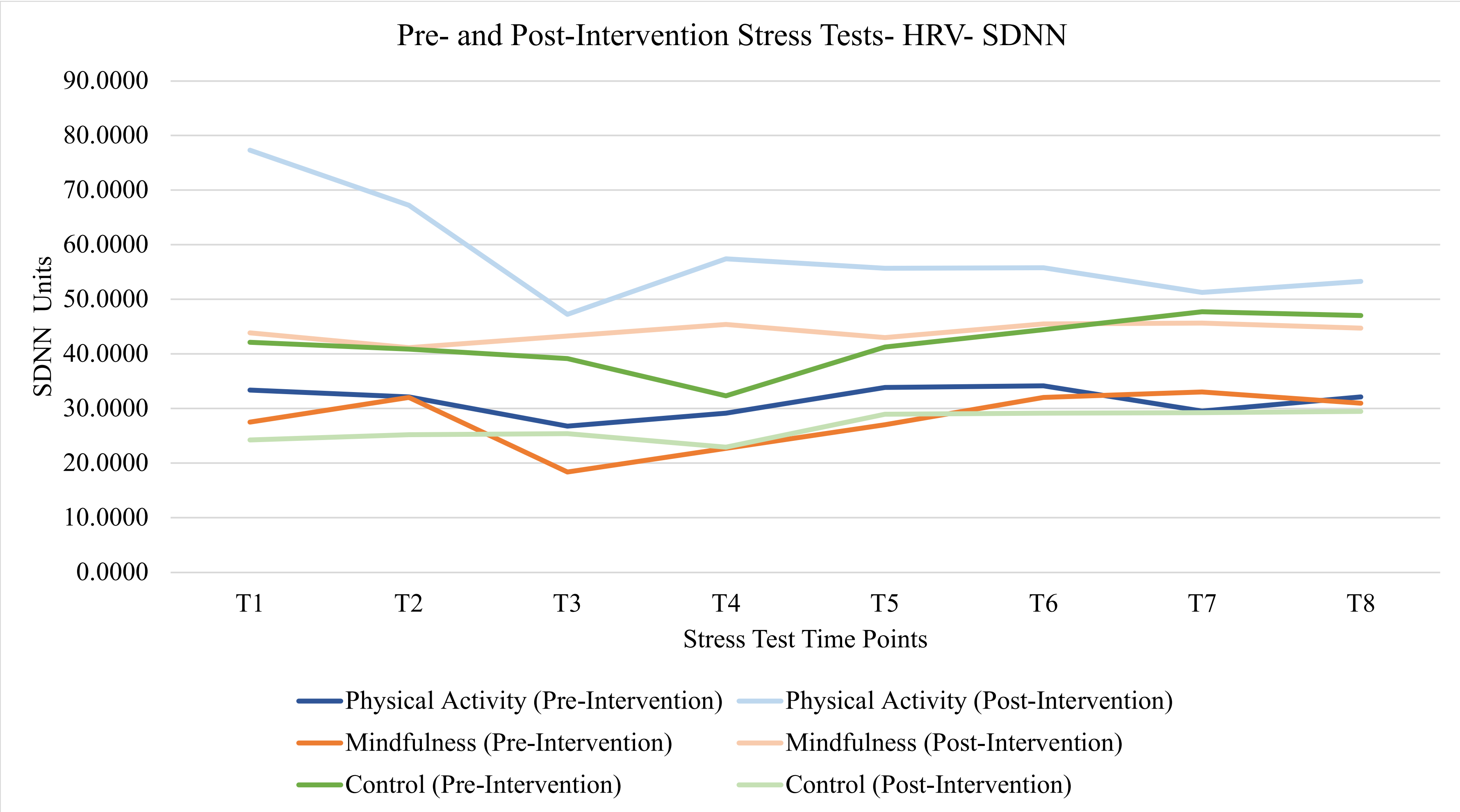
Multiple one-way ANOVA's comparing SDNN during the pre-intervention stress test across time points did not reveal significant findings ($p > .05$). See graphical data (Figure 3.6) and means and standard deviations (see Appendix AE) for further information.

Multiple one-way ANOVAs comparing SDNN during the post-intervention stress test for SDNN did not discover significant results ($p > .05$).

Multiple paired samples t-tests comparing the pre- and post-intervention scores on SDNN across stress test time points did not indicate significant results for PA, MIND nor CG ($p > .05$).

Figure 3.6

Mean Scores for SDNN during Pre- and Post-Intervention Stress Tests for Experimental Groups



Root Mean Square of Successive Differences between Normal Heartbeats (RMSSD)

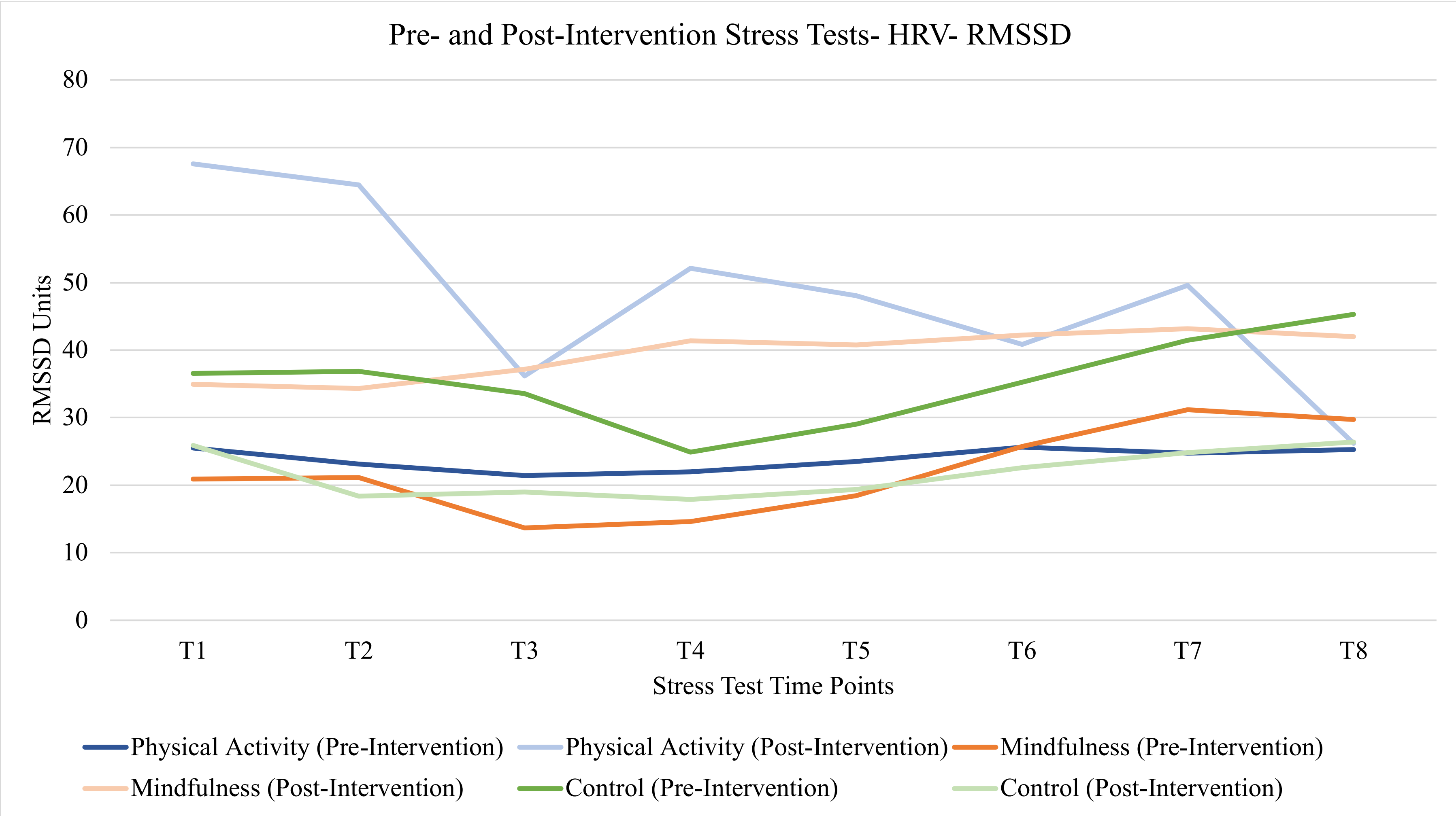
Multiple one-way ANOVA's comparing RMSSD during the pre-intervention stress test across all time-points did not illuminate any significant results ($p > .05$). . For graphical data of RMSSD see Figure 3.7 and for means and standard deviations of SDNN see Appendix AF.

Multiple one-way ANOVA's comparing RMSSD during the post-intervention stress test across all time points did not procure significant results ($p > .05$).

Multiple paired samples t-tests comparing the pre- and post-intervention scores on RMSSD across stress test time points did not indicate significant results for PA, MIND or CG ($p > .05$).

Figure 3.7

Mean Scores for RMSSD during Pre- and Post-Intervention Stress Tests for Experimental Groups



Analysis of Physiological Parameters at Rest, Over Time

Multiple one-way ANOVAs indicated there were no significant results for each of the physiological parameters at rest over time ($p > .05$). Multiple paired samples t-tests indicated identical results on cardiovascular parameters at rest (on baseline scores from pre-intervention phase and post-intervention phase stress tests).

Summary of Quantitative Findings

Quantitative data indicated hints of positive changes in physiological and psychological parameters post-intervention. Specifically, the physical activity group demonstrated improved cardiovascular recovery in response to a psychological stressor, as evidenced by significant changes in HR, DBP, SDNN, and RMSSD. The mindfulness group, whilst not significant, displayed distinctive cardiovascular responses during the post-intervention stress test, suggesting alternative reactions to stress after mindfulness training.

Given the limited sample size of this feasibility study, the interpretation of quantitative results becomes challenging due to insufficient statistical power. To comprehensively understand the impact of high-intensity physical activity and mindfulness interventions on stress resilience among student nurses, further investigation is warranted. One-on-one interviews with participants can provide qualitative insights that quantitative data may not adequately capture. These interviews would allow participants to elaborate on their experiences and perceptions of how the interventions influenced their stress resilience. The qualitative data gathered through these interviews contribute to a more holistic understanding of the feasibility and potential efficacy of the interventions, providing valuable context to complement the quantitative findings.

Qualitative Findings

Qualitative thematic analysis resulted in three main themes: (a) Building stress resilience, (b) Improving health and well-being and (c) COVID-19 impact. Three minor themes under Building stress resilience included (a1) Optimising physiological and psychological stress resilience, (a2) Developing psychological resilience, and (a3) Enhancing physiological stress resilience. Furthermore, two minor themes under Improving health and wellbeing were (b1) Coping and personal growth, and (b2) Reflection of the intervention. COVID-19 was a stand-alone theme.

Building Stress Resilience

Three minor themes under the building stress resilience contributed to an understanding of physical activity, mindfulness, and inadvertently, life experiences throughout a pandemic. Individual participants were assigned a numerical identifier to preserve their anonymity and confidentiality, based on the group in which they were assigned (e.g., PA, MIND, or CG), so participants' privacy was protected data was presented accurately.

Optimising Physiological and Psychological Stress Resilience. Participants from the PA group perceived improvements in both physiological and psychological stress resilience, though participants from the mindfulness and control groups did not express the same sentiment. When asked specifically about stress resilience, participants from the PA group explained, "Exercise was the best thing for resiliency" (PA4). Specifically, one participant suggested, "My resilience has definitely changed as a result of the intervention" (PA4). When probed about their stress resilience, one PA participant indicated, "I can describe my resilience as being more adaptable. My resilience is one where I can step back and think about things before reacting. It's made me stronger physically and mentally… which ultimately affects my resilience" (PA7). From this quote, participant PA7 highlighted how engaging in a physical activity program can optimise the psychological component of stress resilience by mentally adapting to a stressful situation and the physiological component of stress resilience by feeling stronger physically when faced with daily stressors (alluding to stress response pathways).

PA3 explained that engaging in physical activity assisted in alleviating the stress response, to stressors in general, “Exercise…my heart rate drops down…so the intervention to do exercise… would have gotten rid of stressors from my mind” (PA3). PA3 explained that they used physical activity as an intervention to alleviate stress both during and after experiencing stressors. By doing so, they found relief from the effects of stress on their body and mind and highlighted the use of physical activity as a stress reduction technique. Whilst this may not indicate physiological adaptation occurred at the time the stressor was present, it may indicate that the use of PA as a stress reduction exercise can assist with psychological wellbeing and may contribute to the development of stress resilience by enhancing stress response recovery to future stressors. Another participant from the PA group echoed similar thoughts, “You can use physical ways to get rid of stress, like doing an activity” (PA1), further indicating that physical activity may act as a resilience technique to promote an optimised mental health response to stress or after a stress encounter.

Developing Psychological Stress Resilience. Across all groups, participants felt they improved their psychological resilience. The most notable change appeared in the PA group where not only did they believe they had improved their psychological stress resilience but acknowledged the importance of managing a stressor in a more efficient manner with a focus on swift recovery. One participant indicated that their,

> Resilience to stress [felt] quicker [and they] still feel like [they] experience[d] the same level of stress with certain stressors [though] it’s a quicker recovery time…[it’s] purely [their] ability to go from high stress situation to neutral again. It’s quicker. [They’re] able to get onto the next most stressful thing quicker than [they were] previously… [their] need to rest has shortened (PA2).

Another participant in the PA group expressed they are “More comfortable with stress now” (PA1) and believed they can “tackle stress differently… it’s always going to be there as an everyday thing… I've been able to look at it, process it a bit quicker and move through it… it's accelerated" (PA1). Participants in the PA group felt that doing physical activity changed the way they "act and react" (PA4) to stressful situations. These examples highlight how participants may have changed their mindset to create a more efficient stress response process. Apparently, PA group participants regulated their psychological response to daily stressors whilst consciously focusing on the physiological reactivity to a stressor. PA1 explained, "Resilience to stress is when an obstacle comes up…you have the ability to power through it and overcome… it's like mentally able to get past the stress level to complete an obstacle or challenge" (PA1). PA1 directly attributed being a part of the intervention and engaging in physical activity in optimising their reactivity and recovery from stressors and improving their resilience. This indicates that participants in the PA group may think differently about stressors, some participants suggest changes have occurred as a result of the intervention.

Participants from the MIND, PA, and CG groups believed that they increased their psychological stress resilience, which was demonstrated through a perceived change in rumination of stressors and a change in the thought process of stressors. Participants expressed before the intervention they would "Dwell on things" (MIND1) and "It would take quite a while to stress less and switch off" (CG2). At post-intervention, participants were asked if there were changes in how they dealt with, or managed stress from pre- to post-intervention. Participants felt "Better at compartmentalising" (MIND1), "More able to cope with stress now… it helps me stay on a more even emotional plateau… I don't get as heightened as much when a situation arises" (CG2), and "Worry less about the little things… not necessarily getting past the stress but accepting [it]" (PA3). Participants from the MIND suggested they "felt good…calm… bring[s] me back down a level so I can actually think" (MIND3). Interestingly, after engaging in the intervention, the mindfulness group focused on the stress response post-stressor or stressors in general, whereas the PA group concentrated on their initial reactivity to the stressor, the importance of immediate recovery, and their stress response post-stressor. Participants from the PA group indicated they felt they were “getting better… like getting stressors out of my head… instead of it eating away at me” (PA3) and “stronger which affects my mental state…my resilience showed through” (PA7). Participants from the control group believed they had improved their psychological stress resilience through their life experience, which entailed completing their clinical placement during a pandemic with one participant suggesting they can deal with stress “A little bit better… able to work through it a bit quicker” (CG2). Overall, each group may have improved their psychological stress resilience either through the intervention or through pandemic work experience. Both the PA and MIND participants may have improved their thought processes towards stressors and post- stressor with the PA group possibly improving their thought processes on the reactivity and recovery post-stressor. This suggests that PA, MIND and CG may have improved their psychological stress resilience via various means.

Enhancing Physiological Stress Resilience. Both the physical activity and mindfulness groups indicated physiological adaptations post-engagement in their allocated activities, though this presents differently for the intervention groups. One participant expressed she felt “Physically fantastic… I feel absolute calm over me… it’s just the most beautiful thing… I feel really good” (PA4), post-engagement in physical activity, although it is unknown whether this sense of calm was physiological, psychological or a combination. One participant from the MIND group indicated engaging in meditation “Relaxes your body… you get that full rest… your mind and your body” (MIND3), which suggests optimised changes to both physiological and psychological components. MIND intervention participants indicated, the meditation “mentally relax[es] your muscles… and physically you feel lighter” (MIND4), and “I can actually feel my heart rate slow in the first couple of minutes” (MIND2). Some PA intervention participants felt they “Physically look better” (PA3), even though physical activity was always “an effort” (PA3), and “Stronger but it’s not like it got easier” (PA2). Participants identified that engaging in these activities may have had an impact on their physiological wellbeing, either through perceived instant relaxation directly post-activity or feeling stronger physically throughout their daily life. It is difficult to determine whether this relates to physiological stress resilience specifically, however we can speculate that improvements in physiological functioning, such as actively practicing the slowing of heart rate through mindfulness may promote physiological adaptation by practicing heart rate regulation. Additionally, by actively enhancing heart rate through physical activity and encouraging self-regulation, it may also promote physiological adaptations that assists with physiological responses to psychological stressors.

Improving Health and Wellbeing

Under the improving health and wellbeing major theme, thematic analysis generated two minor themes named coping and personal growth, and reflection of the intervention. These minor themes contributed to a broader understanding of participation in a physical activity or mindfulness intervention, though not directly related to stress resilience or how these interventions can be better facilitated.

Coping and Personal Growth. Participants from all groups expressed that they increased their self-esteem and emotional regulation over the course of the intervention period. When asked if participants believed there were changes to their self-esteem and emotional control from pre- to post-intervention, one participant from the PA group indicated they had improved, they felt an “Increase…level of control over emotions” and in their self-esteem (PA1). Another participant from the PA group highlighted “Some areas of self-esteem have improved… certainly whilst on placement” (PA2) suggesting that being part of the intervention may have indirectly improved their experience on clinical placements. Other participants from the PA group expressed “…getting better at letting go” (PA3) when ruminating on stressors and when they are "Exercising regularly… have better control over their emotions" (PA3). Additionally, participants highlighted that after engaging in physical activity, it "Puts [the participant] in a better mood" (PA3) and "[the participant] always feel[s] so much better… it's almost like I have this little reset" (PA5) whereby you have "A mini debrief and then get on with your day" (PA3). Participants from the PA group seemed better able to regulate their emotional reactivity to stressful situations and the act of engaging in physical activity may have improved their perspective with an optimised outlook on life in general.

Participants from MIND also experienced improved emotional regulation and self-esteem from pre- to post-intervention phases. One participant suggested that the mindfulness intervention, "Put things in perspective… trying to get on top of emotions… and mindfulness is good at keeping a quiet mind" (MIND1), whilst another participant expressed that "It doesn't have to be something stressful or important… I think the skills from the mindfulness [training] have helped me control my emotions" (MIND2). Apparently, participants were better able to regulate their emotions when faced with stressful situations after the MIND intervention period. Another participant mentioned "I know how good it's going to feel afterwards, so that encourages me to engage (in mindfulness training)" (MIND1); the participant highlights the immediate effect of practicing mindfulness that evokes a sense of encouragement to continue participation due to heightened feelings of elation post-activity.

The control group, despite not receiving any specific training, perceived enhancements in emotional regulation attributed to life experiences, including clinical placement during COVID-19 and their participation in the overall study. Participants were asked if they decreased their rumination from pre- to post-intervention. The control group participants suggested that they are "Better at it (rumination)… I have always been a dweller" (CG1) though "Think I have improved a bit (rumination) … try not to let things get to [the participant] as much" (CG2) and these participants attribute these changes to being a part of the study generally. The participants have “Learned from it” (CG2) but also highlight the changes can be attributed to clinical placement , where one participant suggested she had “So much thrown at me with the two placements” (CG2). One participant suggested that during COVID-19 and clinical placements, a social group was established and suggested that social support allowed her to “Bounce back… resilience has certainly improved” (CG1). This highlights that the entire sample were placed in high-stress situations throughout the study where clinical placement during a pandemic may have improved their emotional regulation. Participants in the control group showed differences in self-esteem compared to the physical activity and mindfulness intervention groups. When asked about changes to self-esteem over time, participants in the control group suggested their self-esteem “Dropped a little… you doubt yourself a lot… you overthink massively and expect perfection” (CG1) or expressed “I think they’ve changed” (CG3) and might be “A little bit different ” (CG2) reflecting on self-esteem specifically. This may demonstrate that whilst life experience may improve emotional regulation, and potentially psychological stress resilience, it may not improve self-esteem specifically or is difficult to determine. Improvements in self-esteem may require additional attention, such as being involved in mindfulness or physical activity interventions.

Reflection of the Intervention. Participants provided feedback on the interventions and how methods within the interventions may have affected their psychological health, wellbeing, and adherence to the program. The PA group and mindfulness group suggested that whilst they found engaging in an online intervention difficult at times because of life interruptions or technological difficulties, participants understood the benefits that would occur post-activity engagement and beyond. Participants from the PA group mentioned the intervention produced “Quite good results… mentally it’s been productive” (PA1) and thought “It was definitely worth doing” (PA2) with some participants suggesting “it was easy to access” (PA3) with the intervention being delivered online. Some PA group participants also mentioned some difficulties such as "The hardest part was… finding the time… I knew it was going to make me feel better but at the same time it was finding those three days a week" (PA2). Some participants from the PA group suggested being part of the intervention increased their contemplation of engagement in physical activity, "Once things have settled, I really want to try and do it for myself… because I know it's going to help" (PA5) and believe "It's a lifelong thing and I will continue even after this intervention" (PA4). Overall, participants of the PA group benefited from the physical activity intervention in improving their overall health and wellbeing.

Whilst some participants from the mindfulness group found value in the meditations and felt an improvement in the stress resilience and psychological health and wellbeing from pre- to post-intervention, half of the participants from the mindfulness group found the delivery of the intervention to be "A chore… a bit repetitive" (MIND1) and found "There wasn't a lot of variety in the meditations… it's not really engaging" (MIND1) and suggested "It's not easy to do, even if you want to do it… you get too busy" (MIND4). Other participants from the mindfulness group found the application to be an "advantage… it prompts your thinking… it provided structure, and it provided guidance, but it did it in a way that wasn't intrusive or overly complicated" (MIND2). One participant suggested:

> The meditation really helped …just grounding …or taking a moment… beforehand … wound up and probably have some alcohol. After [the intervention they] would [meditate] and go to bed…it's been handy… being able to choose a time or day to do [the] meditation (MIND3).

Despite the barriers suggested, participants felt that doing the meditation "Helped calm me down" (MIND4) and improved their health and wellbeing.

COVID-19

Importantly, all groups emphasised the significant impact of COVID-19. One participant suggested their wellbeing suffered, “It’s all just COVID-19 stuff… travel bans… vaccinations… have had an impact on me” (CG3). Similar sentiment was voiced by a participant in the mindfulness group reflecting on COVID-19 “… certainly had a lot to be stressful about in terms of significant changes in how we did things” (MIND2) including continuously changing protocols during clinical placement, changes to university learning (going online) as well as the government-mandated lockdowns. This highlights the additional pressures placed on all participants during the intervention period.

Feasibility Results

Were Recruitment Protocols Feasible? The reasons for recruitment underscored the relevance and resonance of the intervention programs with the participants’ goals and interests. Students joined the study with a genuine enthusiasm to enhance stress resilience, improve health and well-being, and explore effective coping mechanisms. This alignment between participants’ motivations and the study objectives not only demonstrated the practical feasibility of recruiting participants but also highlighted the intrinsic appeal of stress management interventions in the context of nursing education. The diverse recruitment reasons reflected a genuine interest in the potential benefits of the interventions, emphasising the applicability of similar programs in broader healthcare training settings.

Prior to the allocation of participants to their respective experimental groups, informal researcher notes indicated the majority of students expressed a strong inclination toward participating in the PA intervention rather than the MIND intervention. This indicates potential difficulties in engaging participants in mindfulness activities, compared to physical activity programs. Despite this preference, challenges arose in meeting the target of enrolling 12 participants in each experimental group, in accordance with recommended feasibility study guidelines (Bowen et al., 2009). These challenges in recruitment may also be attributed to the busy schedules of student nurses, particularly during the COVID-19 pandemic, which introduced additional stressors and demands on their time.

Was The Intervention Protocol Acceptable? Attrition manifested at various stages of the intervention protocol, impacting the participant cohort, which initially comprised 20 individuals before pre-testing. During this preliminary phase, three participants withdrew. Subsequently, prior to the commencement of the intervention in Week 1, two participants withdrew due to pregnancy, rendering them ineligible for continued participation. Attrition persisted during the intervention, resulting in three additional departures—a participant citing injury and two formally withdrawing without providing reasons for their disengagement. The culmination of attrition led to a final participant count of 12, underscoring the challenges associated with maintaining participant commitment throughout the intervention period. Understanding the factors contributing to attrition is essential for refining intervention strategies and fostering sustained participant engagement.

Adherence to the intervention protocol was not explicitly monitored by me throughout the intervention due largely to COVID restrictions. Instead, participants reported their engagement in the program on a weekly basis through journal entries. Additionally, I did (or could) not actively monitor the intensity level of participants during each session. This decision was influenced by the substantial amount of data already collected, including weekly journal entries that provided insights into participants' program engagement. The omission of real-time intensity monitoring was deemed reasonable given the comprehensive nature of the data obtained through other means, allowing for a pragmatic balance between data collection and participant burden.

Participants were encouraged to continue any regular exercise they were involved in before the intervention, aiming to maintain real-world relevance. However, interviews revealed that participants engaging in the exercise intervention tended to increase their exercise levels outside the program. External physical activity beyond the intervention was (or could) not be actively monitored. Additionally, the exercise intensity during the intervention was participant-dependent, introducing a potential inconsistency among participants. Despite this, the protocol demonstrated acceptability, with participants integrating the exercise into their routine, highlighting the real-world applicability of the intervention. Future studies might consider refining methods to monitor and standardise external physical activity and exercise intensity for a more comprehensive assessment of intervention purity.

Considerations for Intervention Accessibility. The intervention's accessibility was a crucial consideration, emphasising the need for sustainability and scalability. The study aimed to develop an intervention that could be feasibly implemented on a larger scale, ensuring its accessibility to a broader population. Strategies were employed to enhance sustainability, such as delivering the interventions online, which provided participants with flexibility in engaging with the programs remotely. Despite challenges related to participant adherence and dropouts, the online format contributed to the accessibility of the intervention. The intervention scalability was demonstrated by its potential to be disseminated to a larger audience, leveraging technology to reach diverse settings and populations. Whilst the study encountered some barriers, the emphasis on accessibility, sustainability, and scalability underscored the importance of creating interventions that can be integrated into real-world contexts and extended to diverse participant groups in the future.

Additionally, the intervention feasibility was influenced by the challenges associated with managing participants' submission of data files, particularly those related to heart rate variability (HRV). Participants submitted HRV data files regularly, providing insights into their physiological responses. Managing this process remotely was challenging, especially considering the technological nuances and potential barriers faced by participants. However, the study implemented a practical solution by facilitating the submission of data files through email communication. Whilst this approach added an extra layer of complexity, it proved manageable, enabling participants to share their physiological data without the need for in-person interactions. The experience highlighted the importance of employing adaptable strategies to overcome logistical challenges, ensuring the successful integration of technology-dependent components within the intervention.

Discussion

The purpose of this study was to monitor changes of a physical activity and a mindfulness intervention program on psychological and physiological stress resilience of third-year nursing students during the COVID-19 pandemic. This study provides insight on the psychological wellbeing of student nurses in Australia during COVID-19. Further, this study examined the feasibility of a physical activity and a mindfulness program on stress resilience on nursing students.

Hypotheses

It was hypothesised that positive changes would occur for both physiological and psychological parameters from pre- to post-intervention for both the physical activity and mindfulness intervention groups. This was partially supported. Quantitative data (whilst mostly non-significant) provided hints to support this hypothesis, yet qualitative data may indicate increases in both physiological and psychological stress resilience. This presented differently psychologically and physiologically for the physical activity and mindfulness groups in terms of their experience and reaction to stressful situations overall.

It was assumed that there would be greater physiological improvements in response to stress and enhanced psychological wellbeing scores (including resilience) from pre- to post-intervention for both the physical activity and mindfulness groups. This hypothesis was partially supported through quantitative data but also qualitative data. The PA group improved cardiovascular recovery in response to a psychological stressor for parameters HR, DBP, SDNN and RMSSD. Interestingly, though non-significantly, the mindfulness group 'flat-lined' in their responses during the post-intervention stress test. This was unexpected when quantifying their cardiovascular reactivity and recovery in response to a psychological stressor and may allude to alternative cardiovascular reactions to stress after mindfulness training.

It was presumed that there would be strong positive relationships between resilience and physical activity and strong negative correlations with resilience and stress, resilience and burnout, resilience and distress, physical activity and stress, physical activity and burnout, and physical activity and distress. This was supported at pre-intervention, with results indicating strong negative relationships for the mindfulness group between resilience and sedentary hours per day, and a strong, positive relationship between light hours of physical activity per day and distress. Additionally, at post-intervention, strong, negative relationships were found for resilience and stress for both the physical activity and mindfulness groups.

Feasibility Objectives

The study aimed to assess the feasibility of implementing a high-intensity physical activity program and a mindfulness intervention program for stress resilience among student nurses during the COVID-19 pandemic. In terms of recruitment rates and participants' expectations, the study found that recruitment was challenging, partly due to the busy schedules of student nurses, especially during the pandemic. Despite the majority of students expressing a preference for the physical activity intervention, challenges arose in meeting the target of 12 participants per group. Regarding intervention accessibility, the study employed online delivery, enhancing sustainability and scalability, but encountered challenges in managing participants' submission of data files. Attrition and adherence were notable concerns, with attrition occurring at various stages. Despite some challenges, the protocol demonstrated acceptability, with participants integrating exercise into their routine. The study highlighted the importance of adaptable strategies for intervention accessibility, emphasizing the need for real-world integration and addressing logistical challenges.

Developing Stress Resilience

Based on the tentative relationship between physical activity and resilience, it was assumed that engaging in high-intensity physical activity would improve psychophysiological stress resilience. This was apparent when comparing the non-significant data at pre- and post-intervention phase stress tests on cardiovascular parameters. The current study's primary focus was on a swifter recovery post-stressor, with participants in the PA group showing greater physiological recovery (in some cases a full return to baseline) compared to the mindfulness and control groups during the post-intervention TSST. After the intervention, there was an increase in cardiovascular reactivity (compared to pre-intervention) towards the TSST for HR, SBP and DBP. Further, there was a decrease in cardiovascular parameter output, which indicates recovery across time-points for these parameters except for SBP. There were decreases in SDNN and RMSSD during the stress tasks with the TSST at both pre- and post-intervention, which was an expected outcome of the TSST on HRV indices (Lackschewitz et al., 2008; Sghir et al., 2012) and complements the current data set. Non-significant data indicated that the PA group had a swifter recovery (or increase) in SDNN and RMSSD at post-intervention and SDNN and RMSSD showed an overall higher HRV across all time-points at post-intervention (compared to pre-intervention) during both the speech task, mental arithmetic task, and HRV at rest. This finding is similar to researchers who have also found an efficient recovery from stress suggests a more physiologically resilient stress response system (Hughes et al., 2018; Kim et al., 2018; Tugade & Fredrickson, 2004). Further, a higher HRV overall from pre- to post-intervention highlights participants in the PA group indicated a greater physiological resilience to psychological stressors post-intervention, particularly compared to other groups. Caution is advised when observing changes in cardiovascular variables as variation in measurements can also be attributed to individual variability (Mancia & Grassi, 2000; Muntner et al., 2011), rather than changes based on intervention influence.

It was assumed that engaging in physical activity would improve psychological stress resilience outcomes (as measured by the two resilience scales), however, there were no statistically significant changes in the quantitative data from pre-to post-intervention for the PA group. This is contradictory to past research, which highlights that engaging in physical activity (including high-intensity physical activity) can improve psychological well-being outcomes (Deuster & Silverman, 2013; Gerber, Lindwall, et al., 2013; Hawker, 2012; Heidke et al., 2021; Henwood et al., 2012; Klainin-Yobas et al., 2015; Lovell et al., 2015; Naczenski et al., 2017; Schofield et al., 2016; Tyson et al., 2010) including resilience (Childs & de Wit, 2014; Dunston et al., 2022; Ho et al., 2015; Matzka et al., 2016; Ozkara et al., 2016; Seçer & Çakmak Yıldızhan, 2020), for nursing and the general population. One reason for the disparate results is that most research on physical activity engagement and resilience is cross-sectional. As the current study used an intervention, it is wise to use caution when comparing outcomes, however, limited psychological optimisation of wellbeing parameters in this study may be because of the short duration of the physical activity program rather than alternative study design procedures. There are limited frequency or duration prescription guidelines to improving psychological resilience and wellbeing parameters, let alone by means of a physical activity program. Thus, a longer physical activity program (12-weeks or more) may contribute to positive psychological change over time. A feasibility study conducted by Mealer and colleagues (2014) found that psychological resilience, as measured by the CD-RISC, can improve among intensive-care nurses who engage in 30-45 minutes of exercise three times per week over a three-month period. However, adherence to the exercise program was not monitored, and the exercise program was implemented in conjunction with a psychological resilience program, making it challenging to determine the specific effects of the exercise program on resilience. Additionally, results across the three intervention groups may indicate that the impact of COVID-19 and the increase in workplace stressors for the student nursing sample may have overpowered potential benefits of the program. High workplace stress due to COVID-19 was prevalent in graduate nursing populations globally (Bohlken et al., 2020; Labrague, 2021; Lai et al., 2020; Pappa et al., 2020; Shen et al., 2020; Tiete et al., 2021; Yörük & Güler, 2021), and we can assume the same for the student population considering they were on clinical placement during the intervention period as well.

Qualitative analysis indicated changes to both physiological and psychological outcomes in response to real-life stressful situations (including COVID-19 related stressors) based on involvement in the physical activity intervention. There is limited interview-based research on the effects of physical activity on resilience within a nursing population (let alone student nurses during COVID-19), yet some qualitative research alludes to the importance of physical activity in improving resilience. In a qualitative interview-based study conducted by Mealer et al. (2012) on 27 nurses, the highly resilient nurses, who were identified as having better coping abilities both at home and work environments (using the CD-RISC), tended to engage in physical activity, healthy nutrition choices, and good sleeping habits as coping mechanisms and implemented them into their daily lives. Further, Brown et al. (2021)'s interview-based research explored resilience-building resources among Australian clinicians and nurses during COVID-19 and found participants were likely to use physical activity as a resilience resource to combat workplace stress. Participants within Brown et al.'s study highlighted the importance of adaptability to the changing environment as essential to their personal psychological resilience. Participants in the current study made similar comparisons, suggesting physical activity to be a resource that can assist in combating the stressful situations within the workplace and improve stress resilience overall. Fried et al. (2018) reported comparable findings to the current qualitative results in a mixed-method study on 30 university students that implemented a year-long physical activity and mentoring program aimed at enhancing psychological resilience; however, it should be noted that their program promoted participation in physical activity rather than providing physical activity prescriptions. Fried et al.'s study showcased similar themes, to the current study, such as increased psychological resilience (with a specific focus on stress management), improved personal growth, increased contemplation and engagement in physical activity and the importance of mental health (awareness). Fried et al.'s program appeared to improve psychological resilience (though physiological resilience was not considered) and used a similar definition to the current study with a focus on adversity (stress) and positive adaptation (to environmental conditions), paralleling stress resilience conceptually. Differences between the Fried et al. and the current study were that the Fried et al. participants were not nursing students specifically, and the research was not conducted during a pandemic. Fried et al., Brown et al., and the current study's results suggest that stress resilience can be optimised by increasing engagement in physical activity and physical activity should be considered as a therapeutic intervention to improve stress resilience.

The Impact of Physical Activity

Physical activity did not optimise psychological wellbeing from pre- to post-intervention. Participants in the PA group presented with moderate levels of stress, burnout, and distress levels before and after the intervention (no change). This contradicts research on physical activity and the improvement of psychological wellbeing variables (Bentley et al., 2013; Gerber, Lindwall, et al., 2013; Heidke et al., 2021; Hui, 2002; Klainin-Yobas et al., 2015; Lovell et al., 2015; Schofield et al., 2016; Tyson et al., 2010). Moreover, the correlations between RPAQ and psychological variables conducted at post-intervention across groups did not yield significant findings indicating that participation in the physical activity intervention did not have a positive impact on psychological well-being, including resilience. According to the RPAQ data, participants in the PA group did not exhibit an increase in their level of physical activity engagement from pre- to post-intervention. Participants might have maintained a consistent level of involvement in high-intensity physical activity three days per week even before the intervention. Such pre-existing high engagement levels could contribute to the limited observed findings regarding psychological changes over the intervention period. It is essential to consider potential factors contributing to this lack of change, including the effectiveness of the intervention or the likelihood that participants did not adhere to the prescribed regimen. Additionally, comparison of pre- and post-intervention fitness scores (MET and VO_{2max}) did not indicate a change for the PA group. A potential confounding factor that may have influenced results is participant accountability when engaging in the physical activity program. Firstly, regarding adherence to the program, participants indicated that they engaged in the intervention three days per week though this was not monitored specifically by the lead researcher (due to COVID-19 restrictions). Secondly, regarding energy output, participants engaged at a high-intensity level throughout the intervention (and were shown how to check this via the heart rate on their watch), though each session could not be monitored by the lead researcher remotely and participants may not have engaged in the program at the appropriate intensity. Physical activity research, particularly when conducted remotely due to COVID-19 mandated lockdowns, is challenging to implement. In addition, the relationship between physical activity and psychological wellbeing is complex and therefore it is difficult to ascertain a dose-response (Rejeski, 1994; Scully et al., 1998).

The Impact of Mindfulness Training

During COVID-19, mindfulness might have become a resilience building resource, similar to physical activity (Brown et al., 2021). Upon examination of the physiological data comparing pre- and post-TSST for the mindfulness group, unexpected patterns emerged, especially when contrasting the results with the physical activity program. Notably, inspection of graphical representations indicated that participants in the mindfulness group exhibited a distinctive ‘flat-lining’ pattern in their cardiovascular reactivity during the TSST. Perhaps individuals in the mindfulness group did not display the expected fluctuations in HRV parameters typically associated with stressors during the TSST, indicating a unique physiological response that did not necessitate subsequent recovery for HRV parameters.. These results juxtapose the physical activity results for reactivity and recovery. Additionally, SDNN and RMSSD showed greater HRV overall at post-intervention (including baseline, during the stress tasks and at rest) for the mindfulness group, which was similar to the PA group and presented similar results to a randomised control trial on undergraduate students (Shearer et al., 2016). This may suggest that engaging in the mindfulness intervention improved HRV, and therefore may have increased physiological resilience to stressors. However, the flat-lining effect suggests that mindfulness may affect the likelihood of stress response activation, though this may not suggest an optimised physiological response. The ‘flat-lining’ effect may present an alternative presentation of physiological adaptation of the stress response, one that is optimised yet not well understood within the literature of stress resilience physiology. The mindfulness group showed a decrease in reactivity from pre- to post-intervention for HR and DBP but not for SBP. This aligns with the ‘flat-lining effect’ observed in the HRV parameters, indicating a physiological stress response change in reaction to the stressors presented during the TSST. Research has shown decreased reactivity to psychosocial stressors after mindfulness training (Christodoulou et al., 2020; Keng et al., 2011; Nyklíček et al., 2013), yet the ‘flat-lining’ effect is difficult to compare with previous research using the TSST unless diagrams of HRV fluctuations over time can be inspected. ‘Flat-lining’ may suggest: 1) habituation occurred within the mindfulness group where the participants adapted to the stressors presented in the TSST, 2) participants showed a cardiovascular maladaptive response in reactivity to stress, even though participants HRV increased overall from pre- to post-intervention and finally, 3) participants showed adaptation to psychosocial stressors in an unexpected manner where limited reactivity could be construed as benefit and the body (or stress response) maintains homeostasis in the face of a stressor. Further research is needed to understand this physiological presentation towards a psychosocial stressor.

Psychologically, mindfulness group participants did not improve in psychological wellbeing from pre- to post-intervention. The mindfulness group showed a moderate level of stress and burnout from pre- to post-intervention, distress was low from pre- to post-intervention, and resilience increased from low to moderate levels from pre- to post-intervention (albeit a non-significant increase). The small sample size may have contributed to a lack of power within statistical analysis to capture the modest effects of changes from pre- to post-intervention. The current results challenge the literature that has demonstrated the positive impact of mindfulness in improving resilience (Sood et al., 2011), stress (Wolever et al., 2012), and burnout (Goodman & Schorling, 2012) amongst healthcare worker populations. Contradictorily, an Australian pilot study on a nursing population implemented a mindfulness program over four-weeks and indicated improvements in burnout and stress, though not resilience, as measured by the CD-RISC (Craigie et al., 2016). One difference between the Craigie et al. and the current study was that the Craigie et al. sample consisted of highly experienced senior nurses, rather than student nurses. It is understood that greater workplace experience correlates with greater psychological wellbeing including lower prevalence of burnout, anxiety and stress (Abram & Jacobowitz, 2021; Gómez-Urquiza et al., 2017; Holland et al., 2013; McGarry et al., 2013; Robins et al., 2018; Zeng et al., 2020) and may account for the discrepancy in results. Nevertheless, mindfulness interventions vary in their delivery and their content; some mindfulness programs involve cognitive behavioural therapy, yoga sessions, educational information, and breathing exercises, which makes comparison of data amongst studies difficult. In addition, researchers stipulate that there is no suggested duration for mindfulness interventions to be effective (Carmody & Baer, 2009; Dharmawardene et al., 2016) and therefore hard to compare studies. It is conceivable that a lack of improvement in resilience and psychological wellbeing factors may be due to intervention length and/or may require additional components within the program itself, such as cognitive behavioural therapy. A shorter intervention may be more conducive to the high-stress workplace environments of nurses and student nurses.

Qualitative analysis revealed the mindfulness group may have improved in both physiological and psychological stress resilience. Psychologically, the mindfulness group may have focused on their relationship with stress overall (i.e., how stressors at work impact their daily living), compared to the PA group that focused on their immediate response to an imminent stressor (i.e., reactivity and recovery in a psychological capacity). Research on the effects of mindfulness training indicates improvements in cognitive appraisal of stressors, resulting in a decreased stress response (Garland et al., 2010; Mantzios, 2014) with similar results to the current sample on their perception towards stressors and improvement in stress resilience. Researchers have proposed that engaging in mindfulness training decreases emotional reactivity and rumination of stressors, which improves the stress response processes (Chiesa & Serretti, 2010). Physiologically, mindfulness participants in the current study indicated changes to their general daily living, feeling more 'relaxed', though did not indicate changes to how they handle an immediate stressor. In a mindfulness training study, Craigie et al. (2016) also found participants recognised the impact of workplace stressors upon daily living and learned the importance of resilience and coping skills which brought them a sense of calm (physiologically and psychologically). These two Australian intervention studies may highlight the overarching impact of mindfulness training in optimising the stress response by continually adapting to daily stressors which assists when major stressors arise.

COVID-19: A Real-World Stressor

It must be acknowledged that the impact of COVID-19 may have influenced results of the present study and negated results of the intervention. The pressures of COVID-19 on student nurses and the nursing population were all-encompassing, affecting university, work, and family life (Jackson et al., 2023). Garcia-Martin et al. ‘s (2021) qualitative research on Spanish graduate nurses within the ED highlighted high levels of stress due to inexperience during the pandemic. In Australia, Halcomb et al. (2020) cross-sectional study on the experiences of nurses during COVID-19 indicated participants were worried for their physical, psychological, and family safety. Interviews in the current study highlighted the negative impact of COVID-19 on participants regarding “stress” due to change in university and clinical placement processes. It is difficult to ascertain, yet it may be presumed, that whilst there were no significant changes in psychological variables from pre- to post-intervention, the participants psychological wellbeing may have declined from pre- to post-intervention had they not been involved in the physical activity or mindfulness interventions. Although we included a control group to compare psychological and physiological measures (and results were similar to the experimental groups), this pilot study control group sample size was too small for comparisons among groups.

Feasibility Findings

Recruitment. Despite employing flexible recruitment strategies, participants cited ongoing challenges in balancing academic commitments and personal obligations, especially during the COVID-19 pandemic. Future research could explore targeted engagement initiatives, such as academic incentives, mentorship programs, or leveraging peer networks, to address specific barriers faced by student nurses. This may enhance participation rates and provide a more nuanced understanding of individualised recruitment preferences within the nursing education context.

Attrition. Participants revealed various reasons for attrition, including unexpected life events and competing priorities. Integrating regular check-ins and feedback sessions could provide a platform for participants to voice concerns and allow researchers to proactively address issues, potentially reducing attrition rates. Exploring personalised interventions based on individual needs emerged as a participant-suggested strategy, emphasising the importance of participant-centred approaches in intervention design.

Adherence and Intervention Purity. Whilst the study demonstrated participants' commendable dedication through weekly journal entries, fostering an even more enriched participant experience could involve real-time engagement tracking tools. Implementing innovative technologies, such as wearable devices or mobile applications, could enhance adherence monitoring without imposing additional burdens. Moreover, future research might consider refining intervention protocols to include personalised exercise plans, ensuring alignment with participants' evolving fitness goals. This approach could optimise intervention purity by standardising and tailoring exercise intensity, promoting a more consistent and impactful experience across diverse participants. The integration of technology-driven solutions and personalised interventions could elevate the study's approach, offering participants a dynamic and adaptive stress management experience.

Intervention Accessibility. The online delivery format was generally well-received; however, participants indicated a preference for a more interactive and user-friendly platform. Future interventions could benefit from incorporating interactive elements, discussion forums, and a user-friendly interface. Additionally, exploring the integration of mobile applications or virtual communities could enhance engagement and accessibility, aligning with participants' desire for more dynamic and engaging program formats.

Managing participant data. The study successfully navigated the intricacies of collecting heart rate variability (HRV) data from participants, emphasising the need for sophisticated data management strategies. As technology evolves, future investigations could explore cutting-edge data platforms, leveraging artificial intelligence algorithms for seamless HRV analysis. Additionally, establishing a participant-centred data-sharing platform, where individuals can gain insights into their physiological responses, may foster a sense of empowerment and further engagement. This forward-thinking approach aligns with the ever-expanding landscape of digital health and underscores the potential for transformative participant experiences in stress management interventions.

Limitations

The current findings should be interpreted in light of the present limitations. Firstly, this was a feasibility study and contained a small sample with third-year nursing students volunteering for the study, therefore may not represent findings that can be generalised to other student nursing populations. Further, given the small sample size, statistical analyses are limited, and interpretations, particularly for effects less than large, should be approached with caution; hence, both significant and non-significant data were considered for a more comprehensive understanding. Secondly, the psychological data may be subjected to social desirability bias particularly for retrospective physical activity and resilience questionnaires (Adams et al., 2005; van de Mortel, 2008) and physical activity specifically, may not provide accurate information of frequency, duration and intensity levels of physical activity compared to more objective measures. Additionally, due to social distancing requirements imposed by COVID-19, our face-to-face physical activity sessions were conducted remotely, as such we did not obtain objective data on intensity level of participants during workouts. Whilst we calculated physical activity intensity ranges for each participant, and participants could check these intervals on their Suunto wristwatch, the lead researcher had to trust participants were performing at a high intensity level during their workload sessions, which could not be helped due to COVID-19 lockdown mandates. Lastly, the sample completed night shift rounds on their placement, and whilst this was unavoidable given the population type, interruptions to circadian rhythms can have a negative impact on cardiovascular functioning (Arslan et al., 2019; Burch et al., 2019; Souza et al., 2015; Stein & Pu, 2012).

Future Research

The findings of the current study present solid foundations for further research. Whilst the sample size was small, this mixed-method pilot study explored the use of physical activity as an intervention to optimise stress resilience and captured physiological, psychological, and qualitative data on a critical population during the COVID-19 pandemic. Further research should include a larger sample in order for the study to be more reflective of the target population. Intervention studies during COVID-19, whilst difficult, present underlying opportunities for researchers within the stress field. The pandemic environment provided a real-world stressor for all participants involved in the study and offers additional information on how target populations handle real-world stressors, which is highly critical given the research is focused on stress resilience. Further, as research on physical activity as a facilitator of stress resilience is limited, the frequency and duration of the physical activity program may have been insufficient to optimise physiological and psychological stress resilience. Whilst 20 minutes of exercise, three times per week for 8-weeks has been shown to induce positive psychological optimisation (Morgan et al., 2013), a longer program such as 12-weeks may promote measurable changes that indicate improvements in stress resilience.

Future recommendations for the study involve advancing technological capabilities, leveraging wearable devices, and artificial intelligence algorithms for real-time physiological data collection and analysis. A participant-centric approach should be emphasised through the development of secure and user-friendly platforms, enhancing participant engagement with their physiological data. Further exploration of artificial intelligent-driven algorithms for HRV analysis is warranted to uncover patterns and enhance stress management strategies. Future interventions can benefit from incorporating real-time adherence monitoring through wearable technology or apps, ensuring continuous tracking of participant adherence to protocols. Integrating quantitative data with qualitative insights should remain a priority for enhancing future feasibility assessments and refining intervention strategies.

Conclusion

Although caution must be exercised when drawing inferences from both significant and non-significant data in both psychological and physiological measured used in this study, nursing students in the PA group exhibited an improvement in physiological resilience for specific cardiovascular parameters, as evidenced by pre- and post-intervention comparisons. Both the physical activity and mindfulness groups displayed increased HRV adaptability from pre- to post- intervention when faced with a psychosocial stressor and at rest. Nevertheless, the mindfulness group illustrated limited reactivity to the psychosocial stressor at post-intervention. Considering the implications in results of the present study, it would be beneficial to replicate this study outside of a pandemic situation to compare results, which would help researchers further understand the ramifications of COVID-19 on psychological wellbeing and stress resilience. Stress resilience interventions, which incorporate physical activity, may improve psychological health, increase workplace productivity, and decrease the likelihood of stress-related disorders and burnout that are prevalent within nursing populations and student nurses entering the workforce.

Chapter 6

General Discussion

The primary aims of this dissertation were to understand the relationship between stress resilience and physical activity and to monitor changes that may have occurred through engagement of physical activity on stress resilience. To explore these aims, the dissertation comprised of three studies. Study 1 monitored the relationships between stress resilience, stress, and burnout amongst hospital staff over a longitudinal period during the COVID-19 pandemic. Study 2 examined the relationship between stress resilience and physical activity cross-sectionally on emergency nurses before and during the pandemic. Using a mixed-method approach, Study 3 explored the use of physical activity as a facilitator of stress resilience on student nurses during COVID-19, and compared a physical activity program to a mindfulness intervention in optimising stress resilience.

Whilst Study 1 did not directly compare physical activity and stress resilience directly, it alluded to information on the effect of COVID-19 on psychological variables of hospital staff, including stress resilience. Study 1 results indicated that COVID-19 had a negative influence on psychological health over time, resulting in high stress and burnout and a decline in stress resilience across generalised nursing populations. Study 2's correlational data before and during COVID-19 on ED nurses indicated no relationship between physical activity and stress resilience, though it also demonstrated that ED nurses have limited engagement in physical activity overall. Study 3 provided conflicting results on the relationship and facilitative approach of physical activity on stress resilience, whereby cardiovascular markers of stress resilience indicated subtle improvements from pre-to-post intervention, psychological parameters did not indicate change over time, and interview-based data indicated improvements in stress resilience based on physical activity and mindfulness training. This chapter presents overarching outcomes from the three studies and provides an in-depth exploration of the COVID-19 impact with subsequent sections delving into additional dimensions. These include the intricate interplay between stress resilience and physical activity, as well as the theoretical and practical implications for hospitals, future research, and the nursing community.

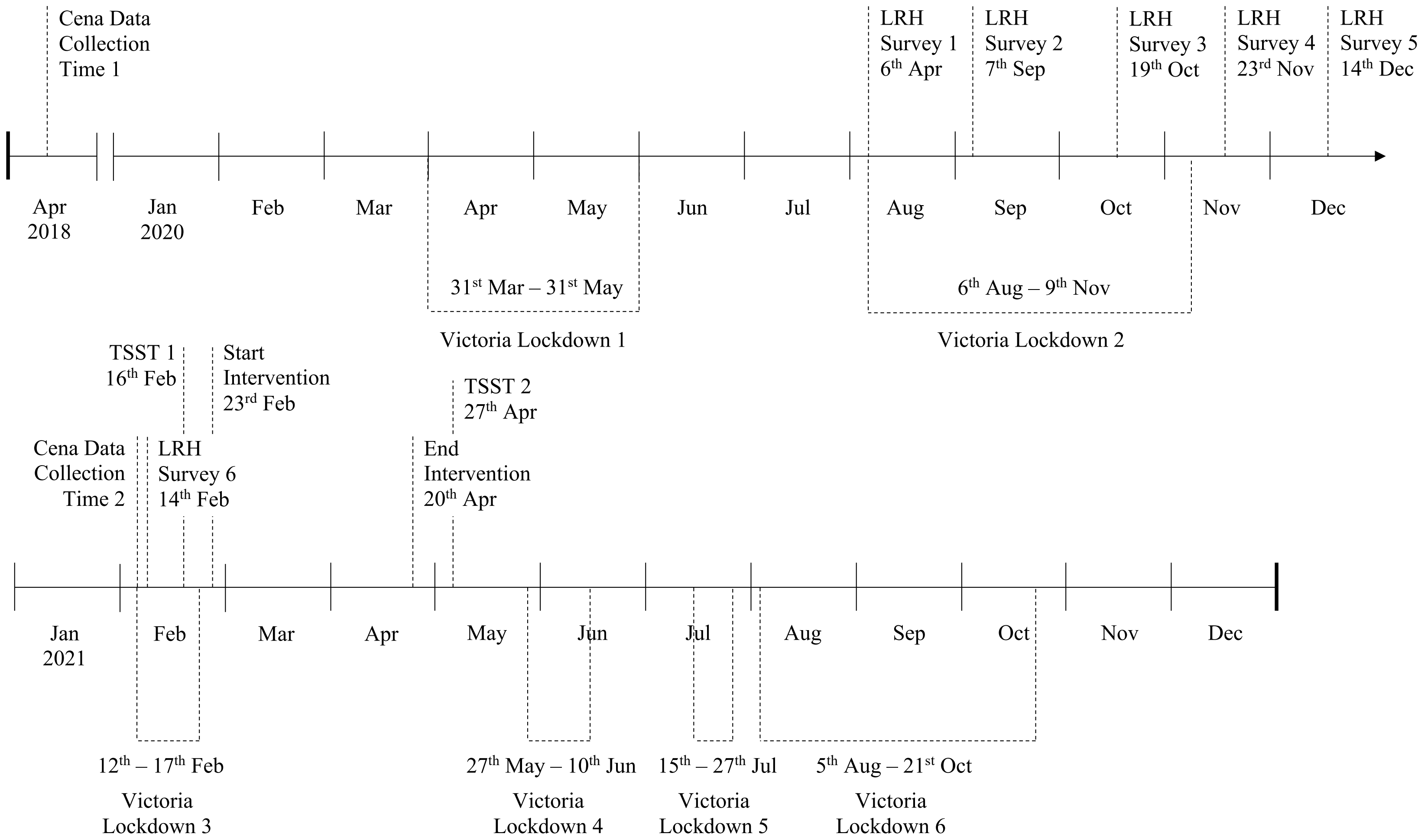
COVID-19

Study Timeline

The situation brought on by COVID-19 was ever-evolving and as such, changes to psychological wellbeing, hospital procedures, and personal lifestyles were affected over the COVID-19 period. Variation in results amongst the studies may have been affected by the timeline of data collection across the COVID-19 years (see Figure 4.1 for timeline). Study 1 showed moderate to high levels of resilience across each survey, though these levels declined over time (from late 2020 to early 2021), and Study 2 indicated moderate levels of stress resilience in 2018, but the 2021 data set displayed low levels of stress resilience. This indicates that COVID-19 may have gradually eroded stress resilience levels of nursing populations over time, albeit with a different nursing population each data collection period. Further, Study 1 indicated moderate to high levels of stress, particularly in November 2020 (after a long lockdown period), whilst Study 2 indicated moderate, and high, levels of stress during 2018 and 2021, respectively. This further emphasises the detrimental impact of a pandemic on the psychological wellbeing (particularly stress and stress resilience) of nursing populations in general.

Figure 4.1.

Studies and COVID-19 timeline



Note. LRH = Latrobe Regional Hospital, Cena = College of Emergency Nurses Australasia

Time-series or longitudinal studies on resilience of nursing populations during COVID-19 during 2020 and 2021 are limited. Particularly as repeated-measures, within-subjects longitudinal research designs were difficult to implement during the pandemic as the attrition rates were high, since nurses were either sick with COVID-19 or suffering from workload exhaustion. Longitudinal studies during 2020 on nursing populations have mainly focused on stress-related psychological health outcomes, indicating a decline in psychological health during 2020 (Cai et al., 2020), which is similar to Study 1. A longitudinal study on 443 Spanish healthcare workers (mainly nurses) reviewed psychological resilience in April 2020 (when there was the first COVID-19 wave in Spain) and in July 2020 and found resilience was moderate at both time-points, though resilience was higher in the latter part of the year. Cross-sectional research shows that nurses demonstrated a moderate to high level of resilience during 2020 (Alameddine et al., 2021; Di Giuseppe et al., 2021; Labrague, 2021; Pappa et al., 2020; Yörük & Güler, 2021), similar to Studies 1 and 2 in this dissertation. Overall data on resilience of nursing populations during 2020 (from previous studies in this dissertation) indicated the target population showed moderate levels of resilience.

The data from 2021, consistent with the findings of the 2020 study, revealed that resilience levels amongst the nursing population remained moderate, despite a significant increase in stress-related psychological variables such as stress and burnout (Reicherts et al., 2022; Zerbini et al., 2020). Zerbini et al. (2020) conducted a cross-sectional survey on nurses at the beginning of COVID-19 (March 2020) and found nurses working within COVID-19 wards were more likely to display symptoms of stress, burnout, and depression, compared to nurses working within non-COVID-19 wards. Zerbini et al. did not explore resilience in the first survey, but the cross-sectional follow-up study in March 2021 by Reicherts et al. (2022) found nurses showed moderate levels of resilience (as measured by the CD-RISC), yet the nurse's symptoms of burnout, depression, anxiety, and stress had significantly increased in comparison to the first survey. Zerbini et al. and Reicherts et al.'s findings parallel those of Studies 1 and 2 in this dissertation, whereby Study 1 indicated a decline in resilience over time, whilst maintaining a moderate to high level of resilience, and Study 2 showed a significant increase in stress, burnout, and distress symptoms from pre- to during-COVID-19 time-points. Further, Reicherts et al. found individuals who were vaccinated were less likely to indicate poor psychological health outcomes and that resilience was negatively correlated with symptoms of burnout, depression, anxiety, and stress. Longitudinal research studies (e.g., Reicherts et al., 2022; Zerbini et al., 2020) and findings from the present dissertation demonstrate that nurses during 2020 and 2021 were struggling to manage their stress and burnout symptoms, though were able to maintain adequate levels of resilience over time. Despite the prolonged work demands that eventuated from COVID-19 that can negatively impact psychological wellbeing, nurses were able to 'bounce back', reflected in their resilience scores, and deal with workplace adversity brought on by the pandemic.

Additionally, the collective experience of navigating a global health crisis, such as the COVID-19 pandemic, may have profoundly influenced nurses' stress resilience, impacting both physiological and psychological dimensions. Psychologically, the shared understanding and unity forged among nurses during the pandemic (Nurcan et al., 2022) could have acted as a shield against the escalating stress and burnout levels. The sense of collective purpose and mutual support, although speculative, may have fostered a heightened sense of social connectedness, positively influencing mental well-being and preserving stress resilience even in the face of increasing stressors (Reyes et al., 2015). The continuous exposure to shared adversity may provide an environment conducive to the development of adaptive coping mechanisms. The exposure to shared adversity could have prompted a dynamic and continuous process of positive adaptation and potentially optimising psychophysiological functioning and contributing to the stress resilience observed. The theory of a potential observed positive adaptation to shared adversity within a group setting among nurses during the pandemic suggests a compelling avenue for further exploration in resilience research. However, acknowledging the unique circumstances of a pandemic, the replication of such conditions may prove challenging for future investigations. Researchers could explore analogous scenarios and create controlled environments where individuals face significant challenges (more heightened stressors than within an ED), and may offer further insights on stress resilience within group settings. Also, longitudinal studies examining diverse stressors and adaptive responses in various contexts could contribute to a nuanced understanding of shared adversity and positive adaptation. By implementing longitudinal studies in different contexts, researchers can monitor how these variables interact and evolve, gaining insights into the dynamic nature of resilience in the face of ongoing stressors. This approach allows for the examination of patterns and changes in stress resilience, stress, and burnout over time, and may provide an enhanced understanding of their interconnected dynamics during prolonged and challenging situations, such as a global pandemic.

Participant recruitment was difficult during COVID-19. As such, participant numbers dwindled or were small as a result in each of the studies. Numerous studies conducted on hospital staff across the globe found that hospital staff were less likely to participate in research, and posed the possibility of survey fatigue (Al Hariri et al., 2022; Sotomayor-Castillo et al., 2021; Zhou et al., 2022). Study 3 recruitment occurred during November and December of 2020, where Australian individuals believed the rate of infection and prevalence of the virus was receding and marked their interest in participation in the study. The intervention started in February 2021, and the infection rates of COVID-19 were on the rise, with impending mandated lockdowns in the imminent future, thus interest in Study 3 dropped. The rise in infection may also account for the high drop-out rate in the intervention study. Whilst there were positives and negatives to moving interventions online (Saberi, 2020), it can deter individuals from participating in research.

Nursing Populations

It was assumed that ED nurses would have an advantageous aptitude to handle the high-pressures of a pandemic based on previous experience and training within emergency departments, given that their workplace environment typically encompasses high-stress situations. Higher educational training and greater workplace experience (within high-pressure situations) has shown to correlate with greater psychological resilience during COVID-19 (Alameddine et al., 2021; Li et al., 2021; Song et al., 2020). In the current dissertation, greater workplace exposure, experience and training corresponded to greater resilience in Study 1 (general nurses), though not Study 2 (ED nurses) where the advantage of further training and greater experience was negated by the effects of COVID-19. The observed inconsistencies in the relationship between workplace exposure, experience, and resilience among ED nurses, as compared to general nurses may be attributed to several factors. Firstly, the nature of pandemic stressors, distinct from the acute and immediate stressors typically encountered in ED settings, might have disrupted the expected correlation between workplace experience and resilience. The prolonged and pervasive stressors, including the fear of infection and resource shortages, posed challenges beyond the scope of their usual high-stress work environment. Secondly, the cumulative impact of chronic stress during the extended duration of the pandemic may have overridden the potential benefits of greater workplace exposure and experience. Despite assumptions that these factors would translate into higher resilience, the cumulative nature of pandemic stress could have influenced resilience levels differently than the acute stressors typically faced in EDs. Lastly, the psychological toll of uncertainty, rapid changes, and unpredictability associated with the pandemic may have played a role. ED nurses that are typically adept at managing immediate stressors, may have struggled to adapt to the prolonged uncertainty and ambiguity, negating the advantages assumed to come from further training and greater experience in high-stress settings. The analysis conducted on the nursing populations in Study 1 and Study 2 yielded inconclusive evidence to support the notion that ED nurses would exhibit greater resilience than general nurses amidst the pandemic.

Comparing ED staff with a generalised nursing population regarding resilience and psychological wellbeing during COVID-19 presents complexities. Traditionally, ED staff are the frontline personnel in hospital settings, and whilst this holds true during non-COVID-19 times, the pandemic also led to generalised nurses assuming frontline roles to address the urgent situation. Consequently, this dissertation's alignment with research on ED or frontline staff might be affected due to shifts in occupational roles. Highlighting this issue, a time-series study (Cai et al., 2020) conducted at the beginning of the pandemic comparing nurses in Wuhan, China working on and off the COVID-19 frontline found front-line nurses showed poorer psychological wellbeing across the two time-points. Further, cross-sectional research on frontline nurses during COVID-19 demonstrated that high anxiety, moral distress and emotional exhaustion was prevalent (Labrague, 2021; Yörük & Güler, 2021), especially when compared to non-frontline nurses (Di Giuseppe et al., 2021; Hao et al., 2021; Lai et al., 2020; Smallwood, Karimi, et al., 2021).

During COVID-19, comparing different nursing departments for research purposes becomes intricate due to the amalgamation of several nursing wards/units to establish COVID-19-specific EDs. For example, a longitudinal, cross-sectional study comparing Belgian intensive care nurses to ED nurses just before (January 2020) and during (April 2020) the pandemic found the prevalence of burnout was higher for ED nurses before and during the pandemic, though during the pandemic, symptoms of burnout did not significantly increase for ED nurses, whilst burnout increased for intensive care nurses. One theory for these findings may be that intensive care nurses became frontline nurses in order to manage the patient crisis of the pandemic, though not trained in frontline/emergency healthcare, which may have contributed to the increase in burnout symptoms. A second theory is that ED nurses experience stress-related situations differently (as hypothesised); whilst ED nurses indicate poor psychological wellbeing when working in ED, their resilience is still maintained at a moderate to high level (Jose et al., 2020), which allows ED nurses to manage the psychological consequences of COVID-19 more efficiently.

Gender is a factor known to moderate psychological wellbeing. The dissertation's population was predominately female, however contrary to the literature, there were no significant differences between genders on psychological wellbeing parameters amongst the three studies. Cross-sectional research during COVID-19 found frontline female nurses were more susceptible to stress-related health conditions than their male counterparts (Alameddine et al., 2021; Batra et al., 2020; Coco et al., 2021; Di Giuseppe et al., 2021; Huang et al., 2020). Similar gender-based results were found amongst nurses working in Melbourne during 2020 (Holton et al., 2021); though males are less likely to report subjective negative psychological wellbeing on surveys (Diener & Ryan, 2009; Parker et al., 2014). Researchers highlight that female nurses tend to experience stress differently to males, where females are more vulnerable to symptoms of stress (Vagni et al., 2020). This may occur because there are more females within the nursing healthcare system (Australian Institute of Health and Welfare; Nursing and Midwifery Board of Australia, 2020), and therefore had greater exposure to COVID-19 patients where they needed to provide emotional support for a virus with a high medical uncertainty and high mortality rate. It is unknown why there was a juxtaposition between the current dissertation's results and results from the current literature. Speculatively, when making comparisons with global literature, awareness of the distinction between Western and Eastern cultures are relevant; gender-related work is more prevalent in Eastern countries suggesting that females work in 'caring and sympathetic' career roles such as nursing (Mao et al., 2021).

As Australia is a Western culture, and society changes on gender-related work roles are evolving, the stereotypical perspective on what constitutes a nurse and personal attributes that drives an individual to study nursing is/are changing and becoming more equalised amongst genders. The role of gender may account for the variance in results within the present studies and global research.

Prior to COVID-19, regional/rural nurses showed greater psychological wellbeing compared to metropolitan nurses (Clough et al., 2020; Fenwick et al., 2018). Despite that fact that nurses in regional areas withstand a lack of resources including a smaller pool of specialised healthcare professionals required and limited access to mental health services for staff members within hospitals and clinics (McEvoy et al., 2021). Similar results were found during the COVID-19 pandemic, where regional/rural nurses fared better psychologically compared to metropolitan nursing populations (Hao et al., 2021; Lai et al., 2020). A reason for the maintenance in these results may be that during COVID-19 rural and regional areas experienced a lower prevalence of COVID-19 in comparison to metropolitan areas and hospital settings. Whilst the current dissertation did not compare this directly, the dissertation compared regional nurses to nurses across Australasia (including nurses within metropolitan areas). Studies using the CENA population have indicated the majority of CENA affiliated nurses originate from metropolitan areas (Ross-Adjie et al., 2007). The current studies indicated that regional nurses demonstrated greater stress resilience and better psychological well-being during COVID-19, whereas Australasian nurses showed lower resilience levels during the pandemic (though still moderate to high levels). Research on the location of nursing populations during COVID-19 in Australian nursing samples found better psychological health (specifically symptoms of burnout) in regional populations (Smallwood, Karimi, et al., 2021; Tham et al., 2022). Tham et al. (2022) found no significant differences between resilience scores for rural and metropolitan nurses, yet both populations indicated moderate levels of resilience during 2020 of COVID-19. This suggests that location may have a pivotal role in the psychological wellbeing of Australian nursing populations during COVID-19.

It was expected that Victorian nurses would have poorer psychological wellbeing compared to other Australian states given the strict government mandatory lockdowns and higher infection rates. However, across Study 1, 2 and 3, a comparison of Victorian nurses compared to nurses across Australasia did not complement these findings. Nurses across Australasia demonstrated poorer psychological wellbeing outcomes compared to nurses based in the state of Victoria. Research comparing the psychological wellbeing of nurses across Australian states indicated similar findings (Smallwood, Karimi, et al., 2021; Smallwood, Pascoe, et al., 2021). Smallwood, Karimi, et al. (2021) indicates that the high mortality rates overseas may have developed anticipation and fear of the virus and may have contributed to a decline in psychological wellbeing amongst the other Australian states, which may be one reason there were no significant differences among Australian states.

In addition to the potential influence of overseas mortality rates on the psychological wellbeing of nurses across Australasia, other factors may have contributed to the unexpected findings where nurses in Victoria exhibited better psychological wellbeing outcomes compared to their counterparts. Firstly, the intensity of government-mandated lockdowns and higher infection rates in Victoria might have led to a heightened sense of community and solidarity among the nursing workforce. Facing a common adversity, nurses in Victoria may have experienced a sense of shared purpose and mutual support, factors known to positively impact psychological wellbeing during challenging times (Lapum et al., 2021). Secondly, the proactive measures and robust healthcare infrastructure implemented in response to the higher infection rates in Victoria might have instilled a sense of preparedness and confidence among the nursing community. The implementation of effective strategies and resources to manage the crisis could have mitigated the psychological impact on nurses, contributing to the unexpected positive outcomes in psychological wellbeing observed in Victorian nurses compared to their Australasian counterparts.

Psychological Wellbeing

The majority of research conducted on nursing populations during COVID-19 was cross-sectional, but cross-sectional research only provides a snapshot of the situation and researchers can only glean inferential conclusions from the data. The current dissertation collected data cross-sectionally (Study 1 and 2), longitudinally (albeit involving cohorts of samples, rather than individually, Study 1), and qualitatively (Study 3) to broaden the breadth of data across various nursing populations on their psychological wellbeing during the pandemic. Longitudinal and cross-sectional data within the current dissertation demonstrated that burnout, stress, and distress increased, and resilience decreased as a result of the pandemic. The results also indicated that resilience was moderate to high and burnout symptoms were maintained at a moderate level. Qualitative research highlighted the facilitative effects of physical activity and the effects of COVID-19 during clinical placement on psychological wellbeing.

Qualitative research provides information on the researched topic, but also the surrounding situation that may have influenced results. Regarding Study 3, the control group interviews (whilst small) suggested that completing clinical placement during COVID-19 was stressful, though also led to an increased sense of personal growth and resilience. Some researchers propose that nurses felt a greater sense of purpose during the pandemic and therefore indicated greater resilience (DeTore et al., 2022; Ostafin & Proulx, 2020). Whilst it is difficult to ascertain whether the impact of COVID-19 or being involved in the intervention programs improved stress resilience specifically, it suggests that adversity (regardless of the type of stressor) can lead to positive adaptations and greater stress resilience. Godara et al. (2022) proposed that the prolonged exposure to COVID-19-induced stressors could potentially improve resilience. This increase in resilience, when combined with coping strategies like psychological flexibility, social support, and physical activity, has the potential to enhance mental health outcomes, as evidenced by other studies conducted during COVID-19 (Chong et al., 2021; Gloster et al., 2020; Pakenham et al., 2020). Brown et al.'s (2021) qualitative research study on 20 Australian frontline personnel (including nurses) exploring sources of resilience during COVID-19 found cognitive flexibility, a positive outlook, a greater sense of purpose, implementing self-care practices such as physical activity and mindfulness meditation helped to stabilise levels of resilience (as indicated by the CD-RISC). These results are similar to Study 3 with participants indicating they had used physical activity as a stress-buffering resource to combat pressures felt within hospital settings. Whilst Study 3 did not indicate an increase in resilience over time, resilience levels were maintained and the program (as well as other potential coping strategies implemented by the participants) may have reduced the likelihood of decline in psychological wellbeing. Further, the frequent stressors posed by the pandemic may have presented intermittently, similar to the COVID-19 infection waves, allowing a level of recovery to ensue, thereby allowing positive adaptation of the stress response to occur and improvements in stress resilience. Again, based on Study 3 interventions, it is uncertain whether engaging in the intervention programs served to improve stress resilience, or whether it was the presence of a constantly changing global pandemic that led to an optimised/sustained stress resilient response.

Physical Activity

The COVID-19 Effect

Research conducted during COVID-19 found strong, positive relationships between engagement in physical activity and resilience within the general population (Carriedo et al., 2020; Killgore et al., 2020; Lancaster & Callaghan, 2022; To et al., 2022). To et al. (2022) longitudinal study on an Australian population during COVID-19 in 2020 found individuals who engaged in moderate to high physical activity for a minimum of 150 minutes per week demonstrated higher resilience levels than individuals who engaged in low-intensity physical activity and less time during the week, though resilience was moderate for the population and did not increase over time. One explanation for the observed plateau in resilience despite sustained physical activity engagement could be related to the principle of progressive overload in exercise physiology (Webb et al., 2013). The concept suggests that to induce positive physiological adaptations, such as increased resilience, the intensity of the stimulus (in this case, physical activity) needs to progressively rise over time. Research indicates that individuals who maintain the same absolute workload in their physical activity routines may not experience significant positive adaptations in their HPA axis and SNS responses compared to those who continually increase their workload (Webb et al., 2013). In the context of physical fitness, individuals with higher aerobic fitness exhibit lower stress responses at the same absolute workload than their less fit counterparts. However, for individuals engaging in regular physical activity, especially at moderate intensities, without a progressive increase in workload, the potential for additional positive physiological adaptations, including enhanced resilience, may be limited. This is why determining dose-response of physical activity workload is essential to understanding the relationship between physical activity and stress resilience.

Whilst the current dissertation did not find significant relationships between physical activity and resilience, To et al. presents similar results on resilience comparing the general population to the dissertation's nursing populations during COVID-19 and highlighting that resilience remained stable and moderate to high over time. Additionally, To et al.'s research indicated that almost 50 percent of the sample were meeting the recommended physical activity guidelines and this suggests that Australians were still engaging in physical activity despite the mandated lockdowns. Contradictorily, Stanton et al. (2020)'s research on an Australian sample during COVID-19 found that even though participants met the weekly duration requirements for physical activity engagement (150 minutes), nearly 50% of participants reported a negative change to their physical activity participation since the beginning of the pandemic and this change was negatively associated with depression, anxiety, and stress scores. Further, these researchers' (i.e., Stanton et al., 2020; To et al., 2022) findings were conducted Australia-wide, and the mandated lockdowns affected Victorians more than any other Australian state thus more specific demographic information is required to understand the effect of the mandated lockdowns on physical activity engagement. Nevertheless, the lockdowns may have had a more significant effect on active populations (active prior to COVID-19). In light of the unique contextual factors, particularly the stringent lockdown measures experienced by Victorians, it is plausible that these specific circumstances contributed to the absence of a discernible relationship between physical activity and resilience within the current dissertation, specifically Study 2.

Nursing populations are generally inactive populations (Ahmad et al., 2015; Naidoo & Coopoo, 2007; Yu et al., 2022). In this dissertation, Study 2's comparison data demonstrated low engagement in physical activity before and during the pandemic, and Study 3 mirrored the results on limited engagement in physical activity at pre-intervention. Based on the current dissertation's results, it is difficult to suggest that low engagement in physical activity was a result of living in Victoria where lockdowns were rife during the pandemic. Despite the generally low engagement in physical activity among nursing populations, their moderate to high resilience levels during the pandemic may be attributed to the unique stressors and demands of their profession. Nurses are routinely exposed to high-stress situations, potentially fostering stressor-induced positive adaptation and stress resilience. The continuous exposure to workplace stressors and the need for rapid adaptation may contribute significantly to their ability to navigate challenges, providing an alternative explanation for the observed resilience levels, irrespective of low physical activity engagement.

Additionally, the RPAQ questionnaire obtained information on physical activity output across lifestyle domains rather than categorising physical activity based on daily energy output and time spent in leisure-time physical activity. In hindsight, it would have been beneficial to also analyse engagement in uncategorised leisure-time physical activity- the RPAQ included categorised leisure-time activities such as swimming and tennis but did not include, for example, pilates or meditation. Leisure-time physical activity can have a more positive, significant impact on psychological wellbeing, compared to individuals who engage in higher levels of physical activity output throughout the day within nursing populations (Henwood et al., 2012). The current research should have inspected leisure-time physical activity, as this would have provided further information of the effect of COVID-19 on participation in leisure-time physical activity pursuits and how the mandated lockdowns affected psychological wellbeing (as leisure-time physical activity was restricted by the lockdowns).

Stress Resilience and Physical Activity

Psychological Parameters

Based solely on the BRS, CD-RISC and RPAQ, across Study 2 and 3, a relationship between stress resilience and physical activity was not found. Study 2 found the target population was an inactive population, thus any relationships pertaining to physical activity and stress resilience may have been undiscoverable due to the disposition of those within the sample. Further, the all-encompassing impact of COVID-19 may have further deterred engagement in leisure-time physical activity and may account for a lack of findings between stress resilience and physical activity. The current dissertation data presents conflicting conclusions comparing research on the relationship between resilience and physical activity conducted before COVID-19 (Deuster & Silverman, 2013; Levone et al., 2015; Salmon, 2001), during COVID-19 (Carriedo et al., 2020; Killgore et al., 2020; Lancaster & Callaghan, 2022; To et al., 2022), and specifically regarding stress resilience and physical activity (Hegberg &

Tone, 2015). Discrepancies may be due to the heterogeneity of resilience definitions, and therefore inconsistencies emerging based on outcome measures of resilience. Theoretically, the BRS and CD-RSIC measures align with stress resilience. For example, the BRS attempts to measure the ability to recover from stress (a key outcome of stress resilience), though both measures focus on resilient resources (such as personality type), which can enhance an individual's adaptation to adversity. Rather, stress resilience focuses on the exposure to adversity and the positive adaptation that follows and enables physiological and psychological stress resilience to be developed. Whilst the lack of consensus on the conceptualisation of stress resilience exists, limited conclusions can be drawn. The decision to employ these questionnaires in the present dissertation was reached after a comprehensive review of alternative instruments used to measure stress resilience, which led to the determination that the BRS and CD-RISC were the most suitable measures for this purpose. This dissertation's findings highlight the importance of a tool that assesses both physiological and psychological aspects of stress resilience within a single questionnaire. The selected measures (BRS, CD-RISC) primarily focus on the psychological dimension, potentially overlooking the intricate interplay with physiological elements. Whilst the new stress resilience questionnaire (Obbarius et al., 2018) that encompasses both dimensions could provide a more comprehensive understanding of stress resilience and its relationship with physical activity, it's essential to acknowledge that such a tool was not available for use during this PhD project. Regardless, subjective psychological measures within the research studies postulate that relationship between physical activity and stress resilience may not exist.

Physiological Parameters

Whilst there were some significant findings amongst cardiovascular parameters of stress resilience for both the physical activity and mindfulness intervention groups in Study 3, the results do not lend strong support for physical activity to be a facilitator of stress resilience.

The biomarkers chosen for the current dissertation represent resilience or elements of stress resilience (Silverman & Deuster, 2014; Thayer et al., 2012), yet the majority of results on these relationships are from animal research (Hare et al., 2014; Kingston et al., 2018; Kochi et al., 2017; Nasrallah et al., 2019; Pan-Vazquez et al., 2015; Sciolino et al., 2015; Tillage et al., 2020), with a paucity of research from human trials (Hegberg & Tone, 2015). Only limited research adequately indicates that these biomarkers are appropriate to measure stress resilience, and the current research contends these biomarkers may not indicate physiological adaptation derived from participation in physical activity.

There is contention as to what constitutes an optimal adaptation of the stress response. Research highlights the role of physical activity upon the positive adaption of the stress response, for example, individuals with greater fitness levels are more likely to exhibit a high stress reactivity and swift recovery to stressors compared to an unfit population (de Geus et al., 1993; Jackson & Dishman, 2006). de Geus et al. (1993) investigation on the effects of aerobic fitness found that those with higher aerobic fitness exhibited greater stress reactivity and more efficient recovery (for HR and BP) from a psychosocial stressor compared to individuals with lower levels of aerobic fitness. Though, meta-analyses have indicated mixed results regarding stress reactivity levels and what constitutes an optimised psychobiological stress resilient response (Forcier et al., 2006; Jackson & Dishman, 2006), Silverman and Deuster (2014) contend that a blunting effect in response to a stressor (reactivity) brought on by regular participation in physical activity is indicative of stress resilience. The present dissertation posits that the swiftness of recovery post-stressor, irrespective of reactivity level, serves as a more salient indicator of stress resilience. Given the subtle evidence (patterns of HRV during the stress test) within the current dissertation supporting the role of swift stress recovery, future research should prioritise the investigation of recovery processes to gain a more comprehensive understanding of stress adaptations mechanisms, rather than solely focusing on reactivity levels to stressors.

Considering the importance of both physiological and psychological processes involved within stress resilience research, including the impact of physiological-based programs to enhance stress resilience within the current dissertation, there is a need to test both physiological and psychological stressors within stress resilience research. The intervention study in the current dissertation had planned to implement a physical and psychological stress test, the Maastricht Acute Stress Test (includes the TSST and cold pressor test), however due to social distancing, only a psychological stress test was used. Examining cardiovascular reactivity and recovery and monitoring psychological changes in psychological wellbeing before and after a physical activity intervention may help researchers discover and consolidate the appropriate biomarkers that represent stress resilience and how physical activity may facilitate an optimised stress resilient response.

Nurses' Perspectives on Stress Resilience and Physical Activity

Despite the shortcomings of biomarkers and issues with the definition of stress resilience, student nurses from Study 3 of this dissertation suggested (based on interview data) that physical activity improved their stress resilience. Further, student nurses suggested that engaging in mindfulness training also improved their stress resilience. This provides support for the relationship between a physiological intervention program and stress resilience, and that engaging in physical activity and mindfulness training may assist in the development of stress resilience. This may also indicate that the BRS and CD-RISC measures used within for Study 2 and 3 may not be reflective of stress resilience (hence the non-significant results), though further research is required on what measures would best assess stress resilience.

Research has indicated the benefits of being involved in a physiological program on nurse's wellbeing, yet research indicating the impact of a mindfulness intervention on stress resilience is limited. Slatyer et al. (2018) research on a mindfulness intervention conducted on 65 nurses (26 in control) working within an Australian hospital found significant positive changes for symptoms of burnout, stress, self-efficacy, and quality of life at the 6-month follow up for the intervention group. However, Slatyer et al. did not find significant changes in resilience as measured by the CD-RISC after the intervention. It is possible that the intervention had an impact on other aspects of psychological wellbeing, including stress resilience, that were not captured by the CD-RISC (similar to the current dissertation). Slatyer et al. (2018) qualitative interviews at the 6-month follow-up of the mindfulness program indicated that the physiological intervention helped nurses become less reactive to stressful situations (decreased rumination), which resulted in a reduction in stress, greater cognitive clarity, and better compartmentalisation of stressors within the workplace. This further emphasises the positive impact of a physiological (or physical activity; in the case of Study 3 in this dissertation) intervention on the psychological wellbeing of Australian nurses, despite the limited changes of resilience within the psychological test battery. Similar results have been found for other mindfulness-based interventions on Australian nurses in reducing workplace stress and improved psychological wellbeing, though not specifically stress resilience (Craigie et al., 2016; Foster et al., 2018; Foureur et al., 2013). The research implies that mindfulness interventions may be an effective method to manage adversity and promote positive adaptation within a hospital workplace yet requires further research on the link between a physiological program and stress resilience.

Practical Implications

Based on the intricate interplay of findings across the three studies and upon the literature indicating a potential relationship between physical activity and stress resilience, there are several practical implications for healthcare settings. Firstly, in light of the growing emphasis on enhancing stress resilience (albeit resilience in general) amongst institutions and the broader community (Windle et al., 2011), particularly post-COVID-19, hospitals and healthcare institutions could consider implementing integrated wellness programs that emphasise the significance of physical activity as a means to enhance stress resilience. These programs could encompass regular physical activity sessions, mindfulness practices, and education on the reciprocal benefits of these approaches in fostering psychological wellbeing. Embedding these practices within the healthcare environment may promote the mental and physical health of nursing populations.

Secondly, whilst recognising the debatable findings regarding the link between physical activity and stress resilience, physical activity remains one of the most effective preventative health behaviours to improve psychological wellbeing. Thus, educational institutions offering nursing programs have the opportunity to integrate physical activity initiatives into their curriculum. Intertwining physical activity practices may create a holistic foundation for coping and resilience, contributing to a toolkit for navigating the multifaceted challenges of a nursing career. For example, practical components might involve integrating exercise breaks into tutorial sessions or coursework could include modules on stress management and the role of physical activity in enhancing mental health. This approach could equip student nurses with the skills to manage stress but also nurture a proactive mindset towards their physical and mental wellbeing, preparing them to thrive in demanding healthcare environments. Further, acknowledging the diversity amongst nursing cohorts (novice to professional) and designing interventions that specifically align with the contextual needs of each group may encourage greater adherence to programs. For example, providing an on-site gym would improve convenience of immediate access to exercise facilities, eliminating the need to travel and making it easier to incorporate physical activity into their busy shift work schedule.

Lastly, recognising the prevalence of online platforms and the constraints posed by pandemic-related measures, similar to Study 3, hospitals and educational institutions could leverage technology to provide accessible resources. Online workout sessions, mindfulness applications, and resilience-based educational content can be disseminated to nursing staff and students alike, enabling them to engage in activities that optimise stress resilience regardless of their location and shift work schedule.

Research Implications

This dissertation aimed to inform future research on the relationship between physical activity and stress resilience and to inform practices for workplaces to improve stress resilience through physiological interventions. The three studies in this dissertation provided partial support for the relationship between stress resilience and physical activity.

Since stress resilience is elusive in measurement due to a lack of conceptualisation of the construct, research is required to further quantify the definition of stress resilience. Some researchers have attempted to do this (O'Donohue et al., 2021). As such, researchers should be wary of the way they view the concept of resilience versus stress resilience and how they apply the definition within the theoretical framework of their research. For example, researchers should consider how they view the concepts of adversity and positive adaptation to stress and whether positive adaptation is a consequence of adversity or whether these processes occur simultaneously and may evoke stress resilience. There is a need for a clear and comprehensive definition of stress resilience that captures its various dimensions, clarifies its relationship with other related constructs, such as resilience and coping, and how it incorporates the concepts of positive adaptation and adversity to stress. Additionally, it is important to determine whether stress resilience is a capability to return to normal functioning following exposure to a stressor or whether stress resilience occurs through habituation and desensitisation to stress because it has implications for how stress resilience is conceptualised and measured. If stress resilience is viewed as the ability to return to normal functioning after exposure to a stressor, then it may be measured in terms of speed and effectiveness of recovery. However, if stress resilience occurs through habituation and desensitisation to stress, then it may be measured in terms of the level of stress exposure that an individual can tolerate without experiencing physiological and/or psychological vulnerability. Understanding the mechanisms through which stress resilience is achieved can inform interventions aimed at promoting stress resilience. Therefore, clarifying the mechanisms of stress resilience is crucial for advancing our understanding of the construct and developing effective interventions to promote it.

In order to further advance our understanding of the relationship between physical activity and stress resilience, future research should gather more specific information on the types of physical activity in which nurses' engage. Categorising the difference between total physical activity versus leisure-time physical activity (including broader category types) would provide more detailed information about the impact of physical activity on stress resilience. Yu et al. (2020) provided a recent example that categorised distinct types of workplace physical activity, including standing, sitting, and various intensity levels. Yu et al. examined relationships between resilience and occupational physical activity workloads of New Zealand intensive care unit nurses prior to the pandemic and found nurses that exhibited greater levels of resilience indicated higher-intensity physical activity occupational workloads (as measured by accelerometers). Yu et al. concluded that nurses capable of managing significant physical workloads may be more resilient, which may be due (in part) to the role that higher intensity physical activity plays. What if the high-intensity physical workload optimised resilience in nurses? Based on the cross-sectional design of Yu et al.'s research, this question cannot be answered, and requires further investigation. Further, Yu et al.'s research focuses on resilience rather than stress resilience specifically. Yu et al. concludes the need for comparison between occupational physical activity and leisure-time physical activity and its impact on resilience in nurses. Other nursing research has indicated that greater leisure-time physical activity improves psychological health outcomes, in comparison to greater daily physical output (Henwood et al., 2012). Therefore, we should acknowledge whether the benefits of physical activity for stress resilience are specific to leisure-time physical activity (outside of RPAQ categorisation). Additionally, we should examine if the benefits can also be achieved through other forms of physical activity, such as high-intensity physical activity (either occupationally or during leisure-time). By identifying the different types of physical activity engagement, researchers could more accurately examine the relationship between physical activity and stress resilience and consequently develop interventions that target specific types of physical activity to promote stress resilience.

Other future research may compare alternative emergency high-stress populations, such as firefighters, police, and ambulance services, to develop further information on the impact of lifestyle choices (engagement in physical activity) on stress resilience in general. In the current dissertation, it was difficult to ascertain whether a relationship existed between stress resilience and physical activity as the population demonstrated low engagement in physical activity in general. Populations that already participate in physical activity may provide telling, alternative results that are in conjunction with research on physical activity and resilience (Carriedo et al., 2020; Deuster & Silverman, 2013; Hegberg & Tone, 2015; Killgore et al., 2020; Lancaster & Callaghan, 2022; Levone et al., 2015; To et al., 2022).

Future research will be conducted outside the COVID-19 pandemic, even though the remnants of the virus may remain within global communities for years to come. Ascertaining the after-effects of a pandemic on nursing populations is critical, as anecdotally the current nursing workforce is experiencing high rates of absenteeism and the nursing population (regardless of workplace experience) are leaving the healthcare workforce (Cornish et al., 2021). Implementing follow-up studies so that hospitals can continuously monitor the resilience and wellbeing of their staff would provide tangible evidence whether intervention programs are required for particular wards within a hospital, or for nursing populations in general.

Limitations

There are limitations throughout the current dissertation. Firstly, due to the rising interest surrounding resilience and stress resilience research over the past few years, particularly during COVID-19, a new measure of stress resilience has been developed. Obbarius et al. (2018) developed a 67-item stress resilience measure, though could not be used within the current dissertation as initial data collection processes began prior to the Obbarius et al. study was published and the current dissertation required consistency of measures for all studies. However, evaluation of the psychometric properties revealed the new stress resilience measure was most similar to the CD-RISC in measuring stress resilience. The CD-RISC and BRS were the most appropriate and robust measures of stress resilience at the time of writing this dissertation (Windle et al., 2011).

Secondly, a significant limitation of this dissertation lies in the inclusion of three disparate nursing populations: the general nursing community, ED nurses, and student nurses. Although these groups share compositional similarities, their varying experience levels and roles during the pandemic introduce complexities that hinder the generalisation of stress resilience and physical activity findings. The divergence between seasoned professionals and novices as well as the unique COVID-19 experiences could act as confounding variables, rendering direct comparison unviable. Consequently, extrapolating these findings to broader nursing populations requires careful consideration due to the distinct participant groups' inherent disparities.

Lastly, this dissertation leverages three study designs, each contributing unique insights. The first study's longitudinal approach captures temporal trends, the second study's dual cross-sectional surveys allow for immediate (but not a within-subjects) comparison, and the third study's mixed methods intervention offers comprehensive understanding of the relationship between stress resilience and physical activity. However, these diverse research designs can complicate result synthesis and interpretation, impacting the overall cohesion of the dissertation's narrative. Diverse methodologies can affect data quality and reliability, potentially impacting validity and generalisability (Freshwater, 2007).

Conclusion

The present dissertation explored the potential relationship between stress resilience and physical activity within nursing populations and investigated the potential facilitative nature of physical activity on physiological and psychological indices of stress resilience. The current dissertation presents ambiguous data, though overall would suggest a partial relationship between stress resilience and physical activity. However, I have addressed the conceptual and methodological issues within this research and provided directions for future research on the topic. Furthermore, the intervention study indicates that physical activity may not promote stress resilience, though the data presented interesting results on reactivity and recovery to a psychological stressor. The dissertation capitalised on the COVID-19 pandemic and incorporated additional importance research findings on a critical population, which highlighted a decline in psychological wellbeing across studies over time. Whilst this dissertation generates indistinct outcomes on the core variables of stress resilience and physical activity, this reflects the complexity of these two concepts and how human interpretation of stress resilience affects the relationship overall.

References

Abbott, J. H. (2014). The distinction between randomized clinical trials (RCTs) and preliminary feasibility and pilot studies: What they are and are not. *Journal of Orthopaedic and Sports Physical Therapy*, *44*(8), 555-558. https://doi.org/10.2519/jospt.2014.0110

Abram, M. D., & Jacobowitz, W. (2021). Resilience and burnout in healthcare students and inpatient psychiatric nurses: A between-groups study of two populations. *Archives of Psychiatric Nursing*, *35*(1), 1-8. https://doi.org/10.1016/j.apnu.2020.10.008

Acharya, R. U., Joseph, P. K., Kannathal, N., Lim, C. M., & Suri, J. S. (2006). Heart rate variability: A review. *Medical & Biological Engineering & Computing*, *44*(12), 1031-1051. https://doi.org/10.1007/s11517-006-0119-0

Adams, S. A., Matthews, C. E., Ebbeling, C. B., Moore, C. G., Cunningham, J. E., Fulton, J., & Hebert, J. R. (2005). The effect of social desirability and social approval on self-reports of physical activity. *American Journal of Epidemiology*, *161*(4), 389-398. https://doi.org/10.1093/aje/kwi054

Adeb-Saeedi, J. (2002). Stress amongst emergency nurses. *Australian Emergency Nursing Journal*, *5*(2), 19-24. https://doi.org/http://dx.doi.org/10.1016/S1328-2743(02)80015-3

Adriaenssens, J., De Gucht, V., & Maes, S. (2015). Determinants and prevalence of burnout in emergency nurses: a systematic review of 25 years of research. *International Journal of Nursing Studies*, *52*(2), 649-661. https://doi.org/10.1016/j.ijnurstu.2014.11.004

Ahmad, W., Taggart, F., Shafique, M. S., Muzafar, Y., Abidi, S., Ghani, N., Malik, Z., Zahid, T., Waqas, A., & Ghaffar, N. (2015). Diet, exercise and mental-wellbeing of healthcare professionals (doctors, dentists and nurses) in Pakistan. *PeerJ*, *3*, e1250. https://doi.org/10.7717/peerj.1250

Al Hariri, M., Hamade, B., Bizri, M., Salman, O., Tamim, H., & Al Jalbout, N. (2022). Psychological impact of COVID-19 on emergency department healthcare workers in a tertiary care center during a national economic crisis. *American Journal of Emergency Medicine*, *51*, 342-347. https://doi.org/10.1016/j.ajem.2021.10.055

Alameddine, M., Clinton, M., Bou-Karroum, K., Richa, N., & Doumit, M. A. A. (2021). Factors Associated With the Resilience of Nurses During the COVID-19 Pandemic. *Worldviews on Evidence-Based Nursing*, *18*(6), 320-331. https://doi.org/10.1111/wvn.12544

Alarcon, G., Eschleman, K. J., & Bowling, N. A. (2009). Relationships between personality variables and burnout: A meta-analysis. *Work \& Stress*, *23*(3), 244-263. https://doi.org/10.1080/02678370903282600

Albert, N. M., Butler, R., & Sorrell, J. (2014). Factors Related to Healthy Diet and Physical Activity in Hospital-Based Clinical Nurses. *Online Journal of Issues in Nursing*, *19*(3), 5. https://pubmed.ncbi.nlm.nih.gov/26824153/

Albott, C. S., Wozniak, J. R., McGlinch, B. P., Wall, M. H., Gold, B. S., & Vinogradov, S. (2020). Battle buddies: Rapid deployment of a psychological resilience Intervention for health care workers during the COVID-19 pandemic. *Anesthesia and Analgesia*, *131*(1), 43-54. https://doi.org/10.1213/ane.0000000000004912

Almadi, T., Cathers, I., Hamdan Mansour, A. M., & Chow, C. M. (2012). An Arabic version of the perceived stress scale: Translation and validation study. *International Journal of Nursing Studies*, *49*(1), 84-89. https://doi.org/10.1016/j.ijnurstu.2011.07.012

Almedom, A. M. (2015). Understanding human resilience in the context of interconnected health and social systems. Whose understanding matters most? *Ecology and Society*, *20*(4), 40. https://doi.org/10.5751/ES-08195-200440

Andrew, L., Maslin-Prothero, S. E., Costello, L., Dare, J., & Robinson, K. (2015). The influence of intimate partnerships on nurse student progression: An integrative literature review. *Nurse Educucation Today*, *35*(12), 1212-1220. https://doi.org/10.1016/j.nedt.2015.04.018

Andrews, G., & Slade, T. (2001). Interpreting scores on the Kessler Psychological Distress Scale (K10). *Australian and New Zealand Journal of Public Health*, *25*(6), 494-497. https://doi.org/10.1111/j.1467-842X.2001.tb00310.x

Ang, S. Y., Uthaman, T., Ayre, T. C., Mordiffi, S. Z., Ang, E., & Lopez, V. (2018). Association between demographics and resilience – a cross-sectional study among nurses in Singapore. *International Nursing Review*, *65*(3), 459-466. https://doi.org/10.1111/inr.12441

Arida, R. M., & Teixeira-Machado, L. (2020). The contribution of physical exercise to brain resilience. *Frontiers in Behavioral Neuroscience*, *14*, 626769. https://doi.org/10.3389/fnbeh.2020.626769

Arora, M., Asha, S., Chinnappa, J., & Diwan, A. D. (2013). Review article: Burnout in emergency medicine physicians. *Emergency Medicine Australasia*, *25*(6), 491-495. https://doi.org/10.1111/1742-6723.12135

Arrogante, O., & Aparicio-Zaldivar, E. (2017). Burnout and health among critical care professionals: The mediational role of resilience. *Intensive and Critical Care Nursing*, *42*, 110-115. https://doi.org/10.1016/j.iccn.2017.04.010

Arslan, M., Welcome, M. O., & Dane, S. (2019). The effect of sleep deprivation on heart rate variability in shift nurses. *Journal of Research in Medical and Dental Science*, *7*, 45-52. http://hdl.handle.net/1765/122263

Australian Government Department of Health. (2021). *Coronavirus (COVID-19) case numbers and statistics*. www.health.gov.au/news/health-alerts/novel-coronavirus-2019-ncov-health-alert/coronavirus-covid-19-case-numbers-and-statistics

Australian Government Department of Health. (2024). *Physical activity and exercise guidelines for all Australians*. https://www.health.gov.au/topics/physical-activity-and-exercise/physical-activity-and-exercise-guidelines-for-all-australians/for-adults-18-to-64-years

Australian Institute of Health and Welfare. (2018). *Mental health services in Australia, expenditure on mental health-related services 2018*. https://www.aihw.gov.au/reports/mental-health-services/mental-health-services-in-australia/report-contents/expenditure-on-mental-health-related-services

Ayala, P., & Christina, M. (1978). Characteristics of staff burnout in mental health settings. *Psychiatric Services*, *29*(4), 233-237. https://doi.org/10.1176/ps.29.4.233

Ayaz-Alkaya, S., Yaman-Sözbir, Ş., & Bayrak-Kahraman, B. (2018). The effect of nursing internship program on burnout and professional commitment. *Nurse Education Today*, *68*, 19-22. https://doi.org/10.1016/j.nedt.2018.05.020

Badu, E., O'Brien, A. P., Mitchell, R., Rubin, M., James, C., McNeil, K., Nguyen, K., & Giles, M. (2020). Workplace stress and resilience in the Australian nursing workforce: A comprehensive integrative review. *International Journal of Mental Health Nursing*, *29*(1), 5-34. https://doi.org/10.1111/inm.12662

Baker, D., G., Nash, W., P., Litz, B., T., Geyer, M., A., Risbrough, V., B., & Nievergelt, C., M. (2012). Predictors of risk and resilience for posttraumatic stress disorder among ground combat marines: Methods of the marine resiliency study. *Preventing Chronic Disease*, *9*, E97. https://doi.org/10.5888/pcd9.110134

Ballew, P., Brownson, R. C., Haire-Joshu, D., Heath, G. W., & Kreuter, M. W. (2010). Dissemination of effective physical activity interventions: Are we applying the evidence? *Health Education Research*, *25*(2), 185-198. https://doi.org/10.1093/her/cyq003

Baloch, G. M., Sundarasen, S., Chinna, K., Nurunnabi, M., Kamaludin, K., Khoshaim, H. B., Hossain, S. F. A., & AlSukayt, A. (2021). COVID-19: Exploring impacts of the pandemic and lockdown on mental health of Pakistani students. *PeerJ*, *9*, e10612. https://doi.org/10.7717/peerj.10612

Batra, K., Singh, T. P., Sharma, M., Batra, R., & Schvaneveldt, N. (2020). Investigating the Psychological Impact of COVID-19 among Healthcare Workers: A Meta-Analysis. *International Journal of Environmental Research and Public Health*, *17*(23), 9096. https://www.mdpi.com/1660-4601/17/23/9096

Beaumont, E., Durkin, M., Hollins Martin, C. J., & Carson, J. (2016). Compassion for others, self-compassion, quality of life and mental well-being measures and their association with compassion fatigue and burnout in student midwives: A quantitative survey. *Midwifery*, *34*, 239-244. https://doi.org/10.1016/j.midw.2015.11.002

Benke, C., Autenrieth, L. K., Asselmann, E., & Pané-Farré, C. A. (2020). Stay-at-home orders due to the COVID-19 pandemic are associated with elevated depression and anxiety in younger, but not older adults: Results from a nationwide community sample of adults from Germany. *Psychological Medicine*, 1-2. https://doi.org/10.1017/S0033291720003438

Bentley, M. A., Crawford, J. M., Wilkins, J. R., Fernandez, A. R., & Studnek, J. R. (2013). An assessment of depression, anxiety, and stress among nationally certified EMS professionals. *Prehospital Emergency Care*, *17*(3), 330-338. https://doi.org/10.3109/10903127.2012.761307

- Berger, B. G., & Motl, R. W. (2000). Exercise and mood: A selective review and synthesis of research employing the profile of mood states. *Journal of Applied Sport Psychology*, *12*(1), 69-92. https://doi.org/10.1080/10413200008404214

Bergh, C., Udumyan, R., Fall, K., Almroth, H., & Montgomery, S. (2015). Stress resilience and physical fitness in adolescence and risk of coronary heart disease in middle age. *Heart*, *101*(8), 623-629. https://doi.org/10.1136/heartjnl-2014-306703

Berkes, F., & Ross, H. (2013). Community resilience: Toward an integrated approach. *Society & Natural Resources*, *26*(1), 5-20. https://doi.org/10.1080/08941920.2012.736605

Bernaards, C. M., Jans, M. P., van den Heuvel, S. G., Hendriksen, I. J., Houtman, I. L., & Bongers, P. M. (2006). Can strenuous leisure time physical activity prevent psychological complaints in a working population? *Occupupational and Environmental Medicine*, *63*(1), 10-16. https://doi.org/10.1136/oem.2004.017541

Besson, H., Brage, S., Jakes, R. W., Ekelund, U., & Wareham, N. J. (2010). Estimating physical activity energy expenditure, sedentary time, and physical activity intensity by self-report in adults. *American Journal of Clinical Nutrition*, *91*(1), 106-114. https://doi.org/10.3945/ajcn.2009.28432

Bianchi, R., Schonfeld, I. S., & Laurent, E. (2014). Is burnout a depressive disorder? A reexamination with special focus on atypical depression. *International Journal of Stress Management*, *21*(4), 307. https://doi.org/10.1037/a0037906

Biddle, N., Edwards, B., Gray, M., & Sollis, K. . (2020). Initial impacts of COVID-19 on mental health in Australia. *ANU Centre for Social Research and Methods*, *33*. https://doi.org/10.26193/HLMZNW

Bischoff, L. L., Otto, A. K., Hold, C., & Wollesen, B. (2019). The effect of physical activity interventions on occupational stress for health personnel: A systematic review. *International Journal of Nursing Studies*, *97*, 94-104. https://doi.org/10.1016/j.ijnurstu.2019.06.002

Blair, S. N., LaMonte, M. J., & Nichaman, M. Z. (2004). The evolution of physical activity recommendations: How much is enough? *American Journal of Clinical Nutrition*, *79*(5), 913s-920s. https://doi.org/10.1093/ajcn/79.5.913S

Blanchard, C. M., Stein, K. D., Baker, F., Dent, M. F., Denniston, M. M., Courneya, K. S., & Nehl, E. (2004). Association between current lifestyle behaviors and health-related quality of life in breast, colorectal, and prostate cancer survivors. *Psychology & Health*, *19*(1), 1-13. https://psycnet.apa.org/record/2004-10196-001

Boardman, L. (2016). Building resilience in nursing students: Implementing techniques to foster success. *Journal of Emergency Mental Health and Human Resilience,* , *8*(3), 1-5. https://www.semanticscholar.org/paper/Building-Resilience-in-Nursing-Students%3A-Techniques-Boardman/70b253c44d5f580ffa6f63855ac87fb2caab55a0

Bohlken, J., Schömig, F., Lemke, M. R., Pumberger, M., & Riedel-Heller, S. G. (2020). COVID-19 pandemic: Stress experience of healthcare workers: A short current review. *Psychiatrische Praxis*, *47*(4), 190-197. https://doi.org/10.1055/a-1159-5551

Bond, V., Vaccaro, P., Caprarola, M., Millis, R. M., Blakely, R., Wood, R., Roltsch, M., Fairfax, J., Hatfield, B., Franks, B. D., Williams, D., Davis, G. C., & Adams, R. G. (2000). Blood pressure reactivity to mental stress and aerobic fitness in normotensive young adult African–American males with parental history of hypertension. *Stress Medicine*, *16*(4), 219--227. https://onlinelibrary.wiley.com/doi/10.1002/1099-1700(200007)16:4%3C219::AID-SMI855%3E3.0.CO;2-Q

Bouchard, C. E., Shephard, R. J., & Stephens, T. E. (1994). *Physical activity, fitness, and health: International proceedings and consensus statement*. Human Kinetics Publishers. https://doi.org/10.1249/00005768-199401000-00024

Bouillod, A., Cassirame, J., Bousson, J. M., Sagawa Jr, Y., & Tordi, N. (2015). Accuracy of the Suunto system for heart rate variability analysis during a tilt-test. *Revista Brasileira de Cineantropometria & Desempenho Humano*, *17*(4), 409-417. https://www.scielo.br/j/rbcdh/a/VFhzbLPpsYfYFyCrK9pGLtt/

Boutcher, S., Nurhayati, Y., & McLaren, P. (2001). Cardiovascular response of trained and untrained old men to mental challenge. *Medicine and Science in Sports and Exercise*, *33*(4), 659. https://doi.org/10.1097/00005768-200104000-00023.

Bowen, D. J., Kreuter, M., Spring, B., Cofta-Woerpel, L., Linnan, L., Weiner, D., Bakken, S., Kaplan, C. P., Squiers, L., Fabrizio, C., & Fernandez, M. (2009). How we design feasibility studies. *American Journal of Preventive Medicine*, *36*(5), 452-457. https://doi.org/10.1016/j.amepre.2009.02.002

Bower, J. E., Low, C. A., Moskowitz, J. T., Sepah, S., & Epel, E. (2008). Benefit finding and physical health: Positive psychological changes and enhanced allostasis. *Social and Personality Psychology Compass*, *2*(1), 223-244. https://doi.org/10.1111/j.1751-9004.2007.00038.x

Brachman, R. A., McGowan, J. C., Perusini, J. N., Lim, S. C., Pham, T. H., Faye, C., Gardier, A. M., Mendez-David, I., David, D. J., Hen, R., & Denny, C. A. (2016). Ketamine as a prophylactic against stress-induced depressive-like behavior. *Biological Psychiatry*, *79*(9), 776-786. https://doi.org/10.1016/j.biopsych.2015.04.022

Braun, S. E., Kinser, P. A., & Rybarczyk, B. (2019). Can mindfulness in health care professionals improve patient care? An integrative review and proposed model. *Translational Behavioural Medicine*, *9*(2), 187-201. https://doi.org/10.1093/tbm/iby059

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2013). *Successful qualitative research: A practical guide for beginners*. Sage. https://uk.sagepub.com/en-gb/eur/successful-qualitative-research/book233059

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, *11*(4), 589-597. https://doi.org/10.1080/2159676X.2019.1628806

Bretland, R. J., & Thorsteinsson, E. B. (2015). Reducing workplace burnout: The relative benefits of cardiovascular and resistance exercise. *PeerJ*, *3*, e891. https://doi.org/10.7717/peerj.891

Brewer, E. W., & Shapard, L. (2004). Employee burnout: A meta-analysis of the relationship between age or years of experience. *Human Resource Development Review*, *3*(2), 102-123. https://doi.org/10.1177/1534484304263335

Brown, L., Haines, S., Amonoo, H. L., Jones, C., Woods, J., Huffman, J. C., & Morris, M. E. (2021). Sources of resilience in frontline health professionals during COVID-19. *Healthcare (Basel)*, *9*(12). https://doi.org/10.3390/healthcare9121699

Brown, S., Whichello, R., & Price, S. (2018). The impact of resiliency on nurse burnout: An integrative literature review. *Medsurg Nursing*, *27*(6), 349.

Bruno, G., Panzeri, A., Granziol, U., Alivernini, F., Chirico, A., Galli, F., Lucidi, F., Spoto, A., Vidotto, G., & Bertamini, M. (2021). The Italian COVID-19 psychological research consortium (IT C19PRC): General overview and Replication of the UK study. *Journal of Clinical Medicine*, *10*(1), 52. https://doi.org/10.3390/jcm10010052

Buchheit, M., & Gindre, C. (2006). Cardiac parasympathetic regulation: Respective associations with cardiorespiratory fitness and training load. *America Journal of Physiology Heart Circulatory Physiology*, *291*(1), H451-458. https://doi.org/10.1152/ajpheart.00008.2006

Buising, K., Williamson, D., Cowie, B., MacLachlan, J., Orr, L., MacIsaac, C., Williams, E., Bond, K., Muhi, S., McCarthy, J., Maier, A., Irving, L., Heinjus, D., Kelly, C., & Marshall, C. (2020). A hospital-wide response to multiple outbreaks of COVID-19 in Health Care Workers Lessons learned from the field. *MedRxiv*, *214*(3), 2020.2009.2002.20186452. https://doi.org/10.1101/2020.09.02.20186452

Buising, K. L., Williamson, D., Cowie, B. C., MacLachlan, J., Orr, E., MacIsaac, C., Williams, E., Bond, K., Muhi, S., McCarthy, J., Maier, A. B., Irving, L., Heinjus, D., Kelly, C., & Marshall, C. (2021). A hospital-wide response to multiple outbreaks of COVID-19 in health care workers: Lessons learned from the field. *Medical Journal of Australia*, *214*(3), 101-104.e101. https://doi.org/10.5694/mja2.50850

Burch, J. B., Alexander, M., Balte, P., Sofge, J., Winstead, J., Kothandaraman, V., & Ginsberg, J. P. (2019). Shift work and heart rate variability coherence: Pilot study among nurses. *Applied Psychophysiology and Biofeedback*, *44*(1), 21-30. https://doi.org/10.1007/s10484-018-9419-z

Butera, S., Brasseur, N., Filion, N., Bruyneel, A., & Smith, P. (2021). Prevalence and associated factors of burnout risk among intensive care and emergency nurses before and during the COVID-19 pandemic: A cross-sectional study in Belgium. *Journal of Emergency Nursing*, *47*(6), 879-891. https://doi.org/10.1016/j.jen.2021.08.007

Cabarkapa, S., Nadjidai, S. E., Murgier, J., & Ng, C. H. (2020). The psychological impact of COVID-19 and other viral epidemics on frontline healthcare workers and ways to address it: A rapid systematic review. *Brain, Behavior, & Immunity - Health*, *8*, 100144-100144. https://doi.org/10.1016/j.bbih.2020.100144

Cai, Z., Cui, Q., Liu, Z., Li, J., Gong, X., Liu, J., Wan, Z., Yuan, X., Li, X., Chen, C., & Wang, G. (2020). Nurses endured high risks of psychological problems under the epidemic of COVID-19 in a longitudinal study in Wuhan China. *Journal of Psychiatric Research*, *131*, 132-137. https://doi.org/10.1016/j.jpsychires.2020.09.007

Cale, L. A., & Harris, J. P. (2006). Interventions to promote young people's physical activity: Issues, implications and recommendations for practice. *Health Education Journal*, *65*, 320 - 337. https://doi.org/10.1177/0017896906069370

Campbell-Sills, L., & Stein, M. B. (2007). Psychometric analysis and refinement of the connor–davidson resilience scale (CD-RISC): Validation of a 10-item measure of resilience. *Journal of Traumatic Stress*, *20*(6), 1019-1028. https://doi.org/10.1002/jts.20271

Campbell, C. M., Gilron, I., Doshi, T., & Raja, S. (2019). Designing and conducting proof-of-concept chronic pain analgesic clinical trials. *Pain Reports*, *4*(3), e697. https://doi.org/10.1097/pr9.0000000000000697

Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., & Zheng, J. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Research*, *287*, 112934. https://doi.org/10.1016/j.psychres.2020.112934

Carmody, J., & Baer, R. A. (2008). Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program. *Journal of Behavior Medicine*, *31*(1), 23-33. https://doi.org/10.1007/s10865-007-9130-7

Carmody, J., & Baer, R. A. (2009). How long does a mindfulness-based stress reduction program need to be? A review of class contact hours and effect sizes for psychological distress. *Journal of Clinical Psychology*, *65*(6), 627-638. https://doi.org/10.1002/jclp.20555

Carriedo, A., Cecchini, J. A., Fernández-Río, J., & Méndez-Giménez, A. (2020). Resilience and physical activity in people under home isolation due to COVID-19: A preliminary evaluation. *Mental Health and Physical Activity*, *19*, 100361. https://doi.org/10.1016/j.mhpa.2020.100361

Carroll, D., Lovallo, W. R., & Phillips, A. C. (2009). Are large physiological reactions to acute psychological stress always bad for health? *Social and Personality Psychology Compass*, *3*(5), 725-743. https://doi.org/10.1111/j.1751-9004.2009.00205

Carroll, D., Phillips, A. C., Hunt, K., & Der, G. (2007). Symptoms of depression and cardiovascular reactions to acute psychological stress: Evidence from a population study. *Biological Psychology*, *75*(1), 68-74. https://doi.org/10.1016/j.biopsycho.2006.12.002

Carver, C. S., & Connor-Smith, J. (2010). Personality and coping. *Annual Reviews of Psychology*, *61*, 679-704. https://doi.org/10.1146/annurev.psych.093008.100352

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Reports*, *100*(2), 126-131. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1424733/

Chang, E., & Daly, J. (2016). *Transitions in nursing: Preparing for professional practice*. Elsevier. https://researchdirect.westernsydney.edu.au/islandora/object/uws:34846

Charney, D. S. (2004). Psychobiological mechanisms of resilience and vulnerability: Implications for successful adaptation to extreme stress. *American Journal of Psychiatry*, *161*(2), 195-216. https://doi.org/10.1176/appi.ajp.161.2.195.

Chauhan, E., Bali, A., Singh, N., & Jaggi, A. S. (2015). Cross stress adaptation: Phenomenon of interactions between homotypic and heterotypic stressors. *Life Sciences*, *137*, 98-104. https://doi.org/10.1016/j.lfs.2015.07.018

Chegini, Z., Arab-Zozani, M., Rajabi, M. R., & Kakemam, E. (2021). Experiences of critical care nurses fighting against COVID-19: A qualitative phenomenological study. *Nursing Forum*, *56*(3), 571-578. https://doi.org/10.1111/nuf.12583

Chesak, S. S., Bhagra, A., Schroeder, D. R., Foy, D. A., Cutshall, S. M., & Sood, A. (2015). Enhancing resilience among new nurses: Feasibility and efficacy of a pilot intervention. *The Ochsner Journal*, *15*(1), 38-44. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4365845/

Cheung, T., Fong, T. K. H., & Bressington, D. (2021). COVID-19 under the SARS Cloud: Mental Health Nursing during the Pandemic in Hong Kong. *Journal of Psychiatry and Mental Health in Nursing*, *28*(2), 115-117. https://doi.org/10.1111/jpm.12639

Chiesa, A., & Serretti, A. (2010). A systematic review of neurobiological and clinical features of mindfulness meditations. *Psychological Medicine*, *40*(8), 1239-1252. https://doi.org/10.1017/S0033291709991747

Childs, E., & de Wit, H. (2014). Regular exercise is associated with emotional resilience to acute stress in healthy adults. *Frontiers in Physiology*, *5*, 161. https://doi.org/10.3389/fphys.2014.00161

Chin, B., Lindsay, E. K., Greco, C. M., Brown, K. W., Smyth, J. M., Wright, A. G. C., & Creswell, J. D. (2019). Psychological mechanisms driving stress resilience in mindfulness training: A randomized controlled trial. *Health Psychol*, *38*(8), 759-768. https://doi.org/10.1037/hea0000763

Chong, Y. Y., Chien, W. T., Cheng, H. Y., Lamnisos, D., Ļubenko, J., Presti, G., Squatrito, V., Constantinou, M., Nicolaou, C., Papacostas, S., Aydin, G., Ruiz, F. J., Garcia-Martin, M. B., Obando-Posada, D. P., Segura-Vargas, M. A., Vasiliou, V. S., McHugh, L., Höfer, S., Baban, A., . . . Kassianos, A. P. (2021). Patterns of psychological responses among the public during the rarly phase of COVID-19: A cross-regional analysis. *International Journal of Environmental Research and Public Health*, *18*(8), 4143. https://www.mdpi.com/1660-4601/18/8/4143

Chor, W. P. D., Ng, W. M., Cheng, L., Situ, W., Chong, J. W., Ng, L. Y. A., Mok, P. L., Yau, Y. W., & Lin, Z. (2020). Burnout amongst emergency healthcare workers during the COVID-19 pandemic: A multi-center study. *American Journal of Emergency Medicine*, *46*, 700-702. https://doi.org/10.1016/j.ajem.2020.10.040

Christodoulou, G., Salami, N., & Black, D. S. (2020). The utility of heart rate variability in mindfulness research. *Mindfulness*, *11*(3), 554-570. https://doi.org/10.1007/s12671-019-01296-3

Chrousos, G. P., & Gold, P. W. (1992). The concepts of stress and stress system disorders: Overview of physical and behavioral homeostasis. *Journal of the American Medical Association*, *267*(9), 1244-1252. https://doi.org/10.1001/jama.1992.03480090092034

Chrousos, George P., & Kino, T. (2005). Interactive functional specificity of the stress and immune responses: The Ying, the Yang, and the defense against 2 major classes of bacteria. *The Journal of Infectious Diseases*, *192*(4), 551-555. https://doi.org/10.1086/432135

Clough, B. A., Ireland, M. J., Leane, S., & March, S. (2020). Stressors and protective factors among regional and metropolitan Australian medical doctors: A mixed methods investigation. *Journal of Clinical Psychology*, *76*(7), 1362-1389. https://doi.org/10.1002/jclp.22940

Coco, M., Guerrera, C. S., Santisi, G., Riggio, F., Grasso, R., Di Corrado, D., Di Nuovo, S., & Ramaci, T. (2021). Psychosocial impact and role of resilience on healthcare workers during COVID-19 Pandemic. *Sustainability*, *13*(13), 7096. https://www.mdpi.com/2071-1050/13/13/7096

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. L. Erlbaum Associates.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385. https://doi.org/10.2307/2136404

Coleman, A., Steel, S., Freeman, P., de Greeff, A., & Shennan, A. (2008). Validation of the Omron M7 (HEM-780-E) oscillometric blood pressure monitoring device according to the British Hypertension Society protocol. *Blood Pressure Monitors*, *13*(1), 49-54. https://doi.org/10.1097/MBP.0b013e3282cb57b6

Collins, A., Hill, L. E., Chandramohan, Y., Whitcomb, D., Droste, S. K., & Reul, J. M. (2009). Exercise improves cognitive responses to psychological stress through enhancement of epigenetic mechanisms and gene expression in the dentate gyrus. *PLoS One*, *4*(1), e4330. https://doi.org/10.1371/journal.pone.0004330

Conn, V. S., Hafdahl, A. R., Cooper, P. S., Brown, L. M., & Lusk, S. L. (2009). Meta-analysis of workplace physical activity interventions. *American Journal of Preventative Medicine*, *37*(4), 330-339. https://doi.org/10.1016/j.amepre.2009.06.008

Connor, K. M., & Davidson, J. R. T. (2003). Development of a new resilience scale: The Connor-Davidson Resilience Scale (CD-RISC). *Depression and Anxiety*, *18*(2), 76-82. https://doi.org/10.1002/da.10113

Cornish, S., Klim, S., & Kelly, A. M. (2021). Is COVID-19 the straw that broke the back of the emergency nursing workforce? *Emergency Medicine Australasia*, *33*(6), 1095-1099. https://doi.org/10.1111/1742-6723.13843

Cowen, E. L., Wyman, P. A., Work, W. C., & Parker, G. R. (1990). The Rochester Child Resilience Project: Overview and summary of first year findings. *Development and Psychopathology*, *2*(2), 193-212. https://doi.org/10.1017/S0954579400000705

Cox, R. H., Thomas, T. R., Hinton, P. S., & Donahue, O. M. (2004). Effects of acute bouts of aerobic exercise of varied intensity on subjective mood experiences in women of different age groups across time. *Journal of Sport Behavior*, *29*(1). https://doi.org/10.1080/02701367.2004.10609148

Craigie, M., Slatyer, S., Hegney, D., Osseiran-Moisson, R., Gentry, E., Davis, S., Dolan, T., & Rees, C. (2016). A pilot evaluation of a mindful self-care and resiliency (MSCR) intervention for nurses. *Mindfulness*, *7*(3), 764-774. https://doi.org/10.1007/s12671-016-0516-x

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. SAGE publications. https://us.sagepub.com/en-us/nam/a-concise-introduction-to-mixed-methods-research/book266037

Crum, A. J., Jamieson, J. P., & Akinola, M. (2020). Optimizing stress: An integrated intervention for regulating stress responses. *Emotion, 20*(1), 120-125. https://doi.org/10.1037/emo0000670

Crum, A. J., Salovey, P., & Achor, S. (2013). Rethinking stress: the role of mindsets in determining the stress response. *Journal of Personality and Social Psychology*, *104*(4), 716-733. https://doi.org/10.1037/a0031201

Culver, D. M., Gilbert, W., & Sparkes, A. (2012). Qualitative research in sport psychology journals: The next decade 2000-2009 and beyond. *The Sport Psychologist*, *26*(2), 261-281. https://doi.org/10.1123/tsp.26.2.261

da Silva, R. M., Goulart, C. T., Lopes, L. F. D., Serrano, P. M., Costa, A. L. S., & de Azevedo Guido, L. (2014). Hardy personality and burnout syndrome among nursing students in three Brazilian universities—An analytic study. *BMC Nursing*, *13*(1), 9. https://doi.org/10.1186/1472-6955-13-9

Dal Grande, E., Taylor, A., & Wilson, D. (2002). *South Australian Health and Wellbeing Survey: December 2000*. https://www.researchgate.net/profile/Anne-Taylor-7/publication/254442590_South_Australian_Health_Wellbeing_Survey/links/0f31753b0ad8926a7d000000/South-Australian-Health-Wellbeing-Survey.pdf

Davis, M. C., Luecken, L., & Lemery-Chalfant, K. (2009). Resilience in common life: Introduction to the special issue. *Journal of Personality*, *77*(6), 1637-1644. https://doi.org/10.1111/j.1467-6494.2009.00595.x

Davydov, D. M., Stewart, R., Ritchie, K., & Chaudieu, I. (2010). Resilience and mental health. *Clinical Psychological Reviews*, *30*(5), 479-495. https://doi.org/10.1016/j.cpr.2010.03.003

de Geus, E. J., Van Doornen, L. J., & Orlebeke, J. F. (1993). Regular exercise and aerobic fitness in relation to psychological make-up and physiological stress reactivity. *Psychosomatic Medicine*, *55*(4), 347-363. https://doi.org/10.1097/00006842-199307000-00003.

De Vente, W., Olff, M., Van Amsterdam, J. G. C., Kamphuis, J. H., & Emmelkamp, P. M. G. (2003). Physiological differences between burnout patients and healthy controls: Blood pressure, heart rate, and cortisol responses. *Occupational and Environmental Medicine*, *60*(suppl 1), i54-i61. https://doi.org/10.1136/oem.60.suppl_1.i54

de Wit, E., van Doremalen, N., Falzarano, D., & Munster, V. J. (2016). SARS and MERS: recent insights into emerging coronaviruses. *Nature Reviews Microbiology*, *14*(8), 523-534. https://doi.org/10.1038/nrmicro.2016.81

Dekker, J. M., Crow, R. S., Folsom, A. R., Hannan, P. J., Liao, D., Swenne, C. A., & Schouten, E. G. (2000). Low heart rate variability in a 2-minute rhythm strip predicts risk of coronary heart disease and mortality from several causes: The ARIC Study. Atherosclerosis Risk In Communities. *Circulation*, *102*(11), 1239-1244. https://doi.org/10.1161/01.cir.102.11.1239.

Deligkaris, P., Panagopoulou, E., Montgomery, A. J., & Masoura, A. (2014). Job burnout and cognitive functioning: A systematic review. *Work & Stress*, *28*(2), 107-123. https://doi.org/10.1080/02678373.2014.909545

Denzin, N. K. (2009). *The research act: A theoretical introduction to sociological methods*. Routledge. https://doi.org/10.4324/9781315134543

Denzin, N. K. (2017). Critical qualitative inquiry. *Qualitative Inquiry*, *23*(1), 8-16. https://doi.org/10.1177/1077800416681864

DeTore, N. R., Sylvia, L., Park, E. R., Burke, A., Levison, J. H., Shannon, A., Choi, K. W., Jain, F. A., Coman, D. C., Herman, J., Perlis, R., Fava, M., & Holt, D. J. (2022). Promoting resilience in healthcare workers during the COVID-19 pandemic with a brief online intervention. *Journal of Psychiatric Research*, *146*, 228-233. https://doi.org/10.1016/j.jpsychires.2021.11.011

Deuster, P. A., Petrides, J. S., Singh, A., Chrousos, G. P., & Poth, M. (2000). Endocrine response to high-intensity exercise: Dose-dependent effects of dexamethasone. *Journal of Clinical Endocrinology and Metabolism*, *85*(3), 1066-1073. https://doi.org/10.1210/jcem.85.3.6444

Deuster, P. A., & Silverman, M. N. (2013). Physical fitness: A pathway to health and resilience. *US Army Meical. Department Journal*, 24-35. https://www.ncbi.nlm.nih.gov/pubmed/24146240

Dharmawardene, M., Givens, J., Wachholtz, A., Makowski, S., & Tjia, J. (2016). A systematic review and meta-analysis of meditative interventions for informal caregivers and health professionals. *BMJ Supportive and Palliative Care*, *6*(2), 160-169. https://doi.org/10.1136/bmjspcare-2014-000819

Di Giuseppe, M., Nepa, G., Prout, T. A., Albertini, F., Marcelli, S., Orrù, G., & Conversano, C. (2021). Stress, burnout, and resilience among healthcare workers during the COVID-19 emergency: The role of defense mechanisms. *International Journal of Environmental Research and Public Health*, *18*(10), 5258. https://www.mdpi.com/1660-4601/18/10/5258

Diener, E., & Ryan, K. (2009). Subjective well-being: A general overview. *South African Journal of Psychology*, *39*(4), 391-406. https://doi.org/10.1177/008124630903900402

Dienstbier, R. A. (1989). Arousal and physiological toughness: Implications for mental and physical health. *Psychological Review*, *96*(1), 84-100. https://doi.org/10.1037/0033-295x.96.1.84.

Ding, Y., Yang, Y., Yang, X., Zhang, T., Qiu, X., He, X., Wang, W., Wang, L., & Sui, H. (2015). The mediating role of coping style in the relationship between psychological capital and burnout among Chinese nurses. *PLoS ONE 10*(4), e0122128. https://doi.org/10.1371/journal.pone.0122128

Dishman, R. K., Sallis, J. F., & Orenstein, D. R. (1985). The determinants of physical activity and exercise. *Public Health Reports*, *100*(2), 158.

Dobson, H., Malpas, C. B., Burrell, A. J., Gurvich, C., Chen, L., Kulkarni, J., & Winton-Brown, T. (2021). Burnout and psychological distress amongst Australian healthcare workers during the COVID-19 pandemic. *Australasian Psychiatry*, *29*(1), 26-30. https://doi.org/10.1177/1039856220965045

Drach-Zahavy, A., Goldblatt, H., Admi, H., Blau, A., Ohana, I., & Itzhaki, M. (2021). A multi-level examination of nursing students' resilience in the face of the COVID-19 outbreak: A cross-sectional design. *Journal of Advanced Nursing*, *78*(1), 109-120. https://doi.org/10.1111/jan.14951

Driscoll, T. (2008). *Occupational exposures of Australian nurses: Methodological report* (Report to the Australian Safety and Compensation Council, ACT, Australia, Issue. https://www.safeworkaustralia.gov.au/system/files/documents/1702/occupationalexposures_australiannurses_methodologyreport_2008_pdf.pdf

Du, J., Dong, L., Wang, T., Yuan, C., Fu, R., Zhang, L., Liu, B., Zhang, M., Yin, Y., Qin, J., Bouey, J., Zhao, M., & Li, X. (2020). Psychological symptoms among frontline healthcare workers during COVID-19 outbreak in Wuhan. *General Hospital Psychiatry*, *67*, 144-145. https://doi.org/10.1016/j.genhosppsych.2020.03.011

Dunston, E. R., Messina, E. S., Coelho, A. J., Chriest, S. N., Waldrip, M. P., Vahk, A., & Taylor, K. (2022). Physical activity is associated with grit and resilience in college students: Is intensity the key to success? *Journal of American College Health*, *70*(1), 216-222. https://doi.org/10.1080/07448481.2020.1740229

Efendy, I., Afriani, M., & Lubis, S. (2021). The effectiveness of stress management and physical activity to working stress reduction on nurses. *Journal La Medihealtico*, *2*(2), 16-22. https://doi.org/10.37899/journallamedihealtico.v2i2.310

Ehrlich, H., McKenney, M., & Elkbuli, A. (2020). Protecting our healthcare workers during the COVID-19 pandemic. *The American Journal of Emergency Medicine*, *38*(7), 1527-1528. https://doi.org/10.1016/j.ajem.2020.04.024

Ekstedt, M., Soderstrom, M., Akerstedt, T., Nilsson, J., Sondergaard, H. P., & Aleksander, P. (2006). Disturbed sleep and fatigue in occupational burnout. *Scandinavian Journal of Work, Environment and Health*, *32*(2), 121-131. https://doi.org/10.5271/sjweh.987.

Embriaco, N., Papazian, L., Kentish-Barnes, N., Pochard, F., & Azoulay, E. (2007). Burnout syndrome among critical care healthcare workers. *Current Opinion in Critical Care*, *13*(5), 482-488. https://doi.org/10.1097/MCC.0b013e3282efd28a.

Epel, E. S., McEwen, B. S., & Ickovics, J. R. (1998). Embodying psychological thriving: Physical thriving in response to stress. *Journal of Social Issues*, *54*(2), 301-322.

Eriksson, J., Taimela, S., & Koivisto, V. (1997). Exercise and the metabolic syndrome. *Diabetologia*, *40*(2), 125-135. https://doi.org/10.1007/s001250050653.

Eyre, D. W., Lumley, S. F., O'Donnell, D., Campbell, M., Sims, E., Lawson, E., Warren, F., James, T., Cox, S., Howarth, A., Doherty, G., Hatch, S. B., Kavanagh, J., Chau, K. K., Fowler, P. W., Swann, J., Volk, D., Yang-Turner, F., Stoesser, N., . . . Walker, T. M. (2020). Differential occupational risks to healthcare workers from SARS-CoV-2 observed during a prospective observational study. *eLife*, *9*, e60675. https://doi.org/10.7554/eLife.60675

Fauci, A. S., Lane, H. C., & Redfield, R. R. (2020). Covid-19: Navigating the uncharted. *New England Journal of Medicine*, *382*(13), 1268-1269. https://doi.org/10.1056/NEJMe2002387

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175-191. https://doi.org/10.3758/bf03193146

Feder, A., Nestler, E. J., & Charney, D. S. (2009). Psychobiology and molecular genetics of resilience. *Nature Reviews Neuroscience*, *10*(6), 446-457. https://doi.org/10.1038/nrn2649

Fenwick, J., Lubomski, A., Creedy, D. K., & Sidebotham, M. (2018). Personal, professional and workplace factors that contribute to burnout in Australian midwives. *Journal of Advanced Nursing*, *74*(4), 852-863. https://doi.org/10.1111/jan.13491

Ferguson, C. J. (2016). *An effect size primer: A guide for clinicians and researchers*. American Psychological Association. https://doi.org/10.1037/14805-020

Fielding, N. G., & Fielding, J. L. (1986). *Linking data: The articulation of qualitative and quantitative methods in social research*. Beverley Hills & London.

Figueroa, M. A., Demeersman, R. E., & Manning, J. (2012). The autonomic and rate pressure product responses of tai chi practitioners. *North American Journal of Medicine and Science*, *4*(6), 270-275. https://doi.org/10.4103/1947-2714.97208

Fisher, J. R., Tran, T. D., Hammarberg, K., Sastry, J., Nguyen, H., Rowe, H., Popplestone, S., Stocker, R., Stubber, C., & Kirkman, M. (2020). Mental health of people in Australia in the first month of COVID-19 restrictions: A national survey. *Medical Journal of Australia*, *213*(10), 458-464. https://doi.org/10.5694/mja2.50831

Fjorback, L. O., Arendt, M., Ørnbøl, E., Fink, P., & Walach, H. (2011). Mindfulness-based stress reduction and mindfulness-based cognitive therapy: A systematic review of randomized controlled trials. *Acta Psychiatrica Scandinavica*, *124*(2), 102-119. https://doi.org/10.1111/j.1600-0447.2011.01704.x

Fletcher, D., & Sarkar, M. (2013). Psychological resilience. *European Psychologist*, *18*(1), 12-23. https://doi.org/10.1027/1016-9040/a000124

Forcier, K., Stroud, L. R., Papandonatos, G. D., Hitsman, B., Reiches, M., Krishnamoorthy, J., & Niaura, R. (2006). Links between physical fitness and cardiovascular reactivity and recovery to psychological stressors: A meta-analysis. *Health Psychology*, *25*(6), 723. https://doi.org/10.1037/0278-6133.25.6.723

Foss, C., & Ellefsen, B. (2002). The value of combining qualitative and quantitative approaches in nursing research by means of method triangulation. *Journal of Advanced Nursing*, *40*(2), 242-248. https://doi.org/10.1046/j.1365-2648.2002.02366.x

Foster, K., Shochet, I., Wurfl, A., Roche, M., Maybery, D., Shakespeare-Finch, J., & Furness, T. (2018). On PAR: A feasibility study of the Promoting Adult Resilience programme with mental health nurses. *International Journal of Mental Health Nursing*, *27*(5), 1470-1480. https://doi.org/10.1111/inm.12447

Foureur, M., Besley, K., Burton, G., Yu, N., & Crisp, J. (2013). Enhancing the resilience of nurses and midwives: pilot of a mindfulness-based program for increased health, sense of coherence and decreased depression, anxiety and stress. *Contemporary Nurse*, *45*(1), 114-125. https://doi.org/10.5172/conu.2013.45.1.114

Freshwater, D. (2007). Reading mixed methods research: Contexts for criticism. *Journal of Mixed Methods Research*, *1*(2), 134-146. https://doi.org/10.1177/1558689806298578

Fried, R. R., Karmali, S., Irwin, J. D., Gable, F. L., & Salmoni, A. (2018). Making the grade: Mentors' perspectives of a course-based, smart, healthy campus pilot project for building mental health resiliency through mentorship and physical activity. *International Journal of Evidence Based Coaching and Mentoring*, *16*(2), 84-98. https://doi.org/10.24384/000566

Frodl, T., & O'Keane, V. (2013). How does the brain deal with cumulative stress? A review with focus on developmental stress, HPA axis function and hippocampal structure in humans. *Neurobiology Disorders*, *52*, 24-37. https://doi.org/10.1016/j.nbd.2012.03.012

Galantino, M. L., Baime, M., Maguire, M., Szapary, P. O., & Farrar, J. T. (2005). Association of psychological and physiological measures of stress in health-care professionals during an 8-week mindfulness meditation program: mindfulness in practice. *Stress and Health: Journal of the International Society for the Investigation of Stress*, *21*(4), 255-261. https://doi.org/10.1002/smi.1062

Gao, J., Wang, F., Guo, S., & Hu, F. (2021). Mental health of nursing students amid Coronavirus disease 2019 pandemic. *Frontiers in Psychology*, *12*(3287), 699558. https://doi.org/10.3389/fpsyg.2021.699558

García-Fernández, L., Romero-Ferreiro, V., López-Roldán, P. D., Padilla, S., Calero-Sierra, I., Monzó-García, M., Pérez-Martín, J., & Rodriguez-Jimenez, R. (2020). Mental health impact of COVID-19 pandemic on Spanish healthcare workers. *Psychological Medicine*, *52*(1), 1-3. https://doi.org/10.1017/S0033291720002019

García-Martín, M., Roman, P., Rodriguez-Arrastia, M., Diaz-Cortes, M. d. M., Soriano-Martin, P. J., & Ropero-Padilla, C. (2021). Novice nurse's transitioning to emergency nurse during COVID-19 pandemic: A qualitative study. *Journal of Nursing Management*, *29*(2), 258-267. https://doi.org/10.1111/jonm.13148

Garland, E. L., Fredrickson, B., Kring, A. M., Johnson, D. P., Meyer, P. S., & Penn, D. L. (2010). Upward spirals of positive emotions counter downward spirals of negativity: Insights from the broaden-and-build theory and affective neuroscience on the treatment of emotion dysfunctions and deficits in psychopathology. *Clinical Psychology Review*, *30*(7), 849-864. https://doi.org/10.1016/j.cpr.2010.03.002

Garrosa, E., Moreno-Jiménez, B., Liang, Y., & González, J. L. (2008). The relationship between socio-demographic variables, job stressors, burnout, and hardy personality in nurses: An exploratory study. *International Journal of Nursing Studies*, *45*(3), 418-427. https://doi.org/10.1016/j.ijnurstu.2006.09.003

Gauthier, J. T., Meyer, R., Grefe, D., & Gold, J. (2014). An on-the-job mindfulness-based intervention for pediatric ICU nurses: A pilot. *Journal of Alternative and Complementary Medicine 20*(2), A87. https://doi.org/10.1089/acm.2014.5230.abstract

Gavin, B., Hayden, J., Adamis, D., & McNicholas, F. (2020). Caring for the psychological well-being of healthcare professionals in the Covid-19 pandemic crisis. *Irish Medical Journal*, *113*(4), 51. https://www.ncbi.nlm.nih.gov/pubmed/32268045

Georgiades, A., Sherwood, A., Gullette, E. C., Babyak, M. A., Hinderliter, A., Waugh, R., Tweedy, D., Craighead, L., Bloomer, R., & Blumenthal, J. A. (2000). Effects of exercise and weight loss on mental stress–induced cardiovascular responses in individuals with high blood pressure. *Hypertension*, *36*(2), 171-176. https://doi.org/10.1161/01.hyp.36.2.171.

Gerber, M., Brand, S., Elliot, C., Holsboer-Trachsler, E., Puhse, U., & Beck, J. (2013). Aerobic exercise training and burnout: a pilot study with male participants suffering from burnout. *BMC Research Notes*, *6*, 78. https://doi.org/10.1186/1756-0500-6-78

Gerber, M., Holsboer-Trachsler, E., Pühse, U., & Brand, S. (2016). Exercise is medicine for patients with major depressive disorders: but only if the "pill" is taken! *Neuropsychiatric Disorders and Treatment*, *12*, 1977-1981. https://doi.org/10.2147/ndt.S110656

Gerber, M., Kellmann, M., Hartmann, T., & Pühse, U. (2010). Do exercise and fitness buffer against stress among Swiss police and emergency response service officers? *Psychology of Sport and Exercise*, *11*(4), 286-294. https://doi.org/10.1016/j.psychsport.2010.02.004

Gerber, M., Lindwall, M., Lindegård, A., Börjesson, M., & Jonsdottir, I. H. (2013). Cardiorespiratory fitness protects against stress-related symptoms of burnout and depression. *Patient Education and Counseling*, *93*(1), 146-152. https://doi.org/10.1016/j.pec.2013.03.021

Gerber, M., & Puhse, U. (2009). Review article: Do exercise and fitness protect against stress-induced health complaints? A review of the literature. *Scandinavian Journal of Public Health*, *37*(8), 801-819. https://doi.org/10.1177/1403494809350522

Gerber, M., Schilling, R., Colledge, F., Ludyga, S., Pühse, U., & Brand, S. (2020). More than a simple pastime? The potential of physical activity to moderate the relationship between occupational stress and burnout symptoms. *International Journal of Stress Management*, *27*(1), 53-64. https://doi.org/10.1037/str0000129

Gerra, G., Zaimovic, A., Mascetti, G. G., Gardini, S., Zambelli, U., Timpano, M., Raggi, M. A., & Brambilla, F. (2001). Neuroendocrine responses to experimentally-induced psychological stress in healthy humans. *Psychoneuroendocrinology*, *26*(1), 91-107. https://doi.org/10.1016/s0306-4530(00)00046-9

Gibala, M. J., & Jones, A. M. (2013). Physiological and performance adaptations to high-intensity interval training. In van Loon. L. J. C. & R. Meeusen (Eds.), *Limits of Human Endurance* (Vol. 76, pp. 51-60). Karger Publishers. https://doi.org/10.1159/000350256

Gillespie, E., & Allen-Craig, S. (2009). The enhancement of resilience via a wilderness therapy program: A preliminary investigation. *Australian Journal of Outdoor Education*, *13*(1), 39. https://doi.org/10.1007/BF03400878

Gilmartin, H., Goyal, A., Hamati, M. C., Mann, J., Saint, S., & Chopra, V. (2017a). Brief mindfulness practices for healthcare providers: A systematic literature review. *The American Journal of Medicine*, *130*(10), 1219.e1211-1219.e1217. https://doi.org/10.1016/j.amjmed.2017.05.041

Gilmartin, H., Goyal, A., Hamati, M. C., Mann, J., Saint, S., & Chopra, V. (2017b). Brief mindfulness practices for healthcare providers; A systematic literature review. *The American Journal of Medicine*, *130*(10), 1219.e1211-1219.e1217. https://doi.org/10.1016/j.amjmed.2017.05.041

Glise, K., Hadzibajramovic, E., Jonsdottir, I., & Ahlborg, G. (2010). Self-reported exhaustion: A possible indicator of reduced work ability and increased risk of sickness absence among human service workers. *International Archives of Occupational and Environmental Health*, *83*(5), 511-520. https://doi.org/10.1007/s00420-009-0490-x.

Gloster, A. T., Lamnisos, D., Lubenko, J., Presti, G., Squatrito, V., Constantinou, M., Nicolaou, C., Papacostas, S., Aydın, G., Chong, Y. Y., Chien, W. T., Cheng, H. Y., Ruiz, F. J., Garcia-Martin, M. B., Obando-Posada, D. P., Segura-Vargas, M. A., Vasiliou, V. S., McHugh, L., Höfer, S., . . . Karekla, M. (2020). Impact of COVID-19 pandemic on mental health: An international study. *PLoS ONE*, *15*(12), e0244809. https://doi.org/10.1371/journal.pone.0244809

Godara, M., Silveira, S., Matthäus, H., & Singer, T. (2022). The wither or thrive model of resilience: An integrative framework of dynamic vulnerability and resilience in the face of repeated stressors during the COVID-19 pandemic. *Adversity and Resilience Science*, *3*(4), 261-282. https://doi.org/10.1007/s42844-022-00069-7

Goldberg, A. S. (2005). *Sports slump busting: 10 steps to mental toughness and peak performance*. Llumina Press. https://www.worldcat.org/title/sports-slump-busting-10-steps-to-mental-toughness-and-peak-performance/oclc/162745973

Golubic, R., May, A. M., Benjaminsen Borch, K., Overvad, K., Charles, M.-A., Diaz, M. J. T., Amiano, P., Palli, D., Valanou, E., Vigl, M., Franks, P. W., Wareham, N., Ekelund, U., & Brage, S. (2014). Validity of electronically administered Recent Physical Activity Questionnaire (RPAQ) in ten European countries. *PLOS ONE*, *9*(3), e92829. https://doi.org/10.1371/journal.pone.0092829

Gómez-Ochoa, S. A., Franco, O. H., Rojas, L. Z., Raguindin, P. F., Roa-Díaz, Z. M., Wyssmann, B. M., Guevara, S. L. R., Echeverría, L. E., Glisic, M., & Muka, T. (2021). COVID-19 in health-care workers: A living systematic review and meta-analysis of prevalence, risk factors, clinical characteristics, and outcomes. *American Journal of Epidemiology*, *190*(1), 161-175. https://doi.org/10.1093/aje/kwaa191

Gómez-Urquiza, J. L., Vargas, C., De la Fuente, E. I., Fernández-Castillo, R., & Cañadas-De la Fuente, G. A. (2017). Age as a risk factor for burnout syndrome in nursing professionals: A meta-analytic study. *Research in Nursing & Health*, *40*(2), 99-110. https://doi.org/10.1002/nur.21774

Good, D. J., Lyddy, C. J., Glomb, T. M., Bono, J. E., Brown, K. W., Duffy, M. K., Baer, R. A., Brewer, J. A., & Lazar, S. W. (2016). Contemplating mindfulness at work: An integrative review. *Journal of Management*, *42*(1), 114-142. https://doi.org/10.1177/0149206315617003

Goodman, M. J., & Schorling, J. B. (2012). A Mindfulness Course Decreases Burnout and Improves Well-Being among Healthcare Providers. *The International Journal of Psychiatry in Medicine*, *43*(2), 119-128. https://doi.org/10.2190/PM.43.2.b

Goodnite, P. M. (2014). Stress: A concept analysis. *Nursing Forum*, *49*(1), 71-74. https://doi.org/10.1111/nuf.12044

Grant, N., Wardle, J., & Steptoe, A. (2009). The relationship between life satisfaction and health behavior: A cross-cultural analysis of young adults. *International Journal of Behavioral Medicine*, *16*(3), 259-268. https://doi.org/10.1007/s12529-009-9032

Guan, W.-j., Ni, Z.-y., Hu, Y., Liang, W.-h., Ou, C.-q., He, J.-x., Liu, L., Shan, H., Lei, C.-l., Hui, D. S. C., Du, B., Li, L.-j., Zeng, G., Yuen, K.-Y., Chen, R.-c., Tang, C.-l., Wang, T., Chen, P.-y., Xiang, J., . . . Zhong, N.-s. (2020). Clinical characteristics of Coronavirus Disease 2019 in China. *New England Journal of Medicine*, *382*(18), 1708-1720. https://doi.org/10.1056/NEJMoa2002032

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In *Handbook of Qualitative Research* (pp. 105-117). Sage Publications. https://psycnet.apa.org/record/1994-98625-005

Gucciardi, D. F., Law, K. H., Guerrero, M. D., Quested, E., Thøgersen-Ntoumani, C., Ntoumanis, N., & Jackson, B. (2020). Longitudinal relations between psychological distress and moderate-to-vigorous physical activity: A latent change score approach. *Psychology of Sport and Exercise*, *47*, 101490. https://doi.org/10.1016/j.psychsport.2019.02.005

Guo, Y.-F., Cross, W., Plummer, V., Lam, L., Luo, Y.-H., & Zhang, J.-P. (2017). Exploring resilience in Chinese nurses: A cross-sectional study. *Journal of Nursing Management*, *25*(3), 223-230. https://doi.org/10.1111/jonm.12457

Guo, Y.-f., Luo, Y.-h., Lam, L., Cross, W., Plummer, V., & Zhang, J.-p. (2018). Burnout and its association with resilience in nurses: A cross-sectional study. *Journal of Clinical Nursing*, *27*(1-2), 441-449. https://doi.org/10.1111/jocn.13952

Hagberg, J. M., Park, J. J., & Brown, M. D. (2000). The role of exercise training in the treatment of hypertension: An update. *Sports and Medicine*, *30*(3), 193-206. https://doi.org/10.2165/00007256-200030030-00004

Halcomb, E., McInnes, S., Williams, A., Ashley, C., James, S., Fernandez, R., Stephen, C., & Calma, K. (2020). The experiences of primary healthcare nurses during the COVID-19 pandemic in Australia. *Journal of Nursing Scholarship*, *52*(5), 553-563. https://doi.org/10.1111/jnu.12589

Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., & Ekelund, U. (2012). Global physical activity levels: surveillance progress, pitfalls, and prospects. *Lancet*, *380*(9838), 247-257. https://doi.org/10.1016/s0140-6736(12)60646-1

Hamer, M. (2007). The relative influences of fitness and fatness on inflammatory factors. *Preventative Medicine*, *44*(1), 3-11. https://doi.org/10.1016/j.ypmed.2006.09.005

Hamer, M., Taylor, A., & Steptoe, A. (2006). The effect of acute aerobic exercise on stress related blood pressure responses: A systematic review and meta-analysis. *Biological Psychology*, *71*(2), 183-190. https://doi.org/10.1016/j.biopsycho.2005.04.004

Hao, Q., Wang, D., Xie, M., Tang, Y., Dou, Y., Zhu, L., Wu, Y., Dai, M., Wu, H., & Wang, Q. (2021). Prevalence and risk factors of mental health problems among healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis [Systematic Review]. *Frontiers in Psychiatry*, *12*, 567381. https://doi.org/10.3389/fpsyt.2021.567381

Hare, B. D., Beierle, J. A., Toufexis, D. J., Hammack, S. E., & Falls, W. A. (2014). Exercise-associated changes in the corticosterone response to acute restraint stress: Evidence for increased adrenal sensitivity and reduced corticosterone response duration. *Neuropsychopharmacology*, *39*(5), 1262-1269. https://doi.org/10.1038/npp.2013.329

Harker, R., Pidgeon, A. M., Klaassen, F., & King, S. (2016). Exploring resilience and mindfulness as preventative factors for psychological distress burnout and secondary traumatic stress among human service professionals. *Work*, *54*(3), 631-637. https://doi.org/10.3233/wor-162311

Hawker, C. L. (2012). Physical activity and mental well-being in student nurses. *Nurse Education Today*, *32*(3), 325-331. https://doi.org/10.1016/j.nedt.2011.07.013

Hawn, S. E., Paul, L., Thomas, S., Miller, S., & Amstadter, A. B. (2015). Stress reactivity to an electronic version of the Trier Social Stress Test: a pilot study. *Frontiers in Psychology*, *6*, 724. https://doi.org/10.3389/fpsyg.2015.00724

Hayter, M., & Jackson, D. (2020). Pre-registration undergraduate nurses and the COVID-19 pandemic: Students or workers? *Journal of Clinical Nursing*, *29*(17-18), 3115-3116. https://doi.org/10.1111/jocn.15317

Healy, S., & Tyrrell, M. (2011). Stress in emergency departments: Experiences of nurses and doctors. *Emergency nurse*, *19*(4), 31-37. https://doi.org/10.7748/en2011.07.19.4.31.c8611

Hegberg, N. J., & Tone, E. B. (2015). Physical activity and stress resilience: Considering those at-risk for developing mental health problems. *Mental Health and Physical Activity*, *8*, 1-7. https://doi.org/10.1016/j.mhpa.2014.10.001

Hegney, D. G., Rees, C. S., Eley, R., Osseiran-Moisson, R., & Francis, K. (2015). The contribution of individual psychological resilience in determining the professional quality of life of Australian nurses. *Frontiers in Psychology*, *6*, 1613. https://doi.org/10.3389/fpsyg.2015.01613

Heidke, P., Vandelanotte, C., Irwin, C., Williams, S., Saluja, S., & Khalesi, S. (2021). Associations between health-related quality of life and health behaviors in Australian nursing students. *Nursing & Health Sciences*, *23*(2), 477-489. https://doi.org/10.1111/nhs.12832

Henwood, T., Tuckett, A., & Turner, C. (2012). What makes a healthier nurse, workplace or leisure physical activity? Informed by the Australian and New Zealand e-Cohort Study. *Journal of Clinical Nursing*, *21*(11-12), 1746-1754. . https://doi.org/10.1111/j.1365-2702.2011.03994

Ho, F. K. W., Louie, L. H. T., Chow, C. B., Wong, W. H. S., & Ip, P. (2015). Physical activity improves mental health through resilience in Hong Kong Chinese adolescents. *BMC pediatrics*, *15*(1), 1. https://doi.org/10.1186/s12887-015-0365-0

Hogan, P., Moxham, L., & Dwyer, T. (2007). Human resource management strategies for the retention of nurses in acute care settings in hospitals in Australia. *Contemporary Nurse*, *24*(2), 189-199. https://doi.org/10.5172/conu.2007.24.2.189

Holland, P. J., Allen, B. C., & Cooper, B. K. (2013). Reducing burnout in Australian nurses: The role of employee direct voice and managerial responsiveness. *The International Journal of Human Resource Management*, *24*(16), 3146-3162. https://doi.org/10.1080/09585192.2013.775032

Holmes, P. V. (2014). Trophic mechanisms for exercise-induced stress resilience: Potential role of interactions between BDNF and Galanin. *Frontiers in Psychiatry*, *5*(90), 1-5. https://doi.org/10.3389/fpsyt.2014.00090

Holmes, T. H., & Rahe, R. H. (1967). The social readjustment rating scale. *Journal of Psychosomatic Research*, *11*(2), 213-218. https://doi.org/10.1016/0022-3999(67)90010-4

Holton, S., Wynter, K., Trueman, M., Bruce, S., Sweeney, S., Crowe, S., Dabscheck, A., Eleftheriou, P., Booth, S., Hitch, D., Said, C. M., Haines, K. J., & Rasmussen, B. (2021). Psychological well-being of Australian hospital clinical staff during the COVID-19 pandemic. *Australian Health Review*, *45*(3), 297-305. https://doi.org/10.1071/AH20203

Hsu, C.-Y., Hsieh, P.-L., Hsiao, S.-F., & Chien, M.-Y. (2015). Effects of exercise training on autonomic function in chronic heart failure: Systematic review. *BioMed Research International*, *2015*(2), 1-8. https://doi.org/10.1155/2015/591708

Huang, C.-J., Webb, H. E., Zourdos, M. C., & Acevedo, E. O. (2013). Cardiovascular reactivity, stress, and physical activity. *Frontiers in Physiology*, *4*, 314-314. https://doi.org/10.3389/fphys.2013.00314

Huang, L., Lei, W., Xu, F., Liu, H., & Yu, L. (2020). Emotional responses and coping strategies in nurses and nursing students during Covid-19 outbreak: A comparative study. *PLOS ONE*, *15*(8), e0237303. https://doi.org/10.1371/journal.pone.0237303

Hughes, B. M., Lu, W., & Howard, S. (2018). Cardiovascular stress-response adaptation: Conceptual basis, empirical findings, and implications for disease processes. *International Journal of Psychophysiology*, *131*, 4-12. https://doi.org/10.1016/j.ijpsycho.2018.02.003

Hui, W. H. (2002). The health-promoting lifestyles of undergraduate nurses in Hong Kong. *Journal of Profesional Nursing*, *18*(2), 101-111. https://doi.org/10.1053/jpnu.2002.32346

Hunter, E., Price, D. A., Murphy, E., van der Loeff, I. S., Baker, K. F., Lendrem, D., Lendrem, C., Schmid, M. L., Pareja-Cebrian, L., Welch, A., Payne, B. A. I., & Duncan, C. J. A. (2020). First experience of COVID-19 screening of health-care workers in England. *Lancet*, *395*(10234), e77-e78. https://doi.org/10.1016/S0140-6736(20)30970-3

Iacovides, A., Fountoulakis, K. N., Moysidou, C., & Ierodiakonou, C. (1999). Burnout in nursing staff: As there a relationship between depression and burnout? *International Journal of Psychiatry and Medicine*, *29*(4), 421-433. https://doi.org/10.2190/5yhh-4cvf-99m4-mj28

Jackson, D., Firtko, A., & Edenborough, M. (2007). Personal resilience as a strategy for surviving and thriving in the face of workplace adversity: A literature review. *Journal of Advanced Nursing*, *60*(1), 1-9. https://doi.org/10.1111/j.1365-2648.2007.04412.x

Jackson, D., Hutchinson, M., Everett, B., Mannix, J., Peters, K., Weaver, R., & Salamonson, Y. (2011). Struggling for legitimacy: Nursing students’ stories of organisational aggression, resilience and resistance. *Nursing Inquiry*, *18*(2), 102-110. https://doi.org/10.1111/j.1440-1800.2011.00536.x

Jackson, E. M., & Dishman, R. K. (2006). Cardiorespiratory fitness and laboratory stress: A meta-regression analysis. *Psychophysiology*, *43*(1), 57-72. https://doi.org/10.1111/j.1469-8986.2006.00373.x

Jackson, M. R., Porter, J. E., Peck, B., & Mesagno, C. (2023). "If I can't do it, who will?" Lived experiences of Australian emergency nurses during the first year of the COVID-19 pandemic. *Journal of Emergency Nursing*. https://doi.org/10.1016/j.jen.2023.05.004

James, R., Krause, K.-L., & Jennings, C. (2010). *The first year experience in Australian universities: Findings from 1994 to 2009* (Vol. 326). Melbourne: Centre for the Study of Higher Education, University of Melbourne.

Jamieson, L. N., Williams, L. M., Lauder, W., & Dwyer, T. (2007). Nurses' motivators to work part-time. *Collegian*, *14*(2), 13-19. https://doi.org/10.1016/S1322-7696(08)60550-8

Janoff-Bulman, R. (2014). Schema-change perspectives on posttraumatic growth. In *Handbook of posttraumatic growth* (pp. 95-113). Routledge.

Jassar, A. S., Perkins, K. E., & Sundt, T. M. (2021). Teamwork in the time of coronavirus: An MGH experience. *Journal of Cardiovascular Surgery*, *36*(5), 1644-1648. https://doi.org/10.1111/jocs.15036

Jayasinghe, S. U., Lambert, G. W., Torres, S. J., Fraser, S. F., Eikelis, N., & Turner, A. I. (2016). Hypothalamo-pituitary adrenal axis and sympatho-adrenal medullary system responses to psychological stress were not attenuated in women with elevated physical fitness levels. *Endocrine*, *51*(2), 369-379. https://doi.org/10.1007/s12020-015-0687-6

Johansson, T., Lindstrfm, M., & Holm, K. (2005). The morning salivary cortisol response in burnout. *Journal of Psychosomatic Research*, *59*, 103-111. https://doi.org/10.1016/j.jpsychores.2005.02.009.

Jönsson, P., Wallergård, M., Osterberg, K., Hansen, A. M., Johansson, G., & Karlson, B. (2010). Cardiovascular and cortisol reactivity and habituation to a virtual reality version of the Trier Social Stress Test: A pilot study. *Psychoneuroendocrinology*, *35*(9), 1397-1403. https://doi.org/10.1016/j.psyneuen.2010.04.003

Jose, S., Dhandapani, M., & Cyriac, M. C. (2020). Burnout and resilience among frontline nurses during COVID-19 pandemic: A cross-sectional study in the emergency department of a tertiary care center, North India. *Indian Journal of Critical Care in Medicine*, *24*(11), 1081-1088. https://doi.org/10.5005/jp-journals-10071-23667

Jung, H.-S., & Lee, B. (2015). Contributors to shift work tolerance in South Korean nurses working rotating shift. *Applied Nursing Research*, *28*(2), 150-155. https://doi.org/10.1016/j.apnr.2014.09.007

Jurca, R., Church, T. S., Morss, G. M., Jordan, A. N., & Earnest, C. P. (2004). Eight weeks of moderate-intensity exercise training increases heart rate variability in sedentary postmenopausal women. *American Heart Journal*, *147*(5), e21. https://doi.org/10.1016/j.ahj.2003.10.024

Juster, R. P., McEwen, B. S., & Lupien, S. J. (2010). Allostatic load biomarkers of chronic stress and impact on health and cognition. *Neuroscience and Biobehavior Reviews*, *35*(1), 2-16. https://doi.org/10.1016/j.neubiorev.2009.10.002

Kakemam, E., Chegini, Z., Rouhi, A., Ahmadi, F., & Majidi, S. (2021). Burnout and its relationship to self-reported quality of patient care and adverse events during COVID-19: A cross-sectional online survey among nurses. *Journal of Nurse Management*, *29*(7), 1974-1982. https://doi.org/10.1111/jonm.13359

Kang, H. S., Son, Y. D., Chae, S. M., & Corte, C. (2018). Working experiences of nurses during the Middle East respiratory syndrome outbreak. *International Journal of Nursing Practice*, *24*(5), e12664. https://doi.org/10.1111/ijn.12664

Karageorghis, C. I., Bird, J. M., Hutchinson, J. C., Hamer, M., Delevoye-Turrell, Y. N., Guérin, S. M. R., Mullin, E. M., Mellano, K. T., Parsons-Smith, R. L., Terry, V. R., & Terry, P. C. (2021). Physical activity and mental well-being under COVID-19 lockdown: A cross-sectional multination study. *BMC Public Health*, *21*(1), 988. https://doi.org/10.1186/s12889-021-10931-5

Karatsoreos, I. N., & McEwen, B. S. (2011). Psychobiological allostasis: Resistance, resilience and vulnerability. *Trends in Cognitive Sciences*, *15*(12), 576-584. https://doi.org/ 10.1016/j.tics.2011.10.005.

Keeley, A. J., Evans, C., Colton, H., Ankcorn, M., Cope, A., State, A., Bennett, T., Giri, P., de Silva, T. I., & Raza, M. (2020). Roll-out of SARS-CoV-2 testing for healthcare workers at a large NHS Foundation Trust in the United Kingdom, March 2020. *Eurosurveillance* *25*(14). https://doi.org/10.2807/1560-7917.Es.2020.25.14.2000433

Kelley, G. A., Kelley, K. A., & Vu Tran, Z. (2001). Aerobic exercise and resting blood pressure: A meta-analytic review of randomized, controlled trials. *Preventive cardiology*, *4*(2), 73-80. https://doi.org/10.1111/j.1520-037x.2001.00529

Keng, S. L., Smoski, M. J., & Robins, C. J. (2011). Effects of mindfulness on psychological health: A review of empirical studies. *Clinical Psychology Reviews*, *31*(6), 1041-1056. https://doi.org/10.1016/j.cpr.2011.04.006

Kerbage, S. H., Garvey, L., Willetts, G., & Olasoji, M. (2021). Undergraduate nursing students' resilience, challenges, and supports during corona virus pandemic. *International Journal of Mental Health Nursing*, *30*(S1), 1407-1416. https://doi.org/10.1111/inm.12896

Kessler, R. C., Andrews, G., Colpe, L. J., Hiripi, E., Mroczek, D. K., Normand, S. L. T., Walters, E. E., & Zaslavsky, A. M. (2002). Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine*, *32*(6), 959-976. https://doi.org/10.1017/S0033291702006074

Khoury, B., Sharma, M., Rush, S. E., & Fournier, C. (2015). Mindfulness-based stress reduction for healthy individuals: A meta-analysis. *Journal of Psychosomatic Research*, *78*(6), 519-528. https://doi.org/10.1016/j.jpsychores.2015.03.009

Killgore, W. D. S., Taylor, E. C., Cloonan, S. A., & Dailey, N. S. (2020). Psychological resilience during the COVID-19 lockdown. *Psychiatry Research*, *291*, 113216. https://doi.org/10.1016/j.psychres.2020.113216

Kim, H. G., Cheon, E. J., Bai, D. S., Lee, Y. H., & Koo, B. H. (2018). Stress and heart rate variability: A meta-analysis and review of the literature. *Psychiatry Investigation*, *15*(3), 235-245. https://doi.org/10.30773/pi.2017.08.17

Kim, J. S., & Choi, J. S. (2016). Factors influencing emergency nurses' burnout during an outbreak of Middle East Respiratory Syndrome Coronavirus in Korea. *Asian Nursing Research, 10*(4), 295-299. https://doi.org/10.1016/j.anr.2016.10.002

Kim, M. (2015). *Shifting the stress curve: Using "stress inoculation" and exercise to promote resilience* [Master's Thesis, Andrews University]. http://digitalcommons.andrews.edu/theses/71/

Kim, M., & Windsor, C. (2015). Resilience and work-life balance in first-line nurse manager. *Asian Nursing Research*, *9*(1), 21-27. https://doi.org/10.1016/j.anr.2014.09.003

Kingston, R. C., Smith, M., Lacey, T., Edwards, M., Best, J. N., & Markham, C. M. (2018). Voluntary exercise increases resilience to social defeat stress in Syrian hamsters. *Physiology and Behavior*, *188*, 194-198. https://doi.org/10.1016/j.physbeh.2018.02.003

Kirschbaum, C., Pirke, K.-M., & Hellhammer, D. H. (1993). The ‘Trier Social Stress Test’–A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology*, *28*(1-2), 76-81. https://doi.org/10.1159/000119004

Kirschbaum, C., Prussner, J. C., Stone, A. A., Federenko, I., Gaab, J., Lintz, D., Schommer, N., & Hellhammer, D. H. (1995). Persistent high cortisol responses to repeated psychological stress in a subpopulation of healthy men. *Psychosomatic Medicine*, *57*(5), 468-474. https://doi.org/ 10.1097/00006842-199509000-00009

Klainin-Yobas, P., He, H.-G., & Lau, Y. (2015). Physical fitness, health behaviour and health among nursing students: A descriptive correlational study. *Nurse Education Today*, *35*(12), 1199-1205. https://doi.org/10.1016/j.nedt.2015.06.014

Klaperski, S., von Dawans, B., Heinrichs, M., & Fuchs, R. (2013). Does the level of physical exercise affect physiological and psychological responses to psychosocial stress in women? *Psychology of Sport and Exercise*, *14*(2), 266-274. https://doi.org/10.1016/j.psychsport.2012.11.003

Kline, C., Porcari, J. P., Hintermeister, R., Freedson, P. S., Ward, A., McCarron, R. F., & Rippe, J. (1987). Estimation of from a one-mile track walk, gender, age and body weight. *Medicine and Science in Sports and Exercise*, *19*(3), 253-259. https://www.ncbi.nlm.nih.gov/pubmed/3600239

Kochi, C., Liu, H., Zaidi, S., Atrooz, F., Dantoin, P., & Salim, S. (2017). Prior treadmill exercise promotes resilience to vicarious trauma in rats. *Progress in Neuropsychopharmacology and Biological Psychiatry*, *77*, 216-221. https://doi.org/10.1016/j.pnpbp.2017.04.018

Kochuvilayil, T., Fernandez, R. S., Moxham, L. J., Lord, H., Alomari, A., Hunt, L., Middleton, R., & Halcomb, E. J. (2021). COVID-19: Knowledge, anxiety, academic concerns and preventative behaviours among Australian and Indian undergraduate nursing students: A cross-sectional study. *Journal of Clinical Nursing*, *30*(5-6), 882-891. https://doi.org/10.1111/jocn.15634

Koenig, J., Jarczok, M. N., Kuhn, W., Morsch, K., Schäfer, A., Hillecke, T. K., & Thayer, J. F. (2013). Impact of caffeine on heart rate variability: A systematic review. *Journal of Caffeine Research*, *3*(1), 22-37. https://doi.org/10.1089/jcr.2013.0009

Koh, D. (2020). COVID-19 lockdowns throughout the world. *Occupational Medicine*, *70*(5), 322-322. https://doi.org/10.1093/occmed/kqaa073

Kohl, H. W., Craig, C. L., Lambert, E. V., Inoue, S., Alkandari, J. R., Leetongin, G., & Kahlmeier, S. (2012). The pandemic of physical inactivity: Global action for public health. *Lancet*, *380*(9838), 294-305. https://doi.org/10.1016/s0140-6736(12)60898-8

Koolhaas, J. M., Bartolomucci, A., Buwalda, B., de Boer, S. F., Flügge, G., Korte, S. M., Meerlo, P., Murison, R., Olivier, B., Palanza, P., Richter-Levin, G., Sgoifo, A., Steimer, T., Stiedl, O., van Dijk, G., Wöhr, M., & Fuchs, E. (2011). Stress revisited: A critical evaluation of the stress concept. *Neuroscience Biobehavioral Reviews*, *35*(5), 1291-1301. https://doi.org/10.1016/j.neubiorev.2011.02.003

Kouidi, E., Karagiannis, V., Grekas, D., Iakovides, A., Kaprinis, G., Tourkantonis, A., & Deligiannis, A. (2010). Depression, heart rate variability, and exercise training in dialysis patients. *European Journal of Cardiovascular Prevention & Rehabilitation*, *17*(2), 160-167. https://doi.org/10.1097/HJR.0b013e32833188c4

Krasner, M. S., Epstein, R. M., Beckman, H., Suchman, A. L., Chapman, B., Mooney, C. J., & Quill, T. E. (2009). Association of an educational program in mindful communication with burnout, empathy, and attitudes among primary care physicians. *Journal of the American Medical Association*, *302*(12), 1284-1293. https://doi.org/10.1001/jama.2009.1384

Labrague, L. J. (2021). Resilience as a mediator in the relationship between stress-associated with the Covid-19 pandemic, life satisfaction, and psychological well-being in student nurses: A cross-sectional study. *Nurse Education in Practice*, *56*, 103182. https://doi.org/10.1016/j.nepr.2021.103182

Labuschagne, I., Grace, C., Rendell, P., Terrett, G., & Heinrichs, M. (2019). An introductory guide to conducting the Trier Social Stress Test. *Neurosciene and Biobehavioral Reviews*, *107*, 686-695. https://doi.org/10.1016/j.neubiorev.2019.09.032

Lackschewitz, H., Hüther, G., & Kröner-Herwig, B. (2008). Physiological and psychological stress responses in adults with attention-deficit/hyperactivity disorder (ADHD). *Psychoneuroendocrinology*, *33*(5), 612-624. https://doi.org/10.1016/j.psyneuen.2008.01.016

Lai, J., Ma, S., Wang, Y., Cai, Z., Hu, J., Wei, N., Wu, J., Du, H., Chen, T., Li, R., Tan, H., Kang, L., Yao, L., Huang, M., Wang, H., Wang, G., Liu, Z., & Hu, S. (2020). Factors associated with mental health outcomes among health care workers exposed to Coronavirus Disease 2019. *Journal of American Medical Association*, *3*(3), e203976-e203976. https://doi.org/10.1001/jamanetworkopen.2020.3976

Lam, K. K., & Hung, S. Y. (2013). Perceptions of emergency nurses during the human swine influenza outbreak: A qualitative study. *International Emergency Medicine*, *21*(4), 240-246. https://doi.org/10.1016/j.ienj.2012.08.008

Lancaster, M. R., & Callaghan, P. (2022). The effect of exercise on resilience, its mediators and moderators, in a general population during the UK COVID-19 pandemic in 2020: A cross-sectional online study. *BMC Public Health*, *22*(1), 827. https://doi.org/10.1186/s12889-022-13070-7

Lapum, J., Nguyen, M., McShane, J., & Fredericks, S. (2021). “The little lights in this dark tunnel”: Emotional support of nurses working in COVID-19 acute care hospital environments. *International Health Trends and Perspectives*, *1*(1), 29-43. https://doi.org/10.32920/ihtp.v1i1.1417

Lee, C. C. M., Thampi, S., Lewin, B., Lim, T. J. D., Rippin, B., Wong, W. H., & Agrawal, R. V. (2020). Battling COVID-19: critical care and peri-operative healthcare resource management strategies in a tertiary academic medical centre in Singapore. *Anaesthesia*, *75*(7), 861-871. https://doi.org/10.1111/anae.15074

Lee, S. A. (2020). How much "Thinking" about COVID-19 is clinically dysfunctional? *Brain, Behavior, and Immunity*, *87*, 97-98. https://doi.org/10.1016/j.bbi.2020.04.067

Lerman, Y., Melamed, S., Shragin, Y., Kushnir, T., Rotgoltz, Y., Shirom, A., & Aronson, M. (1999). Association between burnout at work and leukocyte adhesiveness/aggregation. *Psychosomatic Medicine*, *61*(6), 828-833. https://doi.org/10.1097/00006842-199911000-00017

Levine, S. (2005). Developmental determinants of sensitivity and resistance to stress. *Psychoneuroendocrinology*, *30*(10), 939-946. https://doi.org/10.1016/j.psyneuen.2005.03.013

Levitt, H. M. (2015). Interpretation-driven guidelines for designing and evaluating grounded theory research: A constructivist-social justice approach. In O. C. G. Gelo, A. Pritz, & B. Rieken (Eds.), *Psychotherapy Research: Foundations, Process, and Outcome* (pp. 455-483). Springer https://doi.org/10.1007/978-3-7091-1382-0_22

Levone, B. R., Cryan, J. F., & O'Leary, O. F. (2015). Role of adult hippocampal neurogenesis in stress resilience. *Neurobiology of Stress*, *1*, 147-155. https://doi.org/10.1016/j.ynstr.2014.11.003

Li, J., Zhang, S.-X., Wang, W., Cheng, K., Guo, H., Rao, C.-L., Yang, D.-Y., He, Y., Zou, D.-Z., Han, Y., Zhao, L.-B., Li, P.-f., & Xie, P. (2017). Potential antidepressant and resilience mechanism revealed by metabolomic study on peripheral blood mononuclear cells of stress resilient rats. *Behavioural Brain Research*, *320*, 12-20. https://doi.org/10.1016/j.bbr.2016.11.035

Li, Q., Guan, X., Wu, P., Wang, X., Zhou, L., Tong, Y., Ren, R., Leung, K. S. M., Lau, E. H. Y., Wong, J. Y., Xing, X., Xiang, N., Wu, Y., Li, C., Chen, Q., Li, D., Liu, T., Zhao, J., Liu, M., . . . Feng, Z. (2020). Early transmission dynamics in Wuhan, China, of novel Coronavirus–infected pneumonia. *New England Journal of Medicine*, *382*(13), 1199-1207. https://doi.org/10.1056/NEJMoa2001316

Li, S. H., Beames, J. R., Newby, J. M., Maston, K., Christensen, H., & Werner-Seidler, A. (2021). The impact of COVID-19 on the lives and mental health of Australian adolescents. *European Child & Adolescent Psychiatry*, *31*(9), 1465-1477. https://doi.org/10.1007/s00787-021-01790-x

Lim, J., Bogossian, F., & Ahern, K. (2010). Stress and coping in Australian nurses: A systematic review. *International Nursing Review*, *57*(1), 22-31. https://doi.org/10.1111/j.1466-7657.2009.00765

Lin, L., He, G., Yan, J., Gu, C., & Xie, J. (2019). The effects of a modified mindfulness-based stress reduction program for nurses: A randomized controlled trial. *Workplace Health and Safety*, *67*(3), 111-122. https://doi.org/10.1177/2165079918801633

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage. https://us.sagepub.com/en-us/nam/naturalistic-inquiry/book842

Lines, R. L. J., Ducker, K. J., Ntoumanis, N., Thøgersen-Ntoumani, C., Fletcher, D., McGarry, S., & Gucciardi, D. F. (2020). Stress, physical activity, and resilience resources: Tests of direct and moderation effects in young adults. *Sport, Exercise, and Performance Psychology*, *9*(3), 418-436. https://doi.org/10.1037/spy0000152

Liu, Y., Li, J., & Feng, Y. (2020). Critical care response to a hospital outbreak of the 2019-nCoV infection in Shenzhen, China. *Critical Care*, *24*(1), 56. https://doi.org/10.1186/s13054-020-2786-x

Lo, R. (2002). A longitudinal study of perceived level of stress, coping and self-esteem of undergraduate nursing students: An Australian case study. *Journal of Advanced Nursing*, *39*(2), 119-126. https://doi.org/10.1046/j.1365-2648.2000.02251.x

Lopez Steinmetz, L. C., Herrera, C. R., Fong, S. B., & Godoy, J. C. (2022). A longitudinal study on the changes in mental health of healthcare workers during the COVID-19 pandemic. *Psychiatry*, *85*(1), 56-71. https://doi.org/10.1080/00332747.2021.1940469

Lovell, G. P., Nash, K., Sharman, R., & Lane, B. R. (2015). A cross-sectional investigation of depressive, anxiety, and stress symptoms and health-behavior participation in Australian university students. *Nursing & Health Sciences*, *17*(1), 134-142. https://doi.org/10.1111/nhs.12147

Luberto, C. M., Goodman, J. H., Halvorson, B., Wang, A., & Haramati, A. (2020). Stress and coping among health professions students during COVID-19: A perspective on the benefits of mindfulness. *Global Advances in Health and Medicine*, *9*, 2164956120977827. https://doi.org/10.1177/2164956120977827

Luger, A., Deuster, P. A., Gold, P. W., Loriaux, D. L., & Chrousos, G. P. (1988). Hormonal responses to the stress of exercise. *Advances in Experimental Medicine and Biology*, *245*, 273-280. https://doi.org/1309-1315. 10.1007/978-1-4899-2064-5_22.

Luger, A., Deuster, P. A., Kyle, S. B., Gallucci, W. T., Montgomery, L. C., Gold, P. W., Loriaux, D. L., & Chrousos, G. P. (1987). Acute hypothalamic–pituitary–adrenal responses to the stress of treadmill exercise. *New England Journal of Medicine*, *316*(21), 1309. https://doi.org/ 10.1056/NEJM198705213162105

Lukey, B. J., & Tepe, V. (2008). *Biobehavioral resilience to stress*. CRC Press.

Luthar, S. S., & Cicchetti, D. (2000). The construct of resilience: Implications for interventions and social policies. *Development and Psychopathology*, *12*(04), 857-885. https://doi.org/10.1017/s0954579400004156

Magnavita, N., Soave, P. M., & Antonelli, M. (2021). Prolonged stress causes depression in frontline workers facing the COVID-19 pandemic: A repeated cross-sectional study in a COVID-19 hub-hospital in central Italy. *International Journal Of Environmental Research and Public Health 18*(14). https://doi.org/10.3390/ijerph18147316

Magtibay, D. L., Chesak, S. S., Coughlin, K., & Sood, A. (2017). Decreasing stress and burnout in nurses: Efficacy of blended learning with stress management and resilience training program. *Journal of Nursing Administration*, *47*(7/8), 391-395. https://doi.org/10.1097/NNA.0000000000000501

Mancia, G., & Grassi, G. (2000). Mechanisms and clinical implications of blood pressure variability. *Journal of Cardiovascular Pharmacology*, *35*(7 Suppl 4), S15-S19. https://doi.org/10.1097/00005344-200000004-00003

Mantzios, M. (2014). Exploring the relationship between worry and impulsivity in military recruits: The role of mindfulness and self-compassion as potential mediators. *Stress and Health*, *30*(5), 397-404. https://doi.org/10.1002/smi.2617

Manzanares, I., Sevilla Guerra, S., Lombraña Mencía, M., Acar-Denizli, N., Miranda Salmerón, J., & Martinez Estalella, G. (2021). Impact of the COVID-19 pandemic on stress, resilience and depression in health professionals: A cross-sectional study. *International Nursing Reviews*, *68*(4), 461-470. https://doi.org/10.1111/inr.12693

Mao, A., Cheong, P. L., Van, I. K., & Tam, H. L. (2021). "I am called girl, but that doesn't matter" -perspectives of male nurses regarding gender-related advantages and disadvantages in professional development. *BMC Nursing*, *20*(1), 24. https://doi.org/10.1186/s12912-021-00539-w

Maslach, C., Jackson, S. E., Leiter, M. P., Schaufeli, W. B., & Schwab, R. L. (1986). *Maslach burnout inventory* (Vol. 21). Consulting Psychologists Press Palo Alto, CA.

Mason, J. W. (1968). A review of psychoendocrine research on the pituitary-adrenal cortical system. *Psychosomatic Medicine*, *30*(5), 576-607. https://doi.org/10.1097/00006842-196809000-00022.

Matzka, M., Mayer, H., Köck-Hódi, S., Moses-Passini, C., Dubey, C., Jahn, P., Schneeweiss, S., & Eicher, M. (2016). Relationship between resilience, psychological distress and physical activity in cancer patients: A cross-sectional observation study. *PLoS ONE*, *11*(4), 1-13. https://doi.org/10.1371/journal.pone.0154496

Maxcy, S., J. (2003). In Handbook of Mixed Methods in Social and Behavioral Research. In *Pragmatic threads in mixed methods research in the social sciences: The search for multiple modes of inquiry and the end of the philosophy of formalism.Edited by Abbas Tashakkori and Charles Teddlie.* (pp. 51-89). Thousand Oaks: Sage. https://searchworks.stanford.edu/view/5086393

McCarty, R., Konarska, M., & Stewart, R. E. (1992). Adaptation to stress: A learned response? In R. Kvetňanský, R. McCarty, & J. Axelrod (Eds.), *Stress: Neuroendocrine and Molecular Approaches*. Gordon and Breach Science Publishers. https://books.google.com.au/books?id=zoVKAQAAIAAJ

McEvoy, M., Parker, C., Crombie, A., Skinner, T. C., Begg, S., Faulkner, P., McEvoy, A., Bamforth, L., & Caccaviello, G. (2021). Loddon Mallee healthcare worker COVID-19 study—Protocol for a prospective cohort study examining the health and well-being of rural Australian healthcare workers during the COVID-19 pandemic. *BMJ Open*, *11*(8), e050511. https://doi.org/10.1136/bmjopen-2021-050511

McEwen, B. S. (1998). Stress, adaptation, and disease: Allostasis and allostatic load. *Annals of the New York Academy of Sciences*, *840*(1), 33-44.

McEwen, B. S. (2000). Allostasis and allostatic load: implications for neuropsychopharmacology. *Neuropsychopharmacology*, *22*(2), 108-124. https://doi.org/10.1016/S0893-133X(99)00129-3

McEwen, B. S. (2004). Protection and damage from acute and chronic stress: Allostasis and allostatic overload and relevance to the pathophysiology of psychiatric disorders. *Annals of the New York Academy of Sciences*, *1032*(1), 1-7. https://doi.org/10.1196/annals.1314.001

McEwen, B. S. (2005). Stressed or stressed out: What is the difference? *Journal of Psychiatry and Neuroscience*, *30*(5), 315-318. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1197275/

McEwen, B. S. (2007). Physiology and neurobiology of stress and adaptation: Central role of the brain. *Physiology Reviews*, *87*(3), 873-904. https://doi.org/10.1152/physrev.00041.2006

McEwen, B. S. (2016). In pursuit of resilience: Stress, epigenetics, and brain plasticity. *Annals of the New York Academy of Sciences*, *1373*(1), 56-64. https://doi.org/10.1111/nyas.13020

McEwen, B. S., & Gianaros, P. J. (2011). Stress- and allostasis-induced brain plasticity. *Annual Reviews in Medicine*, *62*, 431-445. https://doi.org/10.1146/annurev-med-052209-100430

McEwen, B. S., Gray, J., & Nasca, C. (2015). Recognizing resilience: Learning from the effects of stress on the brain. *Neurobiology of Stress*, *1*, 1-11. https://doi.org/10.1016/j.ynstr.2014.09.001

McEwen, B. S., & Stellar, E. (1993). Stress and the individual. Mechanisms leading to disease. *Archives of International Medicine*, *153*(18), 2093-2101.

McEwen, B. S., & Wingfield, J. C. (2003). The concept of allostasis in biology and biomedicine. *Hormones and Behavior*, *43*(1), 2-15. https://doi.org/10.1016/s0018-506x(02)00024-7

McGarry, S., Girdler, S., McDonald, A., Valentine, J., Lee, S.-L., Blair, E., Wood, F., & Elliott, C. (2013). Paediatric health-care professionals: Relationships between psychological distress, resilience and coping skills. *Journal of Paediatrics and Child Health*, *49*(9), 725-732. https://doi.org/10.1111/jpc.12260

McGowan, J. E., & Murray, K. (2016). Exploring resilience in nursing and midwifery students: A literature review. *Journal of Advanced Nursing*, *72*(10), 2272-2283. https://doi.org/10.1111/jan.12960

McGuinness, S. L., Johnson, J., Eades, O., Cameron, P. A., Forbes, A., Fisher, J., Grantham, K., Hodgson, C., Hunter, P., Kasza, J., Kelsall, H. L., Kirkman, M., Russell, G., Russo, P. L., Sim, M. R., Singh, K. P., Skouteris, H., Smith, K. L., Stuart, R. L., . . . Leder, K. (2022). Mental health outcomes in Australian healthcare and aged-care workers during the second year of the COVID-19 pandemic. *International Journal of Environmental Research and Public Health*, *19*(9), 4951. https://doi.org/10.3390/ijerph19094951

Mealer, M., Conrad, D., Evans, J., Jooste, K., Solyntjes, J., Rothbaum, B., & Moss, M. (2014). Feasibility and acceptability of a resilience training program for intensive care unit nurses. *American Journal of Critical Care*, *23*(6), e97-105. https://doi.org/10.4037/ajcc2014747

Mealer, M., Jones, J., & Moss, M. (2012). A qualitative study of resilience and posttraumatic stress disorder in United States ICU nurses. *Intensive Care Medicine*, *38*(9), 1445-1451. https://doi.org/10.1007/s00134-012-2600-6

Meidiana, D., Badrul, M., Agus, S., Ashri Maulida, R., & Rikhan Luhur, P. (2021). DAHAGA: An Islamic spiritual mindfulness-based application to reduce depression among nursing students during the COVID-19 pandemic. *Belitung Nursing Journal*, *7*(3), 219-226. https://doi.org/10.33546/bnj.1494

Melamed, S., Kushnir, T., & Shirom, A. (1992). Burnout and risk factors for cardiovascular diseases. *Journal of Behavioral Medicine*, *18*(2), 53-60. https://doi.org/10.1080/08964289.1992.9935172

Melamed, S., Shirom, A., Toker, S., Berliner, S., & Shapira, I. (2006). Burnout and risk of cardiovascular disease: Evidence, possible causal paths, and promising research directions. *Psychology Buletinl*, *132*(3), 327-353. https://doi.org/10.1037/0033-2909.132.3.327

Miettinen, O. S. (1985). *Theoretical epidemiology: Principles of occurrence research in medicine.* John Wiley & Sons. https://onesearch.nihlibrary.ors.nih.gov/discovery/fulldisplay?vid=01NIH_INST:NIH&docid=alma991000100689704686&lang=en&context=L&adaptor=Local%20Search%20Engine

Miller, M. J., Mealer, M. L., Cook, P. F., Kittelson, A. J., & Christiansen, C. L. (2021). Psychometric assessment of the Connor-Davidson Resilience Scale for people with lower-limb amputation. *Physical Therapy*, *101*(4). https://doi.org/10.1093/ptj/pzab002

Milosevic, M., Jovanov, E., Frith, K. H., Vincent, J., & Zaluzec, E. (2012, 28 Aug.-1 Sept. 2012). Preliminary analysis of physiological changes of nursing students during training. 2012 Annual International Conference of the IEEE Engineering in Medicine and Biology Society,

Mischler, K., Fischer, J. E., Zgraggen, L., Kudielka, B. M., Preckel, D., & von Känel, R. (2005). The effect of repeated acute mental stress on habituation and recovery responses in hemoconcentration and blood cells in healthy men. *Life Sciences*, *77*(10), 1166-1179. https://doi.org/10.1016/j.lfs.2005.03.006

Mitchell, A. M., Crane, P. A., & Kim, Y. (2008). Perceived stress in survivors of suicide: Psychometric properties of the Perceived Stress Scale. *Research in Nursing and Health*, *31*(6), 576-585.

Miyai, N., Arita, M., Miyashita, K., Morioka, I., Shiraishi, T., & Nishio, I. (2002). Blood pressure response to heart rate during exercise test and risk of future hypertension. *Hypertension*, *39*(3), 761-766. https://doi.org/10.1161/hy0302.105777

Monroe, S. M. (2008). Modern approaches to conceptualizing and measuring human life stress. *Annual Review of Clinical Psychology*, *4*, 33-52. https://doi.org/10.1146/annurev.clinpsy.4.022007.141207

Morgan, A., Parker, A. G., Alvarez-Jimenez, M., & Jorm, A. (2013). Exercise and mental health: An exercise and sports science Australia commissioned review. *Journal of Exercise Physiology Online*, *16*(4), 64-73. https://www.semanticscholar.org/paper/Exercise-and-Mental-Health%3A-An-Exercise-and-Sports-Morgan-Parker/cf1c5775404a8eb203b8fe83bb8119d4ae52c9ee

Morgan, D. L. (2014). Pragmatism as a paradigm for social research. *Qualitative Inquiry*, *20*(8), 1045-1053. https://doi.org/10.3390/socsci8090255

Moya-Albiol, L., Salvador, A., Costa, R., Martinez-Sanchis, S., Gonzalez-Bono, E., Ricarte, J., & Arnedo, M. (2001). Psychophysiological responses to the Stroop Task after a maximal cycle ergometry in elite sportsmen and physically active subjects. *International Journal of Psychophysiology*, *40*(1), 47-59. https://doi.org/10.1016/s0167-8760(00)00125-2.

Muntner, P., Shimbo, D., Tonelli, M., Reynolds, K., Arnett, D. K., & Oparil, S. (2011). The relationship between visit-to-visit variability in systolic blood pressure and all-cause mortality in the general population. *Hypertension*, *57*(2), 160-166. https:// doi:10.1161/HYPERTENSIONAHA.110.162255

Naczenski, L. M., Vries, J. D., Hooff, M., & Kompier, M. A. J. (2017). Systematic review of the association between physical activity and burnout. *Journal of Occupational Health*, *59*(6), 477-494. https://doi.org/10.1539/joh.17-0050-RA

Nahm, E.-S., Warren, J., Zhu, S., An, M., & Brown, J. (2012). Nurses' self-care behaviors related to weight and stress. *Nursing Outlook*, *60*(5), e23-e31. https://doi.org/10.1016/j.outlook.2012.04.005

Naidoo, R., & Coopoo, Y. (2007). The health and fitness profiles of nurses in KwaZulu-Natal. *Curationis*, *30*(2), 66-73. https://doi.org/10.4102/curationis.v30i2.1076

Nasrallah, P., Haidar, E. A., Stephan, J. S., El Hayek, L., Karnib, N., Khalifeh, M., Barmo, N., Jabre, V., Houbeika, R., Ghanem, A., Nasser, J., Zeeni, N., Bassil, M., & Sleiman, S. F. (2019). Branched-chain amino acids mediate resilience to chronic social defeat stress by activating BDNF/TRKB signaling. *Neurobiology of Stress*, *11*, 100170. https://doi.org/10.1016/j.ynstr.2019.100170

Nayak, S. G. (2019). Impact of procrastination and time-management on academic stress among undergraduate nursing students: A cross sectional study. *International Journal* *of Caring Sciences*, *12*(3), 1480-1486. https://www.scirp.org/reference/referencespapers?referenceid=2936449

Neumann, R. J., Ahrens, K. F., Kollmann, B., Goldbach, N., Chmitorz, A., Weichert, D., Fiebach, C. J., Wessa, M., Kalisch, R., Lieb, K., Tüscher, O., Plichta, M. M., Reif, A., & Matura, S. (2022). The impact of physical fitness on resilience to modern life stress and the mediating role of general self-efficacy. *European Archives of Psychiatry and Clinical Neuroscience*, *272*(4), 679-692. https://doi.org/10.1007/s00406-021-01338-9

Newby, J. M., O'Moore, K., Tang, S., Christensen, H., & Faasse, K. (2020). Acute mental health responses during the COVID-19 pandemic in Australia. *PloS one*, *15*(7), e0236562. https://doi.org/10.1371/journal.pone.0236562

Nguyen, L. H., Drew, D. A., Graham, M. S., Joshi, A. D., Guo, C. G., Ma, W., Mehta, R. S., Warner, E. T., Sikavi, D. R., Lo, C. H., Kwon, S., Song, M., Mucci, L. A., Stampfer, M. J., Willett, W. C., Eliassen, A. H., Hart, J. E., Chavarro, J. E., Rich-Edwards, J. W., . . . Chan, A. T. (2020). Risk of COVID-19 among front-line health-care workers and the general community: A prospective cohort study. *Lancet Public Health*, *5*(9), e475-e483. https://doi.org/10.1016/s2468-2667(20)30164-x

Norris, F. H., Tracy, M., & Galea, S. (2009). Looking for resilience: Understanding the longitudinal trajectories of responses to stress. *Social Science & Medicine*, *68*(12), 2190-2198. https://doi.org/https://doi.org/10.1016/j.socscimed.2009.03.043

Norris, R., Carroll, D., & Cochrane, R. (1992). The effects of physical activity and exercise training on psychological stress and well-being in an adolescent population. *Journal of Psychosomatic Eesearch*, *36*(1), 55-65. https://doi.org/10.1016/0022-3999(92)90114-h

Norton, K., & Norton, L. (2012). *Pre-exercise screening: Guide to the Australian adult pre-screening system*. Exercise and Sport Science Australia, Fitness Australia and Sports Medicine Australia. https://ausactive.org.au/policies-guidelines/adult-pre-exercise-screening-system/

Notario-Pacheco, B., Solera-Martínez, M., Serrano-Parra, M. D., Bartolomé-Gutiérrez, R., García-Campayo, J., & Martínez-Vizcaíno, V. (2011). Reliability and validity of the Spanish version of the 10-item Connor-Davidson Resilience Scale (10-item CD-RISC) in young adults. *Health and Quality of Life Outcomes*, *9*, 63. https://doi.org/10.1186/1477-7525-9-63

Nurcan, U., Hatice, D., Elcin, B., & Besti, U. (2022). Experiences of nurses during the fight against COVID-19: A qualitative study. *International Journal of Caring Sciences*, *15*(2), 1374-1383. https://research.ebsco.com/c/np77rt/search/details/ge2fkqzhuz?q=AN%20159484070

Nursing and Midwifery Board of Australia. (2020). *Nursing and Midwifery Board of Australia Registrant Data*. https://ahpra-search.clients.funnelback.com/s/redirect?collection=ahpra-websites-web&url=https%3A%2F%2Fwww.ahpra.gov.au%2Fdocuments%2Fdefault.aspx%3Frecord%3DWD20%252f30054%26dbid%3DAP%26chksum%3DLV85avY0Mg4c4EitkTue6w%253d%253d&auth=Qo25adeTT6gC3mDeS8O3Vw&profile=nursingmidwifery&rank=1&query=registrant+data+2020+nursing+%7Cd%3D2020

Nyklíček, I., Mommersteeg, P. M. C., Van Beugen, S., Ramakers, C., & Van Boxtel, G. J. (2013). Mindfulness-based stress reduction and physiological activity during acute stress: A randomized controlled trial. *Health Psychology*, *32*(10), 1110-1113. https://doi.org/10.1037/a0032200

O'Dowd, E., O'Connor, P., Lydon, S., Mongan, O., Connolly, F., Diskin, C., McLoughlin, A., Rabbitt, L., McVicker, L., Reid-McDermott, B., & Byrne, D. (2018). Stress, coping, and psychological resilience among physicians. *BMC Health Service Research*, *18*(1), 730. https://doi.org/10.1186/s12913-018-3541-8

O'Leary, O. F., Felice, D., Galimberti, S., Savignac, H. M., Bravo, J. A., Crowley, T., El Yacoubi, M., Vaugeois, J.-M., Gassmann, M., Bettler, B., Dinan, T. G., & Cryan, J. F. (2014). GABAB(1) receptor subunit isoforms differentially regulate stress resilience. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(42), 15232-15237. https://doi.org/10.1073/pnas.1404090111

O'Sullivan, S. E., & Bell, C. (2001). Training reduces autonomic cardiovascular responses to both exercise-dependent and-independent stimuli in humans. *Autonomic Neuroscience*, *91*(1-2), 76-84. https://doi.org/10.1016/S1566-0702(01)00288-0

O’Donohue, J. S., Mesagno, C., & O’Brien, B. (2021). How can stress resilience be monitored? A systematic review of measurement in humans. *Current Psychology*, *40*(6), 2853-2876. https://doi.org/10.1007/s12144-019-00226-9

Obbarius, N., Fischer, F., Obbarius, A., Nolte, S., Liegl, G., & Rose, M. (2018). A 67-item stress resilience item bank showing high content validity was developed in a psychosomatic sample. *Journal of Clinical Epidemiology*, *100*, 1-12. https://doi.org/10.1016/j.jclinepi.2018.04.004

Öksüz, E., Demiralp, M., Mersin, S., Tüzer, H., Aksu, M., & Sarıkoc, G. (2019). Resilience in nurses in terms of perceived social support, job satisfaction and certain variables. *Journal of Nursing Management*, *27*(2), 423-432. https://doi.org/10.1111/jonm.12703

Opie, T., Lenthall, S., Wakerman, J., Dollard, M., Macleod, M., Knight, S., Rickard, G., & Dunn, S. (2011). Occupational stress in the Australian nursing workforce: A comparison between hospital-based nurses and nurses working in very remote communities. *Australian Journal of Advanced Nursing*, *28*, 36-43. https://doi.org/https://hdl.handle.net/1959.8/123692

Ostafin, B. D., & Proulx, T. (2020). Meaning in life and resilience to stressors. *Anxiety, Stress, & Coping*, *33*(6), 603-622. https://doi.org/10.1080/10615806.2020.1800655

Ozkara, A. B., Kalkavan, A., Alemdag, S., & Alemdag, C. (2016). The role of physical activity in psychological resilience. *Baltic Journal of Sport and Health Sciences*, *3*(102). https://doi.org/10.33607/bjshs.v3i102.62

Pakenham, K. I., Landi, G., Boccolini, G., Furlani, A., Grandi, S., & Tossani, E. (2020). The moderating roles of psychological flexibility and inflexibility on the mental health impacts of COVID-19 pandemic and lockdown in Italy. *Journal of Contextual Behavioral Science*, *17*, 109-118. https://doi.org/10.1016/j.jcbs.2020.07.003

Pan-Vazquez, A., Rye, N., Ameri, M., McSparron, B., Smallwood, G., Bickerdyke, J., Rathbone, A., Dajas-Bailador, F., & Toledo-Rodriguez, M. (2015). Impact of voluntary exercise and housing conditions on hippocampal glucocorticoid receptor, miR-124 and anxiety. *Molecular Brain*, *8*(1), 40. https://doi.org/10.1186/s13041-015-0128-8

Pappa, S., Ntella, V., Giannakas, T., Giannakoulis, V. G., Papoutsi, E., & Katsaounou, P. (2020). Prevalence of depression, anxiety, and insomnia among healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis. *Brain Behavior and Immunity*, *88*, 901-907. https://doi.org/10.1016/j.bbi.2020.05.026

Parati, G., Stergiou, G. S., Asmar, R., Bilo, G., de Leeuw, P., Imai, Y., Kario, K., Lurbe, E., Manolis, A., Mengden, T., O'Brien, E., Ohkubo, T., Padfield, P., Palatini, P., Pickering, T., Redon, J., Revera, M., Ruilope, L. M., Shennan, A., . . . Mancia, G. (2008). European Society of Hypertension guidelines for blood pressure monitoring at home: A summary report of the Second International Consensus Conference on Home Blood Pressure Monitoring. *Journal of Hypertension*, *26*(8), 1505-1526. https://doi.org/10.1097/HJH.0b013e328308da66

Parker, G., Fletcher, K., Paterson, A., Anderson, J., & Hong, M. (2014). Gender differences in depression severity and symptoms across depressive sub-types. *Journal of Affective Disorders*, *167*, 351-357. https://doi.org/10.1016/j.jad.2014.06.018

Pascoe, A., Paul, E., Willis, K., & Smallwood, N. (2022). Cross-sectional survey of COVID-19-related impacts on mental health of nurses: Occupational disruption, organisational preparedness, psychological harm, and moral distress. *Contemporary Nurse*, *58*(2-3), 212-227. https://doi.org/10.1080/10376178.2022.2080089

Patrick, S. W., Henkhaus, L. E., Zickafoose, J. S., Lovell, K., Halvorson, A., Loch, S., Letterie, M., & Davis, M. M. (2020). Well-being of parents and children during the COVID-19 pandemic: A national survey. *Pediatrics*, *146*(4), e2020016824. https://doi.org/10.1542/peds.2020-016824

Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. *Health Service Research*, *34*(5), 1189-1208. https://www.ncbi.nlm.nih.gov/pubmed/10591279

Penedo, F. J., & Dahn, J. R. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry*, *18*(2), 189-193. https://doi.org/10.1097/00001504-200503000-00013

Perry, L., Gallagher, R., & Duffield, C. (2015). The health and health behaviours of Australian metropolitan nurses: an exploratory study. *BMC Nursing*, *14*(1), 45. https://doi.org/10.1186/s12912-015-0091-9

Philippe, R. A., Schwab, L., & Biasutti, M. (2021). Effects of physical activity and mindfulness on resilience and depression during the first wave of COVID-19 pandemic. *Frontiers in Psycholpgy*, *12*, 700742. https://doi.org/10.3389/fpsyg.2021.700742

Pichot, V., Roche, F., Denis, C., Garet, M., Duverney, D., Costes, F., & Barthélémy, J.-C. (2005). Interval training in elderly men increases both heart rate variability and baroreflex activity. *Clinical Autonomic Research*, *15*(2), 107-115. https://doi.org/10.1007/s10286-005-0251-1

Pickering, T. G., Hall, J. E., Appel, L. J., Falkner, B. E., Graves, J., Hill, M. N., Jones, D. W., Kurtz, T., Sheps, S. G., & Roccella, E. J. (2005). Recommendations for Blood Pressure Measurement in Humans and Experimental Animals. *Hypertension*, *45*(1), 142-161. https://doi.org/10.1161/01.HYP.0000150859.47929.8e

Pierce, M., Hope, H., Ford, T., Hatch, S., Hotopf, M., John, A., Kontopantelis, E., Webb, R., Wessely, S., & McManus, S. (2020). Mental health before and during the COVID-19 pandemic: a longitudinal probability sample survey of the UK population. *The Lancet Psychiatry*, *7*(10), 883-892. https://doi.org/10.1016/S2215-0366(20)30308-4

Potter, C. (2006). To what extent do nurses and physicians working within the emergency department experience burnout: A review of the literature. *Australasian Emergency Nursing Journal*, *9*(2), 57-64. https://doi.org/10.1016/j.aenj.2006.03.006

Preskorn, S. H. (2014). The role of proof of concept (POC) studies in drug development using the EVP-6124 POC study as an example. *Journal of Psychiatric Practice*, *20*(1), 59-60. https://doi.org/10.1097/01.pra.0000442938.61575.c2

Price, L. (2006). Treating the clock and not the patient: ambulance response times and risk. *Quality & Safety in Health Care*, *15*(2), 127-130. https://doi.org/10.1136/qshc.2005.015651

Quigley, A. L., Stone, H., Nguyen, P. Y., Chughtai, A. A., & MacIntyre, C. R. (2021). Estimating the burden of COVID-19 on the Australian healthcare workers and health system during the first six months of the pandemic. *International Journal of Nursing Studies*, *114*, 103811. https://doi.org/10.1016/j.ijnurstu.2020.103811

Ramachandran, H. J., Bin Mahmud, M. S., Rajendran, P., Jiang, Y., Cheng, L., & Wang, W. (2023). Effectiveness of mindfulness-based interventions on psychological well-being, burnout and post-traumatic stress disorder among nurses: A systematic review and meta-analysis. *Journal of Clinical Nursing*, *32*, 2323-2338. https://doi.org/10.1111/jocn.16265

Rankin, C. H., Abrams, T., Barry, R. J., Bhatnagar, S., Clayton, D., Colombo, J., Coppola, G., Geyer, M. A., Glanzman, D. L., Marsland, S., McSweeney, F., Wilson, D. A., Wu, C.-F., & Thompson, R. F. (2009). Habituation revisited: An updated and revised description of the behavioral characteristics of habituation. *Neurobiology of learning and Memory*, *92*(2), 135-138. https://doi.org/10.1016/j.nlm.2008.09.012

Reicherts, P., Zerbini, G., Halms, T., Strasser, M., Papazova, I., Hasan, A., & Kunz, M. (2022). COVID-19 related psychological burden and potential benefits of vaccination - Data from a repeated cross-sectional survey in healthcare workers. *Psychiatry Research Communications*, *2*(3), 100054. https://doi.org/10.1016/j.psycom.2022.100054

Rejeski, W. J. (1994). Dose–response issues from a psychosocial perspective. In *Physical activity, fitness, and health: International proceedings and consensus statement.* (pp. 1040-1055). Human Kinetics Publishers. https://doi.org/10.1249/00005768-199401000-00024

Rella, S., Winwood, P. C., & Lushington, K. (2009). When does nursing burnout begin? An investigation of the fatigue experience of Australian nursing students. *Journal of*

Nursing Management, *17*(7), 886-897. https://doi.org/10.1111/j.1365-2834.2008.00883.x

Rennie, K. L., Hemingway, H., Kumari, M., Brunner, E., Malik, M., & Marmot, M. (2003). Effects of moderate and vigorous physical activity on heart rate variability in a British study of civil servants. *Americal Journal of Epidemiology*, *158*(2), 135-143. https://doi.org/10.1093/aje/kwg120

Reul, J. M. H. M., Collins, A., Saliba, R. S., Mifsud, K. R., Carter, S. D., Gutierrez-Mecinas, M., Qian, X., & Linthorst, A. C. E. (2015). Glucocorticoids, epigenetic control and stress resilience. *Neurobiology of Stress*, *1*, 44-59. https://doi.org/10.1016/j.ynstr.2014.10.001

Reverté-Villarroya, S., Ortega, L., Lavedán, A., Masot, O., Burjalés-Martí, M. D., Ballester-Ferrando, D., Fuentes-Pumarola, C., & Botigué, T. (2021). The influence of COVID-19 on the mental health of final-year nursing students: Comparing the situation before and during the pandemic. *International Journal of Mental Health in Nursing*, *30*(3), 694-702. https://doi.org/10.1111/inm.12827

Reyes, A. T., Andrusyszyn, M. A., Iwasiw, C., Forchuk, C., & Babenko-Mould, Y. (2015). Nursing students' understanding and enactment of resilience: aAgrounded theory study. *Journal of Advanced Nursing*, *71*(11), 2622-2633. https://doi.org/10.1111/jan.12730

Richardson, G. (2002). The metatheory of resilience and resiliency. *Journal of Clinical Psychology*, *58*(3), 307-321. https://doi.org/10.1002/jclp.10020

Rimmele, U., Seiler, R., Marti, B., Wirtz, P. H., Ehlert, U., & Heinrichs, M. (2009). The level of physical activity affects adrenal and cardiovascular reactivity to psychosocial stress. *Psychoneuroendocrinology*, *34*(2), 190-198. https://doi.org/10.1016/j.psyneuen.2008.08.023

Rimmele, U., Zellweger, B. C., Marti, B., Seiler, R., Mohiyeddini, C., Ehlert, U., & Heinrichs, M. (2007). Trained men show lower cortisol, heart rate and psychological responses to psychosocial stress compared with untrained men. *Psychoneuroendocrinology*, *32*(6), 627-635. https://doi.org/10.1016/j.psyneuen.2007.04.005

Ríos-Risquez, M. I., García-Izquierdo, M., Sabuco-Tebar, E. L., Carrillo-Garcia, C., & Martinez-Roche, M. E. (2016). An exploratory study of the relationship between resilience, academic burnout and psychological health in nursing students. *Contemporary Nurse*, *52*(4), 430-439. https://doi.org/10.1080/10376178.2016.1213648

Ripp, J., Peccoralo, L., & Charney, D. (2020). Attending to the emotional well-being of the health care workforce in a new york city health system during the COVID-19 pandemic. *International Journal of Academic Medicine*, *95*(8), 1136-1139. https://doi.org/10.1097/acm.0000000000003414

Robins, T. G., Roberts, R. M., & Sarris, A. (2018). The role of student burnout in predicting future burnout: Eploring the transition from university to the workplace. *Higher Education Research & Development*, *37*(1), 115-130. https://doi.org/10.1080/07294360.2017.1344827

Rodriguez-Rey, R., Alonso-Tapia, J., & Hernansaiz-Garrido, H. (2016). Reliability and validity of the Brief Resilience Scale (BRS) Spanish version. *Psychological Assessment*, *28*(5), e101-e110. https://doi.org/10.1037/pas0000191

Rodriguez-Vega, B., Palao, Á., Muñoz-Sanjose, A., Torrijos, M., Aguirre, P., Fernández, A., Amador, B., Rocamora, C., Blanco, L., Marti-Esquitino, J., Ortiz-Villalobos, A., Alonso-Sañudo, M., Cebolla, S., Curto, J., Villanueva, R., de-la-Iglesia, M.-J., Carracedo, D., Casado, C., Vidal, E., . . . Bayón, C. (2020). Implementation of a mindfulness-based crisis intervention for frontline healthcare workers during the COVID-19 outbreak in a public general Hospital in Madrid, Spain [Brief Research Report]. *Frontiers in Psychiatry*, *11*(1170), 562578. https://doi.org/10.3389/fpsyt.2020.562578

Roozendaal, B. (2000). Glucocorticoids and the regulation of memory consolidation. *Psychoneuroendocrinology*, *25*(3), 213-238. https://doi.org/10.1016/S0306-4530(99)00058-X

Ross-Adjie, G. M., Leslie, G., & Gillman, L. (2007). Occupational stress in the ED: What matters to nurses? *Australasian Emergency Nursing Journal*, *10*(3), 117-123. https://doi.org/http://dx.doi.org/10.1016/j.aenj.2007.05.005

Rossell, S. L., Neill, E., Phillipou, A., Tan, E. J., Toh, W. L., Van Rheenen, T. E., & Meyer, D. (2021). An overview of current mental health in the general population of Australia during the COVID-19 pandemic: Results from the COLLATE project. *Psychiatry Research*, *296*, 113660. https://doi.org/10.1016/j.psychres.2020.113660

Rossy, L. A., & Thayer, J. F. (1998). Fitness and gender-related differences in heart period variability. *Psychosomatic Medicine*, *60*(6), 773-781. https://doi.org/10.1097/00006842-199811000-00022

Rushton, C. H., Batcheller, J., Schroeder, K., & Donohue, P. (2015). Burnout and resilience among nurses practicing in high-intensity settings. *American Journal of Critical Care*, *24*(5), 412-420. https://doi.org/10.4037/ajcc2015291

Rutter, M. (2012). Resilience as a dynamic concept. *Developmental Psychopathology*, *24*(2), 335-344. https://doi.org/10.1017/S0954579412000028

Saberi, P. (2020). Research in the time of Coronavirus: Continuing ongoing studies in the midst of the COVID-19 pandemic. *AIDS and Behavior*, *24*(8), 2232-2235. https://doi.org/10.1007/s10461-020-02868-4

Salmon, P. (2001). Effects of physical exercise on anxiety, depression, and sensitivity to stress: A unifying theory. *Clinical Psychology Review*, *21*(1), 33-61. https://doi.org/10.1016/s0272-7358(99)00032-x

Sameer, A. S., Khan, M. A., Nissar, S., & Banday, M. Z. (2020). Assessment of mental health and various coping strategies among general population living under imposed COVID-lockdown across world: A cross-sectional study. *Ethics, Medicine and Public Health*, *15*, 100571. https://doi.org/10.1016/j.jemep.2020.100571

Sampson, M., Melnyk, B. M., & Hoying, J. (2019). Intervention effects of the MINDBODYSTRONG cognitive behavioral skills building program on newly licensed registered nurses' mental health, healthy lifestyle behaviors, and job satisfaction. *Journal of Nursing Administration*, *49*(10), 487-495. https://doi.org/10.1097/nna.0000000000000792

Sánchez-Zaballos, M., & Mosteiro-Díaz, M. P. (2021). Resilience among professional health workers in emergency services. *Journal of Emergerncy Nursing*, *47*(6), 925-932.e922. https://doi.org/10.1016/j.jen.2020.07.007

Sapolsky, R. M. (1996). Stress, glucocorticoids, and damage to the nervous system: The current state of confusion. *Stress*, *1*(1), 1-19. https://doi.org/10.3109/10253899609001092

Saraswathi, I., Saikarthik, J., Senthil Kumar, K., Madhan Srinivasan, K., Ardhanaari, M., & Gunapriya, R. (2020). Impact of COVID-19 outbreak on the mental health status of undergraduate medical students in a COVID-19 treating medical college: A prospective longitudinal study. *PeerJ*, *8*, e10164. https://doi.org/10.7717/peerj.10164

Savitsky, B., Findling, Y., Ereli, A., & Hendel, T. (2020). Anxiety and coping strategies among nursing students during the covid-19 pandemic. *Nurse Education in Practice*, *46*, 102809. https://doi.org/10.1016/j.nepr.2020.102809

Schindler, R. T. (2010). *Relations among exercise patterns, life satisfaction, and PTSD related symptoms* [Doctoral dissertation, Yeshiva University].

https://www.proquest.com/openview/972dee46acb98184e473246e0551e5cb/1?pq-origsite=gscholar&cbl=18750

Schmitt, L., Regnard, J., Desmarets, M., Mauny, F., Mourot, L., Fouillot, J. P., Coulmy, N., & Millet, G. (2013). Fatigue shifts and scatters heart rate variability in elite endurance athletes. *PLoS One*, *8*(8), e71588. https://doi.org/10.1371/journal.pone.0071588

Schofield, M. J., O'Halloran, P., McLean, S. A., Forrester-Knauss, C., & Paxton, S. J. (2016). Depressive symptoms among Australian university students: Who ss at risk? *Australian Psychologist*, *51*(2), 135-144. https://doi.org/10.1111/ap.12129

Schommer, N. C., Hellhammer, D. H., & Kirschbaum, C. (2003). Dissociation between reactivity of the hypothalamus-pituitary-adrenal axis and the sympathetic-adrenal-medullary system to repeated psychosocial stress. *Psychosomatic Medicine*, *65*(3), 450-460. https://doi.org/10.1097/01.psy.0000035721.12441.17.

Schoonenboom, J., & Johnson, R. B. (2017). How to construct a mixed methods research design. *Kolner Zeitschrift fur Soziologie und Sozpsychologie*, *69*(2), 107-131. https://doi.org/10.1007/s11577-017-0454-1

Sciolino, N. R., Smith, J. M., Stranahan, A. M., Freeman, K. G., Edwards, G. L., Weinshenker, D., & Holmes, P. V. (2015). Galanin mediates features of neural and behavioral stress resilience afforded by exercise. *Neuropharmacology*, *89*, 255-264. https://doi.org/10.1016/j.neuropharm.2014.09.029

Scully, D., Kremer, J., Meade, M. M., Graham, R., & Dudgeon, K. (1998). Physical exercise and psychological well being: A critical review. *British Journal of Sports Medicine*, *32*(2), 111-120. https://doi.org/10.1136/bjsm.32.2.111

Seçer, E., & Çakmak Yıldızhan, Y. (2020). The relationship between physical activity levels and psychological resilience of university students. *Propósitos y representaciones*, *8*(2). https://doi.org/10.20511/pyr2020.v8nSPE2.598

Segan, R., Gupta, V., Walia, L., & Mittal, N. (2013). Rate pressure product predicts cardiovascular risk in type 2 diabetics with cardiac autonomic neuropathy. *National Journal of Physiology, Pharmacy and Pharmacology*, *3*(1), 43-47. https://doi.org/10.5455/njppp.2013.3.43-47

Sembulingam, P., Sembulingam, K., Ilango, S., & Sridevi, G. (2015). Rate pressure product as a determinant of physical fitness in normal young adults. *Journal of Dental and Medical Sciences*, *14*(4), 08-12. https://doi.org/10.9790/0853-14420812

Sghir, H., Löffler, S., Ottenbacher, J., Stumpp, J., & Hey, S. (2012). Investigation of different HRV parameters during an extended Trier Social Stress Test. Proceedings of the 7th

Conference of the European Study Group on Cardiovascular Oscillations. https://www.researchgate.net/publication/278032193_Investigation_of_different_HRV_parameters_during_an_extended_Trier_social_stress_test

Shaffer, F., & Ginsberg, J. P. (2017). An overview of heart rate variability metrics and norms. *Frontier in Public Health*, *5*, 258. https://doi.org/10.3389/fpubh.2017.00258

Shakoor, E., Maryam, J. K., & Hassan, S. (2015). The effects of 10 weeks concurrent aerobic and strength exercise on quality of life and resilience of kidney transplant patients. *International Journal of Applied Exercise Physiology*, *4*(2), 1-8. https://doi.org/10.22631/ijaep.v4i2.31

Shanafelt, T., Ripp, J., & Trockel, M. (2020). Understanding and addressing sources of anxiety among health care professionals during the COVID-19 pandemic. *Journal of American Medical Association*, *323*(21), 2133-2134. https://doi.org/10.1001/jama.2020.5893

Shanafelt, T. D., Boone, S., Tan, L., Dyrbye, L. N., Sotile, W., Satele, D., West, C. P., Sloan, J., & Oreskovich, M. R. (2012). Burnout and satisfaction with work-life balance among US physicians relative to the general US population. *Archives of Internal Medicine*, *172*(18), 1377-1385. https://doi.org/10.1001/archinternmed.2012.3199.

Shearer, A., Hunt, M., Chowdhury, M., & Nicol, L. (2016). Effects of a brief mindfulness meditation intervention on student stress and heart rate variability. *International Journal of Stress Management*, *23*(2), 232-254. https://doi.org/10.1037/a0039814

Shechter, A., Diaz, F., Moise, N., Anstey, D. E., Ye, S., Agarwal, S., Birk, J. L., Brodie, D., Cannone, D. E., Chang, B., Claassen, J., Cornelius, T., Derby, L., Dong, M., Givens, R. C., Hochman, B., Homma, S., Kronish, I. M., Lee, S. A. J., . . . Abdalla, M. (2020). Psychological distress, coping behaviors, and preferences for support among New York healthcare workers during the COVID-19 pandemic. *General Hospital Psychiatry*, *66*, 1-8. https://doi.org/10.1016/j.genhosppsych.2020.06.007

Sheldon, C., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385-396. https://doi.org/10.2307/2136404

Shen, X., Zou, X., Zhong, X., Yan, J., & Li, L. (2020). Psychological stress of ICU nurses in the time of COVID-19. *Critical Care*, *24*(1), 200. https://doi.org/10.1186/s13054-020-02926-2

Shih, F. J. (1998). Triangulation in nursing research: Issues of conceptual clarity and purpose. *Journal of Advanced Nursing*, *28*(3), 631-641. https://doi.org/10.1046/j.1365-2648.1998.00716.x

Shirom, A., & Melamed, S. (2006). A comparison of the construct validity of two burnout measures in two groups of professionals. *International Journal of Stress Management*, *13*(2), 176-200. https://doi.org/ 10.1037/1072-5245.13.2.176

Silverman, M. N., & Deuster, P. A. (2014). Biological mechanisms underlying the role of physical fitness in health and resilience. *Interface Focus*, *4*(5), 20140040. https://doi.org/10.1098/rsfs.2014.0040

Slatyer, S., Craigie, M., Heritage, B., Davis, S., & Rees, C. (2018). Evaluating the effectiveness of a brief mindful self-care and resiliency (MSCR) intervention for nurses: A controlled trial. *Mindfulness*, *9*(2), 534-546. https://doi.org/10.1007/s12671-017-0795-x

Smallwood, N., Karimi, L., Bismark, M., Putland, M., Johnson, D., Dharmage, S. C., Barson, E., Atkin, N., Long, C., Ng, I., Holland, A., Munro, J. E., Thevarajan, I., Moore, C., McGillion, A., Sandford, D., & Willis, K. (2021). High levels of psychosocial distress among Australian frontline healthcare workers during the COVID-19 pandemic: A cross-sectional survey. *General Psychiatry*, *34*(5), e100577-e100577. https://doi.org/10.1136/gpsych-2021-100577

Smallwood, N., Pascoe, A., Karimi, L., Bismark, M., & Willis, K. (2021). Occupational disruptions during the COVID-19 pandemic and their association with healthcare workers' mental health. *International Journal of Environmental Research and Public Health*, *18*(17), 9263. https://doi.org/10.3390/ijerph18179263

Smith, B., & McGannon, K. R. (2018). Developing rigor in qualitative research: Problems and opportunities within sport and exercise psychology. *International Review of Sport and Exercise Psychology*, *11*(1), 101-121. https://doi.org/10.1080/1750984X.2017.1317357

Smith, B., Tooley, E., Christopher, P., & Kay, V. (2010). Resilience as the ability to bounce back from stress: A neglected personal resource? *The Journal of Positive Psychology*, *5*(3), 166-176. https://doi.org/10.1080/17439760.2010.482186

Smith, B. W., Dalen, J., Wiggins, K., Tooley, E., Christopher, P., & Bernard, J. (2008). The Brief Resilience Scale: Assessing the ability to bounce back. *International Journal of Behavioral Medicine*, *15*(3), 194-200. https://doi.org/10.1080/10705500802222972

Smith, B. W., Epstein, E. M., Ortiz, J. A., Christopher, P. J., & Tooley, E. M. (2013). The foundations of resilience: what are the critical resources for bouncing back from stress? In *Resilience in children, adolescents, and adults* (pp. 167-187). Springer. https://doi.org/10.1007/978-1-4614-4939-3_13

Smith, G. D., & Yang, F. (2017). Stress, resilience and psychological well-being in Chinese undergraduate nursing students. *Nurse Education Today*, *49*, 90-95. https://doi.org/10.1016/j.nedt.2016.10.004

Song, X., Fu, W., Liu, X., Luo, Z., Wang, R., Zhou, N., Yan, S., & Lv, C. (2020). Mental health status of medical staff in emergency departments during the Coronavirus disease 2019 epidemic in China. *Brain, Behavior and Immunity*, *88*, 60-65. https://doi.org/10.1016/j.bbi.2020.06.002

Sood, A., Prasad, K., Schroeder, D., & Varkey, P. (2011). Stress management and resilience training among Department of Medicine faculty: A pilot randomized clinical trial. *Journal of General Internal Medicine*, *26*(8), 858-861. https://doi.org/10.1007/s11606-011-1640-x

Sothmann, M. S. (2006). The Cross-Stressor Adaptation Hypothesis and Exercise Training. In *Psychobiology of Physical Activity.* (pp. 149-160). Human Kinetics.

Sothmann, M. S., Buckworth, J., Claytor, R. P., Cox, R. H., White-Welkley, J. E., & Dishman, R. K. (1996). Exercise training and the cross-stressor adaptation hypothesis. *Exercise and Sport Science Reviews*, *24*, 267-287. https://pubmed.ncbi.nlm.nih.gov/8744253/

Sothmann, M. S., Buckworth, J., Claytor, R. P., Cox, R. H., White-Welkley, J. E., & Dishman, R. K. (1996). Exercise training and the cross-stressor adaptation hypothesis. *Exercise and Sport Sciences Reviews*, *24*(1), 267-288. https://pubmed.ncbi.nlm.nih.gov/8744253/

Sothmann, M. S., Hart, B. A., & Horn, T. S. (1991). Plasma catecholamine response to acute psychological stress in humans: Relation to aerobic fitness and exercise training. *Medicine and Science in Sports and Exercise*, *23*(7), 860-867. https://doi.org/10.1249/00005768-199107000-00015

Sotomayor-Castillo, C., Nahidi, S., Li, C., Macbeth, D., Russo, P. L., Mitchell, B. G., Cruickshank, M., Sorrell, T., Gilroy, N., Ferguson, P., Watts, M. R., & Shaban, R. Z. (2021). Infection control professionals' and infectious diseases physicians' knowledge, preparedness, and experiences of managing COVID-19 in Australian healthcare settings. *Infection, Disease & Health*, *26*(4), S2468-0451(2421)00027-00024. https://doi.org/10.1016/j.idh.2021.05.002

Southwick, S., M., Bonanno, G. A., Masten, A. S., Panter-Brick, C., & Yehuda, R. (2014). Resilience definitions, theory, and challenges: Interdisciplinary perspectives. *European Journal of Psychotraumatology*, *5*(1), 25338. https://doi.org/10.3402/ejpt.v5.25338

Souza, B. B., Monteze, N. M., de Oliveira, F. L., de Oliveira, J. M., de Freitas Nascimento, S., Marques do Nascimento Neto, R., Sales, M. L., & Souza, G. G. (2015). Lifetime shift work exposure: Association with anthropometry, body composition, blood pressure, glucose and heart rate variability. *Occupational and Environmental Medicine*, *72*(3), 208-215. https://doi.org/10.1136/oemed-2014-102429

Stallman, H. M. (2010). Psychological distress in university students: A comparison with general population data. *Australian Psychologist*, *45*(4), 249-257. https://doi.org/10.1080/00050067.2010.482109

Stanton, R., Best, T., Williams, S., Vandelanotte, C., Irwin, C., Heidke, P., Saito, A., Rebar, A. L., Dwyer, T., & Khalesi, S. (2021). Associations between health behaviors and mental health in Australian nursing students. *Nurse Education in Practice*, *53*, 103084. https://doi.org/10.1016/j.nepr.2021.103084

Stanton, R., To, Q. G., Khalesi, S., Williams, S. L., Alley, S. J., Thwaite, T. L., Fenning, A. S., & Vandelanotte, C. (2020). Depression, anxiety and stress during COVID-19: Associations with changes in physical activity, sleep, tobacco and alcohol use in Australian adults. *International Journal of Environmental Research and Public Health*, *17*(11), 4065. https://doi.org/10.3390/ijerph17114065

Stein, P. K., Bosner, M. S., Kleiger, R. E., & Conger, B. M. (1994). Heart rate variability: A measure of cardiac autonomic tone. *American Heart Journal*, *127*(5), 1376-1381. https://doi.org/10.1016/0002-8703(94)90059-0

Stein, P. K., & Pu, Y. (2012). Heart rate variability, sleep and sleep disorders. *Sleep Medicine Reviews*, *16*(1), 47-66. https://doi.org/10.1016/j.smrv.2011.02.005

Strahler, J., Rohleder, N., & Wolf, J. M. (2015). Acute psychosocial stress induces differential short-term changes in catecholamine sensitivity of stimulated inflammatory cytokine production. *Brain, Behavior, and Immunity*, *43*, 139-148. https://doi.org/http://dx.doi.org/10.1016/j.bbi.2014.07.014

Sui, X., Lee, D. C., Matthews, C. E., Adams, S. A., Hebert, J. R., Church, T. S., Lee, C. D., & Blair, S. N. (2010). Influence of cardiorespiratory fitness on lung cancer mortality. *Medicine in Science and Sports Exercise*, *42*(5), 872-878. https://doi.org/10.1249/MSS.0b013e3181c47b65

Swain, D. P., & Franklin, B. A. (2006). Comparison of cardioprotective benefits of vigorous versus moderate intensity aerobic exercise. *The American Journal of Cardiology*, *97*(1), 141-147. https://doi.org/ 10.1016/j.amjcard.2005.07.130.

Talapko, J., Perić, I., Vulić, P., Pustijanac, E., Jukić, M., Bekić, S., Meštrović, T., & Škrlec, I. (2021). Mental health and physical activity in health-related university students during the COVID-19 Pandemic. *Healthcare (Basel)*, *9*(7). https://doi.org/10.3390/healthcare9070801

Tarvainen, M. P., Niskanen, J.-P., Lipponen, J. A., Ranta-aho, P. O., & Karjalainen, P. A. (2014). Kubios HRV – Heart rate variability analysis software. *Computer Methods and Programs in Biomedicine*, *113*(1), 210-220. https://doi.org/10.1016/j.cmpb.2013.07.024

Taylor, H., & Reyes, H. (2012). Self-efficacy and resilience in baccalaureate nursing students. *International Journal of Nursing Education Scholarship*, *9*(1), 1-13. https://doi.org/10.1515/1548-923X.2218

Teisala, T., Mutikainen, S., Tolvanen, A., Rottensteiner, M., Leskinen, T., Kaprio, J., Kolehmainen, M., Rusko, H., & Kujala, U. M. (2014). Associations of physical activity, fitness, and body composition with heart rate variability–based indicators of stress and recovery on workdays: A cross-sectional study [journal article]. *Journal of Occupational Medicine and Toxicology*, *9*(1), 16. https://doi.org/10.1186/1745-6673-9-16

Teper, R., Segal, Z. V., & Inzlicht, M. (2013). Inside the mindful mind: How mindfulness enhances emotion regulation through improvements in executive control. *Current Directions in Psychological Science*, *22*(6), 449-454. https://doi.org/10.1177/0963721413495869

Thabane, L., Ma, J., Chu, R., Cheng, J., Ismaila, A., Rios, L. P., Robson, R., Thabane, M., Giangregorio, L., & Goldsmith, C. H. (2010). A tutorial on pilot studies: The what, why and how. *BMC Medical Research Methodology*, *10*(1), 1. https://doi.org/10.1186/1471-2288-10-1

Tham, R., Pascoe, A., Willis, K., Kay, M., & Smallwood, N. (2022). Differences in psychosocial distress among rural and metropolitan health care workers during the COVID-19 pandemic. *Australian Journal of Rural Health*, *30*(5), 683-696. https://doi.org/10.1111/ajr.12873

Thayer, J. F., Åhs, F., Fredrikson, M., Sollers, J. J., & Wager, T. D. (2012). A meta-analysis of heart rate variability and neuroimaging studies: Implications for heart rate variability as a marker of stress and health. *Neuroscience & Biobehavioral Reviews*, *36*(2), 747-756. https://doi.org/10.1016/j.neubiorev.2011.11.009

Thayer, J. F., Hansen, A. L., Saus-Rose, E., & Johnsen, B. H. (2009). Heart rate variability, prefrontal neural function, and cognitive performance: The neurovisceral integration perspective on self-regulation, adaptation, and health. *Annuals in Behavioural Medicine*, *37*(2), 141-153. https://doi.org/10.1007/s12160-009-9101-z

Thogersen-Ntoumani, C., Black, J., Lindwall, M., Whittaker, A., & Balanos, G. M. (2017). Presenteeism, stress resilience, and physical activity in older manual workers: A person-centred analysis. *European Journal of Ageing*, *14*(4), 385-396. https://doi.org/10.1007/s10433-017-0418-3

Thoma, M. V., Gianferante, D., Hanlin, L., Fiksdal, A., Chen, X., & Rohleder, N. (2017). Stronger hypothalamus-pituitary-adrenal axis habituation predicts lesser sensitization of inflammatory response to repeated acute stress exposures in healthy young adults. *Brain, Behavior, and Immunity*, *61*, 228-235. https://doi.org/http://dx.doi.org/10.1016/j.bbi.2016.11.030

Thompson, P. D., Buchner, D., Pina, I. L., Balady, G. J., Williams, M. A., Marcus, B. H., Berra, K., Blair, S. N., Costa, F., Franklin, B., Fletcher, G. F., Gordon, N. F., Pate, R. R., Rodriguez, B. L., Yancey, A. K., & Wenger, N. K. (2003). Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease: A statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Rehabilitation, and Prevention) and the Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity). *Circulation*, *107*(24), 3109-3116. https://doi.org/10.1161/01.Cir.0000075572.40158.77

Throne, L. C., Bartholomew, J. B., Craig, J., & Farrar, R. P. (2000). Stress reactivity in fire fighters: An exercise intervention. *International Journal of Stress Management*, *7*(4), 235-246. https://doi.org/10.1023/a:1009574428627

Tiete, J., Guatteri, M., Lachaux, A., Matossian, A., Hougardy, J.-M., Loas, G., & Rotsaert, M. (2021). Mental health outcomes in healthcare workers in COVID-19 and non-COVID-19 care units: A cross-sectional survey in Belgium. *Frontiers in Psychology*, *11*(3542), 612241. https://doi.org/10.3389/fpsyg.2020.612241

Tillage, R. P., Wilson, G. E., Liles, L. C., Holmes, P. V., & Weinshenker, D. (2020). Chronic environmental or genetic elevation of galanin in noradrenergic neurons confers stress resilience in mice. *Journal of Neuroscience*, *40*(39), 7464-7474. https://doi.org/10.1523/jneurosci.0973-20.2020

To, Q. G., Chen, T. T., Magnussen, C. G., & To, K. G. (2013). Workplace physical activity interventions: A systematic review. *American Journal of Health Promotion*, *27*(6), e113-123. https://doi.org/10.4278/ajhp.120425-LIT-222

To, Q. G., Vandelanotte, C., Cope, K., Khalesi, S., Williams, S. L., Alley, S. J., Thwaite, T. L., Fenning, A. S., & Stanton, R. (2022). The association of resilience with depression, anxiety, stress and physical activity during the COVID-19 pandemic. *BMC Public Health*, *22*(1), 491. https://doi.org/10.1186/s12889-022-12911-9

Toppinen-Tanner, S., Ojajärvi, A., Väänänen, A., Kalimo, R., & Jäppinen, P. (2005). Burnout as a predictor of medically certified sick-leave absences and their diagnosed causes. *Behavioral Medicine*, *31*(1), 18-27. https://doi.org/10.3200/BMED.31.1.18-32.

Treiber, F. A., Kamarck, T., Schneiderman, N., Sheffield, D., Kapuku, G., & Taylor, T. (2003). Cardiovascular reactivity and development of preclinical and clinical disease states. *Psychosomatic Medicine*, *65*(1), 46-62. https://doi.org/ 10.1097/00006842-200301000-00007

Tucker, S. J., Harris, M. R., Pipe, T. B., & Stevens, S. R. (2010). Nurses' ratings of their health and professional work environments. *American Association of Occupational Health Nurses*, *58*(6), 253-267. https://doi.org/10.3928/08910162-20100526-03

Tugade, M. M., & Fredrickson, B. L. (2004). Resilient individuals use positive emotions to bounce back from negative emotional experiences. *Journal of Personality, Sociology and Psychology*, *86*(2), 320-333. https://doi.org/10.1037/0022-3514.86.2.320

Turner, S. B. (2014). The resilient nurse: An emerging concept. *Nurse Leader*, *12*(6), 71-90. https://doi.org/10.1016/j.mnl.2014.03.013

Twenge, J. M., & Joiner, T. E. (2020). Mental distress among U.S. adults during the COVID-19 pandemic. *Journal of Clinical Psychology*, *76*(12), 2170-2182. https://doi.org/10.1002/jclp.23064

Tyson, P., Wilson, K., Crone, D., Brailsford, R., & Laws, K. (2010). Physical activity and mental health in a student population. *Journal of Mental Health*, *19*(6), 492-499. https://doi.org/10.3109/09638230902968308

Uusitupa, M., Louheranta, A., Lindström, J., Valle, T., Sundvall, J., Eriksson, J., & Tuomilehto, J. (2000). The Finnish diabetes prevention study. *British Journal of Nutrition*, *83*(S1), S137-S142. https://doi.org/10.1017/s0007114500001070

Vach, W. (1994). *Logistic regression with missing values in the covariates*. Springer-Verlag. https://link.springer.com/chapter/10.1007/978-1-4612-2650-5_9

Vagni, M., Giostra, V., Maiorano, T., Santaniello, G., & Pajardi, D. (2020). Personal accomplishment and hardiness in reducing emergency stress and burnout among COVID-19 emergency workers. *Sustainability*, *12*(21), 9071. https://www.mdpi.com/2071-1050/12/21/9071

van Agteren, J., Bartholomaeus, J., Fassnacht, D. B., Iasiello, M., Ali, K., Lo, L., & Kyrios, M. (2020). Using internet-based psychological measurement to capture the deteriorating community mental health profile during COVID-19: Observational study. *JMIR Mental Health*, *7*(6), e20696. https://doi.org/10.2196/20696

van de Mortel, T. F. (2008). Faking it: Social desirability response bias in self-report research. *Australian Journal of Advanced Nursing*, *25*(4), 40-48. https://doi.org/10.3316/informit.210155003844269

van der Werff, S., van den Berg, S., Pannekoek, J., Elzinga, B., & Van Der Wee, N. (2013). Neuroimaging resilience to stress: A review. *Frontiers in Behavioral Neuroscience*, *7*(39), 39. https://doi.org/10.3389/fnbeh.2013.00039

Van Steenkiste, E., Schoofs, J., Gilis, S., & Messiaen, P. (2021). Mental health impact of COVID-19 in frontline healthcare workers in a Belgian Tertiary care hospital: A prospective longitudinal study. *Acta Clinica Belgica*, *77*(3), 1-8. https://doi.org/10.1080/17843286.2021.1903660

Victorian State Government Health and Human Services. (2020). *Victorian healthcare worker coronavirus (COVID-19) data.* https://www.dhhs.vic.gov.au/victorian-healthcare-worker-covid-19-data

Villar, R. C., Nashwan, A. J., Mathew, R. G., Mohamed, A. S., Munirathinam, S., Abujaber, A. A., Al-Jabry, M. M., & Shraim, M. (2021). The lived experiences of frontline nurses during the coronavirus disease 2019 (COVID-19) pandemic in Qatar: A qualitative study. *Nursing Open*, *8*(6), 3516-3526. https://doi.org/10.1002/nop2.901

Violant-Holz, V., Gallego-Jiménez, M. G., González-González, C. S., Muñoz-Violant, S., Rodríguez, M. J., Sansano-Nadal, O., & Guerra-Balic, M. (2020). Psychological health and physical activity levels during the COVID-19 pandemic: A systematic review. *International Journal of Environmental Research and Public Health*, *17*(24), 9419. https://www.mdpi.com/1660-4601/17/24/9419

Vogel, C. U., Wolpert, C., & Wehling, M. (2004). How to measure heart rate? *European Journal of Clinical Pharmacology*, *60*(7), 461-466. https://doi.org/10.1007/s00228-004-0795-3 von Haaren, B., Ottenbacher, J., Muenz, J., Neumann, R., Boes, K., & Ebner-Priemer, U. (2016). Does a 20-week aerobic exercise training programme increase our capabilities to buffer real-life stressors? A randomized, controlled trial using ambulatory assessment. *European Journal of Applied Physiology*, *116*(2), 383-394. https://doi.org/10.1007/s00421-015-3284-8.

von Känel, R., Kudielka, B. M., Preckel, D., Hanebuth, D., & Fischer, J. E. (2006). Delayed response and lack of habituation in plasma interleukin-6 to acute mental stress in men. *Brain, Behavior, and Immunity*, *20*(1), 40-48. https://doi.org/10.1016/j.bbi.2005.03.013

Voss, G., Paiva, A. F., & Delerue Matos, A. (2021). A study of the association between the stringency of Covid-19 government measures and depression in older adults across Europe and Israel. *International Journal of Environmental Research and Public Health*, *18*(15), 8017. https://doi.org/10.3390/ijerph18158017

Walker, F. R., Pfingst, K., Carnevali, L., Sgoifo, A., & Nalivaiko, E. (2017). In the search for integrative biomarker of resilience to psychological stress. *Neuroscience & Biobehavioral Reviews*, *74*, 310-320. https://doi.org/10.1016/j.neubiorev.2016.05.003

Wallace, C. L., Wladkowski, S. P., Gibson, A., & White, P. (2020). Grief during the COVID-19 pandemic: Considerations for palliative care providers. *Journal of Pain and Symptom Management*, *60*(1), e70-e76. https://doi.org/10.1016/j.jpainsymman.2020.04.012

Watson, A. G., McCoy, J. V., Mathew, J., Gundersen, D. A., & Eisenstein, R. M. (2019). Impact of physician workload on burnout in the emergency department. *Psychology, Health & Medicine*, *24*(4), 414-428. https://doi.org/10.1080/13548506.2018.1539236

Watson, R., Deary, I., Thompson, D., & Li, G. (2008). A study of stress and burnout in nursing students in Hong Kong: A questionnaire survey. *International Journal of Nursing Studies*, *45*(10), 1534-1542. https://doi.org/10.1016/j.ijnurstu.2007.11.003

Webb, H. E., Rosalky, D. S., Tangsilsat, S. E., McLeod, K. A., Acevedo, E. O., & Wax, B. (2013). Aerobic fitness affects cortisol responses to concurrent challenges. *Medicine & Science in Sports & Exercise*, *45*(2), 379-386. https://doi.org/10.1249/MSS.0b013e318270b381

Weber, C. S., Thayer, J. F., Rudat, M., Wirtz, P. H., Zimmermann-Viehoff, F., Thomas, A., Perschel, F. H., Arck, P. C., & Deter, H. C. (2010). Low vagal tone is associated with impaired post stress recovery of cardiovascular, endocrine, and immune markers. *Eur Journal of Applied Physiology*, *109*(2), 201-211. https://doi.org/10.1007/s00421-009-1341-x

Weiglein, L., Herrick, J., Kirk, S., & Kirk, E. P. (2011). The 1-mile walk test is a valid predictor of VO2max and is a reliable alternative fitness test to the 1.5-mile run in U.S. Air Force males. *Military Medicine*, *176*(6), 669-673. https://doi.org/10.7205/milmed-d-10-00444

Weippert, M., Kumar, M., Kreuzfeld, S., Arndt, D., Rieger, A., & Stoll, R. (2010). Comparison of three mobile devices for measuring R-R intervals and heart rate variability: Polar S810i, Suunto t6 and an ambulatory ECG system. *European Journal of Applied Physiology*, *109*(4), 779-786. https://doi.org/10.1007/s00421-010-1415-9.

Wells, M., Avers, D., & Brooks, G. (2012). Resilience, physical performance measures, and self-perceived physical and mental health in older Catholic nuns. *Journal of Geriatric Physical Therapy*, *35*(3), 126-131. https://doi.org/ 10.1519/JPT.0b013e318237103f.

Wessel, T. R., Arant, C. B., Olson, M. B., Johnson, B. D., Reis, S. E., Sharaf, B. L., Shaw, L. J., Handberg, E., Sopko, G., & Kelsey, S. F. (2004). Relationship of physical fitness vs body mass index with coronary artery disease and cardiovascular events in women. *Journal of the American Medical Association*, *292*(10), 1179-1187. https://doi.org/10.1001/jama.292.10.1179

Weuve, J., Kang, J., Manson, J., Breteler, M., Ware, J., & Grodstein, F. (2005). Physical Activity, Including Walking, and Cognitive Function in Older Women. *Journal of Cardiopulmonary Rehabilitation and Prevention*, *25*(1), 56. https://doi.org/ 10.1001/jama.292.12.1454

White, W. B. (2002). Systolic versus diastolic blood pressure versus pulse pressure. *Current Cardiology Reports*, *4*(6), 463-467. https://doi.org/ 10.1007/s11886-002-0107-4

Wilner, N. (2014). *Physical activity and psychological stress resilience: Considering anxiety vulnerability* [Master's thesis, Georgia State University]. https://scholarworks.gsu.edu/psych_theses/118/

Windle, G. (2010). What is resilience? A review and concept analysis. *Reviews in Clinical Gerontology*, *21*(02), 152-169. https://doi.org/10.1017/s0959259810000420

Windle, G., Bennett, K. M., & Noyes, J. (2011). A methodological review of resilience measurement scales. *Health and Quality of Life Outcomes*, *9*(1), 1-18. https://doi.org/10.1186/1477-7525-9-8

Wolever, R. Q., Bobinet, K. J., McCabe, K., Mackenzie, E. R., Fekete, E., Kusnick, C. A., & Baime, M. (2012). Effective and viable mind-body stress reduction in the workplace: A randomized controlled trial. *Journal of Occupational Health and Psychology*, *17*(2), 246-258. https://doi.org/10.1037/a0027278

Woo, T., Ho, R., Tang, A., & Tam, W. (2020). Global prevalence of burnout symptoms among nurses: A systematic review and meta-analysis. *Journal of Psychiatric Research*, *123*, 9-20. https://doi.org/10.1016/j.jpsychires.2019.12.015

World Health Organisation. (2020). *Coronavirus disease 2019 (COVID-19): Situation report-36.* . (https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200225-sitrep-36-covid-19.pdfsfvrsn=2791b4e0_2).

World Health Organisation. (2021). *Weekly epidemiological update on COVID-19 - 21 December 2021*. www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---21-december-2021

Wu, K., & Wei, X. (2020). Analysis of psychological and sleep status and sxercise rehabilitation of front-line clinical staff in the fight against COVID-19 in China. *Medical Science Monitor BasicRresearch*, *26*, e924085-e924085. https://doi.org/10.12659/MSMBR.924085

Wyss, T., Boesch, M., Roos, L., Tschopp, C., Frei, K. M., Annen, H., & La Marca, R. (2016). Aerobic fitness level affects cardiovascular and salivary alpha amylase responses to acute psychosocial stress. *Sports Medicine - Open*, *2*(1), 33. https://doi.org/10.1186/s40798-016-0057-9

Xu, H., Tuckett, A., Kynoch, K., & Eley, R. (2021). A mobile mindfulness intervention for emergency department staff to improve stress and wellbeing: A qualitative study. *International Emergency Nursing*, *58*, 101039. https://doi.org/10.1016/j.ienj.2021.101039

Yang, J., Tang, S., & Zhou, W. (2018). Effect of mindfulness-based stress reduction therapy on work stress and mental health of psychiatric nurses. *Psychiatria Danubina*, *30*(2), 189-196. https://doi.org/10.24869/psyd.2018.189

Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit formation. *Journal of Comparative Neurology & Psychology*, *18*(5), 459-482. https://doi.org/10.1002/cne.920180503

Yörük, S., & Güler, D. (2021). The relationship between psychological resilience, burnout, stress, and sociodemographic factors with depression in nurses and midwives during the COVID-19 pandemic: A cross-sectional study in Turkey. *Perspectives in Psychiatric Care*, *57*(1), 390-398. https://doi.org/10.1111/ppc.12659

Yu, F., Cavadino, A., Mackay, L., Ward, K., King, A., & Smith, M. (2020). Physical activity and personal factors associated with nurse resilience in intensive care units. *Journal of Clinical Nursing*, *29*(17-18), 3246-3262. https://doi.org/10.1111/jocn.15338

Yu, F., Cavadino, A., Mackay, L., Ward, K., King, A., & Smith, M. (2022). A cluster analysis of physical activity profiles and resilience in intensive care nurses. *International Journal of Workplace Health Management*, *15*(2), 174-192. https://doi.org/10.1108/IJWHM-04-2021-0082

Yu, F., Raphael, D., Mackay, L., Smith, M., & King, A. (2019). Personal and work-related factors associated with nurse resilience: A systematic review. *International Journal of Nursing Studies*, *93*, 129-140. https://doi.org/10.1016/j.ijnurstu.2019.02.014

Zacher, H., & Rudolph, C. W. (2021). Individual differences and changes in subjective wellbeing during the early stages of the COVID-19 pandemic. *American Psychologist*, *76*(1), 50-62. https://doi.org/10.1037/amp0000702

Zeng, L.-N., Zhang, J.-W., Zong, Q.-Q., Chan, S. W.-c., Browne, G., Ungvari, G. S., Chen, L.-G., & Xiang, Y.-T. (2020). Prevalence of burnout in mental health nurses in China: A meta-analysis of observational studies. *Archives of Psychiatric Nursing*, *34*(3), 141-148. https://doi.org/10.1016/j.apnu.2020.03.006

Zerbini, G., Ebigbo, A., Reicherts, P., Kunz, M., & Messman, H. (2020). Psychosocial burden of healthcare professionals in times of COVID-19 - A survey conducted at the University Hospital Augsburg. *German Medical Science*, *18*, Doc-05. https://doi.org/10.3205/000281

Zhang, C., Yang, L., Liu, S., Ma, S., Wang, Y., Cai, Z., Du, H., Li, R., Kang, L., Su, M., Zhang, J., Liu, Z., & Zhang, B. (2020). Survey of insomnia and related social psychological factors among medical staff involved in the 2019 novel coronavirus disease outbreak. *Frontiers in Psychiatry*, *11*, 306-306. https://doi.org/10.3389/fpsyt.2020.00306

Zhang, P., Li, X., Fang, Z., Lu, Y., Cui, J., Du, X., & Hu, R. (2021). Smartphone application-supported validation of three automatic devices for self-measurement of blood pressure according to the European Society of Hypertension International Protocol revision 2010: the Omron HEM-7120, Yuwell YE680A and Cofoe KF-65B. *Blood Pressure Monitoring*, *26*(6), 435-440. https://doi.org/10.1097/mbp.0000000000000547

Zhou, A. Y., Hann, M., Panagioti, M., Patel, M., Agius, R., Van Tongeren, M., Esmail, A., & Bower, P. (2022). Cross-sectional study exploring the association between stressors and burnout in junior doctors during the COVID-19 pandemic in the United Kingdom. *Journal of Occupational Health*, *64*(1), Article e12311. https://doi.org/10.1002/1348-9585.12311

Zhou, H., Peng, J., Wang, D., Kou, L., Chen, F., Ye, M., Deng, Y., Yan, J., & Liao, S. (2017). Mediating effect of coping styles on the association between psychological capital and psychological distress among Chinese nurses: A cross-sectional study. *Journal of Psychiatric Mental Health Nursing*, *24*(2-3), 114-122. https://doi.org/10.1111/jpm.12350

Zhu, Y., Wang, H., & Wang, A. (2021). An evaluation of mental health and emotion regulation experienced by undergraduate nursing students in China during the COVID-19 pandemic: A cross-sectional study. *International Journal of Mental Health in Nursing*, *30*(5), 1160-1169. https://doi.org/10.1111/inm.12867

Zou, G., Shen, X., Tian, X., Liu, C., Li, G., Kong, L., & Li, P. (2016). Correlates of psychological distress, burnout, and resilience among Chinese female nurses. *Indonesian Health*, *54*(5), 389-395. https://doi.org/10.2486/indhealth.2015-0103

Zou, L., Sasaki, J., Wei, G.-X., Huang, T., Yeung, A., Neto, O., Chen, K., & Hui, S. (2018). Effects of mind–body exercises (Tai Chi/Yoga) on heart rate variability parameters and perceived stress: A systematic review with meta-analysis of randomized controlled trials. *Journal of clinical medicine*, *7*(11), 404. https://doi.org 10.3390/jcm7110404

APPENDIX A

Supplementary Data Analysis Material Study 1

Factor Analysis

A factor analysis with varimax rotation was conducted on the August survey (120 participants) to validate the use of the chosen scales with the regional hospital population. Despite the robust nature of factor analysis, prior to running the analysis, examination of the data was conducted to ensure no violation of the assumption of normality occurred. In the current sample, the Kaiser-Meyer-Olkin measure of sampling adequacy was .89 and Bartlett's test of sphericity significant was .001 with both tests indicating the data was suitable for factor analysis. Whilst not every variable was normally distributed, these deviations were not considered problematic.

Principal components analysis using a varimax rotation revealed three factors with eigenvalues exceeding 1, explaining 43.91%, 9.63%, 6.61%, and 5.48% of the variance within the three questionnaires. Cross-loadings were apparent for Factor 1 (SMBM) and Factor 2 (PSS) with shared item loadings for SMBM 4 ('I feel fed up') and SMBM 6 ('I feel burnt out'). It was expected that there would be cross-loadings between the PSS and SMBM as concepts among the two scales are theoretically alike therefore not problematic, and the three scales provide adequate measurements of resilience, stress and burnout within this cohort. Overall, the data were well suited for parametric statistical analyses.

Table 1.5

Factor Analysis on August 2020 Survey.

	Loadings		
Item	Factor 1	Factor 2	Factor 3
BRS 1: I tend to bounce back quickly after hard times			.83
BRS 2: I have a hard time making it through stressful events			.78

BRS 3: It doesn’t take me long to recover from a stressful event			.72
BRS 4: It is hard for me to snap back when something bad happens			.84
BRS 5: I usually come through difficult times with little trouble			.63
BRS 6: I tend to take a long time to get over setbacks in my life			.76
PSS 1: In the last week, how often have you been upset because of something that happened unexpectedly?		.71	
PSS 2: In the last week, how often have you felt that you were unable to control the important things in your life?		.68	
PSS 3: In the last week, how often have you felt nervous or stressed?		.69	
PSS 4: In the last week, how often have you felt confident about your ability to handle your workplace problems within the workplace?			
PSS 5: In the last week, how often have you felt that things were going your way?		.57	
PSS 6: In the last week, how often have you found that you could not cope with all the things you had to do?		.68	
PSS 7: In the last week, how often have you been able to control irritations in your life?		.53	
PSS 8: In the last week, how often have you felt you were on top of things?		.73	
PSS 9: In the last week, how often have you been angered because of things that were outside your control?		.51	
PSS 10: In the last week, how often have you felt difficulties were piling up so high that you could not overcome them?		.56	
SMBM 1: I feel tired		.67	
SMBM 2: I have no energy for going to work every morning	.62		
SMBM 3: I feel physically drained		.70	
SMBM 4: I feel fed up	.55	.56	
SMBM 5: I feel like my batteries are flat		.67	
SMBM 6: I feel burnt out	.52	.55	
SMBM 7: My thinking process is slow	.78		
SMBM 8: I have difficulty concentrating	.84		
SMBM 9: I feel I’m not thinking clearly	.83		

SMBM 10: I feel I’m not focused in my thinking	.86
SMBM 11: I have difficulty thinking about complex things	.85
SMBM 12: I feel I am unable to be sensitive to the needs of coworkers and patients	.75
SMBM 13: I feel I am not capable of investing emotionally in coworkers and patients	.73
SMBM 14: I feel I am not capable of being sympathetic to coworkers and patients	.70

Note: Factor loadings <.5 are suppressed.

APPENDIX B

Brief Resilience Scale (BRS)

The next 6 questions are designed to find out about your level of psychological resilience within the emergency department, based on the last four weeks. Please answer these questions based on your experience in your current workplace environment.
Please tick (✓) one box only per line.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I tend to bounce back quickly after hard times					
I have a hard time making it through stressful events					
I don't not take me long to recovery from a stressful event					
It is hard for me to snap back when something bad happens					
I usually come through difficult times with little trouble					
I tend to take a long time to get over set-backs in my life.					

APPENDIX C

The Perceived Stress Scale (PSS)

The next 10 questions ask you about your feelings and thoughts specific to your current emergency department, felt during the last month. For each question you will be asked how often you felt or thought a certain way.

Please tick (✓) one box only per line.

	Never	Almost Never	Sometimes	Fairly Often	Very Often
In the last month, how often have you been upset because of something that happened unexpectedly?					
In the last month, how often have you felt that you were unable to control the important things in your life?					
In the last month, how often have you felt nervous or stressed?					
In the last month, how often have you felt confident about your ability to handle your personal problems within the workplace?					
In the last month, how often have you felt that things were going your way?					
In the last month, how often have you found that you could not cope with all the things that you had to do?					
In the last month, how often have you been able to control irritations in your life?					
In the last month, how often have you felt you were on top of things?					
In the last month, how often have you been angered because of things that were outside your control?					
In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?					

APPENDIX D

The Shirom-Melamed Burnout Questionnaire (SMBQ)

The next 14 statements describe different feelings that you may feel when working in your current emergency department. Please indicate how often, in the past 4 weeks, you have felt each of the following feelings:

Please tick (✓) one box only per line.

	Never or Almost Never	Very Infrequently	Quite Infrequently	Sometimes	Quite Frequently	Very Frequently	Always or Almost Always
I feel tired							
I have no energy for going to work every morning							
I feel physically drained							
I feel fed up							
I feel like my ‘batteries’ are ‘dead’							
I feel burnt out							

My thinking process is slow							
I have difficulty concentrating							
I feel I'm not thinking clearly							
I feel I'm not focused in my thinking							
I have difficulty thinking about complex things							
I feel I am unable to be sensitive to the needs of co-workers and patients							

I feel I am not capable of investing emotionally in co-workers and patients							
I feel I am not capable of being sympathetic to co-workers and customers							

APPENDIX E

Study 1 Ethics Approval (Latrobe HREC)

Latrobe Regional Hospital

Human Research Ethics Committee
Certificate of Approval

This is to certify that

Project No: 2020-16 HREA

Site/Location: Latrobe Regional Hospital

Project Title: Exploring Stress Resilience and Burnout during COVID-19: An Assessment of Psychological Health in an Australian Hospital.

Principal Researcher: Dr Christopher Mesagno

has been given ethics and governance approval by the Human Research Ethics Committee from:

Approval date: 15.07.2020 **Expiry date: 31.03.2021**

It is the Principal Researcher's responsibility to ensure that all researchers associated with this project are aware of the conditions of approval. A copy of the approved ethics application and supporting documents must be kept on your files for audit purposes.

Documents Approved/Reviewed:

- HREA Application
- Federation University – HREC Approval
- Victorian Specific Module application dated 1 May 2020
- PICF – Version 2 – dated 25/6/2020
- Survey COVID Version 2 dated 25/6/2020
- Federation University – HREC Amendment letter undated

The Principal Researcher is required to notify the Human Research Ethics Committee in relation to the following.

- Any significant changes to the project and the reason for that change, including an indication of ethical implications (Amendment Form on LRH Research website)
- Adverse Event Reports regarding participants;
- Any other unforeseen events or unexpected developments that merit notification;
- The inability of the Principal Researcher to continue in that role, or any other change in research personnel involved in the project;
- Commencement date of the project (form on LRH Research website); and
- Termination or closure of the project.

Additionally, the Principal Researcher is required to submit

- A Progress Report every 12 months for the duration of the project (form are available on the LRH Research website);
- A Request for Extension of the project prior to the expiry date, if applicable; and,
- A detailed Final Report at the conclusion of the project (form are available on the LRH Research website).

The Human Research Ethics Committee may conduct an audit at any time.

All research subject to the Latrobe Regional Hospital Human Research Ethics Committee review must be conducted in accordance with the *National Statement on Ethical Conduct in Human Research (2007) updated 2018.*

The Latrobe Regional Hospital Human Research Ethics Committee is constituted in accordance with the *National Statement on Ethical Conduct in Human Research (2007) – updated 2018.*

SPECIAL CONDITIONS
Nil

[redacted]

28/7/20.

Chief Executive officer

Ethics Approval Federation University HREC

Federation University Australia recognises the approval of Latrobe Regional Hospital Human Research Ethics Committee; Approval Code: 2020-16 HREA	
Principal Researchers:	Dr Christopher Mesagno
Co-Researcher/s:	Dr Brendan O'Brien Dr Joanne Porter Miss Samantha Armstrong
School/Section:	**School of Health**
Project Number:	**E20-011 (2020-16 HREA)**
Project Title:	**Exploring Stress Resilience and Burnout during COVID-19; An Assessment of Psychological Health in an Australian Hospital.**
For the period:	24/08/2020 **to** 31/03/2021

Quote the Project No: E20-011 in all correspondence regarding this application.
Approval has been granted to undertake this project in accordance with the proposal submitted for the period listed above.
Please note: It is the responsibility of the Principal Researcher to ensure the Ethics Office is contacted immediately regarding any proposed change or any serious or unexpected adverse effect on participants during the life of this project.
In Addition: Maintaining Ethics Approval is contingent upon adherence to all Standard Conditions of Approval as listed on the final page of this notification
Please note:

- Annual progress reports are required to be submitted for the duration of the project.
- A final project report is required to be submitted at the conclusion of the project.

Submit copies of the annual and final project reports submitted to Latrobe Regional Hospital.

[redacted]

Fiona Koop
Coordinator, Research Ethics
24 August 2020

APPENDIX F

Study 1 Plain Language Information Statement

SCHOOL OF HEALTH & LIFE SCIENCES

PROJECT TITLE:	Exploring Stress Resilience and Burnout during COVID-19: An Assessment of Psychological Health in an Australian Hospital
PRINCIPAL RESEARCHER:	Dr. Christopher Mesagno
ASSOCIATE RESEARCHER:	Dr. Joanne Porter
ASSOCIATE RESEARCHER:	Dr. Brendan O'Brien
STUDENT RESEARCHER:	Miss Samantha Armstrong

You are invited to participate in a research project conducted by Samantha Armstrong, a PhD student, under the supervision of Dr. Christopher Mesagno, Senior Lecturer in the Faculty of Health and Life Sciences at Federation University Australia, Dr. Joanne Porter, Associate Professor in the School of Nursing, Midwifery and Healthcare at Federation University and Dr. Brendan O'Brien, Senior Lecturer in the Faculty of Health at Federation University. *Please note that you must be aged 18 and over to be eligible to participate in this study.

Aim of the study:

The aim of this study is to firstly, understand the psychological wellbeing, including resilience and burnout, of hospital personnel during the COVID-19 situation. Secondly, to monitor the hospital personnel psychological wellbeing whilst the COVID-19 pandemic progresses.

What you will be asked to do?

You will be asked to complete a survey of 38 questions about resilience, burnout and stress, as well as some general questions about your age, gender, and workplace-related information. The survey will take 5 minutes to complete. The survey will be sent out monthly. If you did not participate in the surveys initially, we still encourage you to complete the subsequent surveys throughout the COVID. Participation is completely voluntary, you shall remain anonymous and there is no obligation to complete the survey before submission. Once the survey has been submitted, there will not be an opportunity to edit or recall the data as individual data is not collected. Your consent shall be gained by submitting the survey and also implied upon agreeing to participate and by clicking 'yes' to this statement. Data from this study will be stored only on a password-protected computer, with access only by the named researchers, and will be destroyed after 5 years. Aggregated results shall be disseminated to the Head of Research at Latrobe Regional Hospital.

Are there any risks in this study?

If you feel uncomfortable or have any concerns at any point during the study, you may discontinue participation, however this can only occur before submission of the survey. If these concerns continue, please contact the named researchers of the project or alternatively you are encouraged to contact Lifeline on 13 11 14 or Beyond Blue on 1300 224 636 at any time.

The results from this study will be reported in the form of the PhD thesis and may also be published in scientific journals. It will not be possible to identify participants or their corresponding data within the dissertation and throughout any publications. You may contact the Principal Researcher, Dr. Christopher Mesagno, at any time throughout the research process and after study completion for an electronic summary of the findings. He can be contacted via the details provided below.

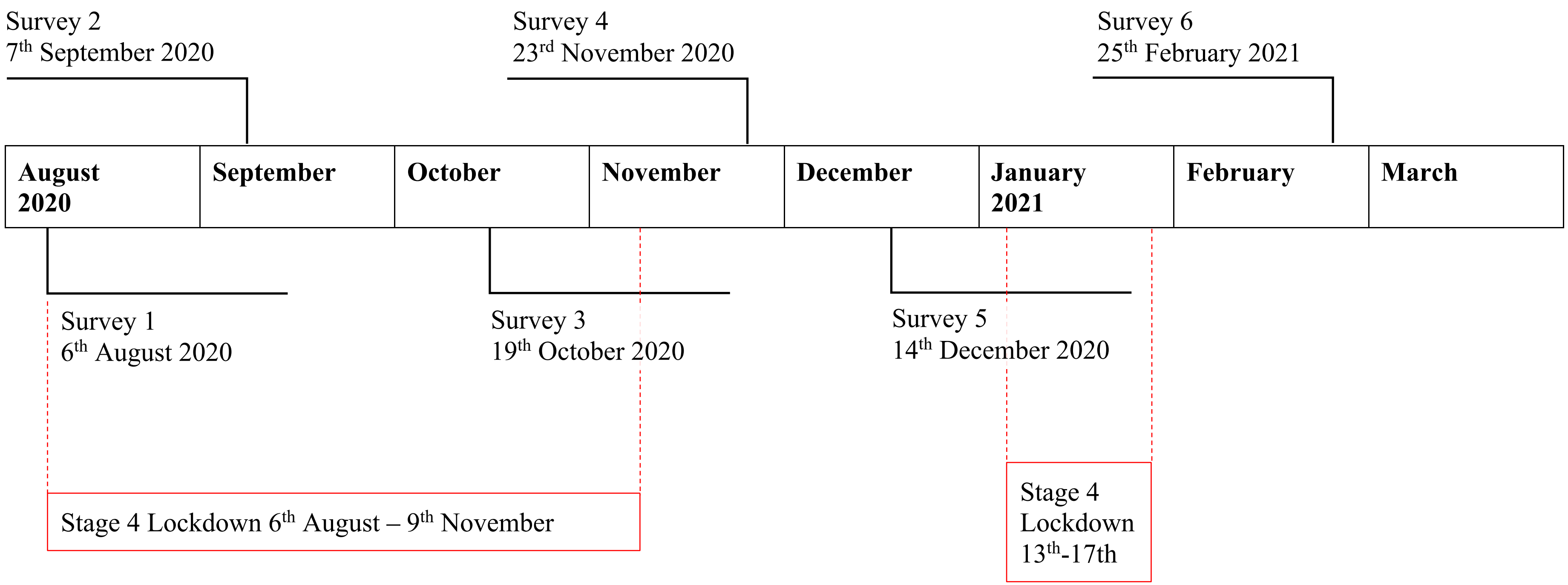
This research has been approved by Federation University Human Research Ethics Committee and the National Human Research Ethics Committee Australia.

If you have any questions, or you would like further information regarding the project titled ***Exploring Stress Resilience and Burnout during COVID-19,*** please contact the Principal Researcher, **Dr. Christopher Mesagno** of the School of Health & Life Sciences:
Should you (i.e. the participant) have any concerns about the ethical conduct of this research project, please contact the Federation University Ethics Officers, Research Services, Federation University Australia, P O Box 663 Mt Helen Vic 3353 or Northways Rd, Churchill Vic 3842. Telephone: (03) 5327 9765, (03) 5122 6446 Email: research.ethics@federation.edu.au CRICOS Provider Number 00103D

APPENDIX G

Figure 1.1

Timeline of study



Note. Red dotted line denotes time in lockdown.

APPENDIX H

Table 1.1

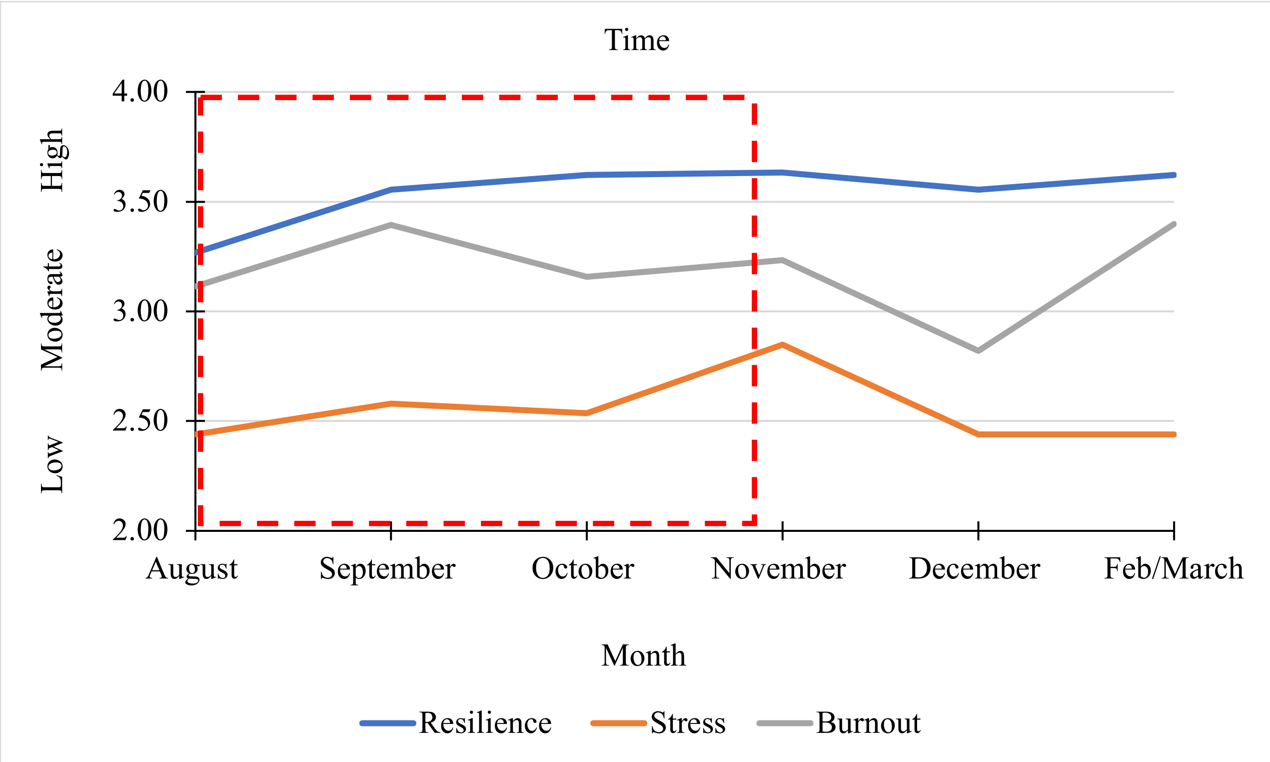
Means (M) and Standard Deviations (SD) for Resilience, Stress, and Burnout across Time.

Time	Resilience				Stress				Burnout			
	M	*SD*	*Min*	*Max*	*M*	*SD*	*Min*	*Max*	*M*	*SD*	*Min*	*Max*
August	3.25	0.69	1.83	5.00	24.30	6.57	10.00	40.00	3.14	1.14	1.00	6.93
September	3.52	0.71	1.50	5.00	25.87	7.21	10.00	40.00	3.42	1.22	1.00	6.93
October	3.61	0.69	2.00	5.00	25.02	6.77	10.00	40.00	3.10	1.25	1.21	6.86
November	3.65	0.74	2.00	5.00	28.62	3.08	22.00	36.00	3.25	1.22	1.43	6.57
December	3.55	0.58	2.33	5.00	23.94	6.50	11.00	39.00	2.87	1.04	1.00	5.64
February/March	3.58	0.71	2.00	5.00	25.41	7.03	11.00	40.00	3.50	1.18	1.43	6.93

APPENDIX I

Figure 1.2.

Mean Scores for Resilience, Stress and Burnout Over Time



Note. Red dotted line denotes time in lockdown.

APPENDIX J

Table 1.2.

Means (M) and Standard Deviations (SD) for Age across Resilience, Stress, and Burnout Parameters

Age	Resilience		Stress		Burnout	
	M	SD	M	SD	M	SD
21-25 (*n* = 33)	3.28	0.70	27.85	6.73	3.5	1.22
26-30 (*n* = 71)	3.22	0.69	26.33	6.63	3.32	1.03
31-35 (*n* = 66)	3.54	0.77	27.85	7.11	3.99	1.40
36-40 (*n* = 55)	3.58	0.56	24.51	6.70	3.26	1.16
41-50 (*n* = 128)	3.58	0.74	24.80	6.84	3.11	1.14
51-60 (*n* = 153)	3.45	0.71	24.95	6.11	3.04	1.16
61-70 (*n* = 50)	3.69	0.58	23.68	5.70	2.80	0.94

APPENDIX K

Table 1.3.

Correlation Matrix (Spearman) for Age, Workload, Resilience, Stress and Burnout

	Gender	Age	Workload	Position	Resilience	Stress	Burnout
Gender	-	-.13** (*n* = 550)	-.17** (*n* = 549)	-.13** (*n* = 520)	-.08* (*n* = 551)	.01 (*n* = 548)	.06 (*n* = 534)
Age		-	-.01 (*n* = 554)	.14** (*n* = 524)	.14** (*n* = 556)	-.14** (*n* = 553)	-.19** (*n* = 539)
Workload			-	.24** (*n* = 526)	.20** (*n* = 539)	-.04 (*n* = 553)	-.05 (*n* = 539)
Position				-	.05 (*n* = 526)	.03 (*n* = 523)	-.09* (*n* = 511)
Resilience					-	-.30** (*n* = 555)	-.36** (*n* = 541)
Stress						-	.58** (*n* = 540)
Burnout							-

** $p < .05$ (two-tailed); ** $p < .01$ (two-tailed).*

APPENDIX L

Table 1.4.

Results of Backward Method Standard Regression Analysis (Dependent Variable- Burnout)

	Step 1					Step 2					Step 3					Step 4				
		$CI_{95\%}$ For *B*					$CI_{95\%}$ For *B*					$CI_{95\%}$ For *B*					$CI_{95\%}$ For *B*			
Variabl	*B*	Lower	Upper	*β*	sr^2	*B*	Lower	Upper	*β*	sr^2	*B*	Lower	Upper	*β*	sr^2	*B*	Lower	Upper	*β*	sr^2
BRS	-.28**	-.40	-.15	-.16	-.15	-.28**	-.40	-.15	-.16	-.15	-.28**	-.40	-.15	-.16	-.15	-.26**	-.38	-.14	-.15	-.15
PSS	.10**	.08	.11	.01	.51	.10**	.08	.11	.53	.51	.10**	.08	.11	.54	.91	.10**	.08	.11	.54	.51
Age	-.06*	-.10	-.01	-.08	-.08	-.06*	-.10	-.01	-.08	-.08	-.06*	-.10	-.01	-.08	-.08	.06*	-.12	-.01	-.09	-.08
Nursing	.20	-.01	.40	.08	.07	.20	-.01	.40	.08	.07	.18*	.01	.35	.08	.07	.16	-.01	.33	.07	.07

Worklo	.05	-.03	.14	.06	.04	.05	-.03	.14	.05	.04	.05	.14	-.02	.05	.04					
Medica	.03	-.20	.26	.01	.01	.03	-.20	.26	.01	.01										
Gender	-.00	-.26	.22	.00	.00															
R	.62					.62					.62					.62				
R^2	.38					.38					.38					.38				
ΔR^2	.38**					.00					.00					.00				

Note. $N = 508$. CI = confidence interval. BRS, Brief Resilience Scale; PSS, Perceived Stress Scale.

* $p < .05$, ** $p < .00$.

APPENDIX M

Supplemental Results: Study 2

T-tests of Individual Scales

An independent samples t-test was used to compare individual items of the resilience, stress, burnout, and distress scores between the 2018 and 2021 surveys. Shapiro-Wilk indicated the assumption of normality was not violated for the stress questionnaire. Shapiro-Wilk was violated for the resilience, burnout and distress questionnaires, though inspection of Q-Q plots indicated equal distribution of scores. Levene's test was not significant for resilience and distress questionnaires thus equal variances were assumed. For the stress questionnaire, three out of ten questions did not highlight significant values, and for the burnout questionnaire, nine out of ten questions did not indicate significant values, thus questions that did not indicate statistical significance according to Levene's test were used. The t-test was statistically significant across all questions for resilience, showing lower resilience scores in 2021 compared to 2018. For example, 'I tend to bounce back quickly after hard times', $t(214) = 2.60$, $p = .010$, $d = .34$, 95% CI of the mean difference [0.07, 0.52], this highlights that participants were finding it difficult to overcome adversity during COVID-19, compared to 2018.

The t-test was statistically significant for stress across all questions, with the 2018 survey showing lower stress scores in 2018 compared to 2021. In particular, 'How often have you found that you could not cope with all the things that you had to do?', $t(209.77) = -8.31$, $p = .000$, two-tailed, $d = 1.13$, 95% CI of the mean difference [-1.37, -0.85]. This highlights that participants may have had higher stress levels during COVID-19.

The t-test was statistically significant across 11 out of 14 questions for burnout, with questions that were statistically significant indicating an increase in burnout scores from 2018 to 2021. Statistically significant questions included, 'I have no energy for going to work every day', $t(214) = -2.51$, $p = .013$, two-tailed, $d = .34$, 95% CI of the mean difference [-0.84, -0.10], indicating that participants have diminished energy levels during 2021. Non-statistically significant questions: ‘My thinking process is slow’, $t(214) = -1.39$, $p = .165$, two-tailed, $d = .19$, 95% CI of the mean difference [-0.58, 0.10], ‘I have difficulty thinking about complex things’, $t(214) = -1.90$, $p = .057$, two-tailed, $d = .26$, 95% CI of the mean difference [-0.66, 0.01], ‘I feel I am not capable of investing emotionally in co-workers and patients’, $t(214) = -1.66$, $p = .099$, two-tailed, $d = .22$, 95% CI of the mean difference [-0.71, 0.06].

The t-test was statistically significant across all questions for distress, indicating levels of distress increased from 2018 to 2021. Specifically, ‘In the past four weeks, about how often did you feel depressed?’, $t(214) = -21.72$, $p = .001$, two-tailed, $d = 2.96$, 95% CI of the mean difference [-2.50, -2.08], suggesting that participants showed greater depressive symptoms in 2021 compared to 2018.

APPENDIX N

Recent Physical Activity Questionnaire (RPAQ)

The next 63 questions are designed to find out about your physical activity in your everyday life in the last four weeks. The questions concern your physical activity patterns in and around the house, your travel to work and activity within your current emergency department and recreational patterns you have engaged in.

Home Activities

Which form of transport have you used **most often** in the last 4 weeks apart from your journey to and from work? Please tick (✓) one box only.

Usual mode of travel			
Car/motor vehicle	Walk	Public transport	Cycle

TV, DVD or Video Viewing

Please put a tick (✓) on every line

Hours of TV, DVD or video watched per day	**Average over the last 4 weeks**					
	None	Less than 1 hour per day	1-2 hours per day	2-3 hours per day	3-4 hours per day	More than 4 hours per day
On a weekday before 6pm						
On a weekday after 6pm						
On a weekend day before 6pm						
On a weekend day after 6pm						

Computer use at home <u>but not at work</u> (eg. Internet, email, Playstation, Xbox, Gameboy, iphone)

Please put a tick (✓) on every line

Hours of home computer use per day	Average over the last 4 weeks					
	None	Less than 1 hour per day	1-2 hours per day	2-3 hours per day	3-4 hours per day	More than 4 hours per day
On a weekday before 6pm						
On a weekday after 6pm						
On a weekend day before 6pm						
On a weekend day after 6pm						

Stair climbing at home

Please put a tick (✓) on every line

Number of times you climbed up a flight of stairs (approximately 10 steps) each day at home	Average over the last 4 weeks					
	None	1 to 5 times per day	6 to 10 times per day	11 to 15 times per day	16 to 20 times per day	More than 20 times per day
On a weekday						
On a weekend day						

Activity at Work

Please answer this section to describe your current place of employment within the emergency department <u>during the past 4 weeks.</u>

Have you been in employment during the last 4 weeks? Please tick (✓) one box only.

Yes	No

Type of work

We would like to know the type and amount of physical activity involved in your work. Please tick (✓) the option that best corresponds with your current emergency department task(s) in the last 4 weeks from the following four possibilities

Please tick (✓) one of the following:

Sedentary Occupation: You spend most of your time sitting (such as in an office)	
Standing Occupation: You spend most of your time standing or walking. However, your work does not require intense physical effort (examples here?)	
Manual Work: This involves some physical effort including handling heavy objects and use of tools (examples here?)	
Heavy Manual Work: This implies very vigorous physical activity including handling of very heavy objects (examples here?)	

Travel to and from work in the last 4 weeks

What is the approximate distance from your home to your work?

Kilometres

How many times a week did you travel from your home to your main work? (Count outward journeys only)

Please tick (✓) one box only per line

How did you normally travel to work?	Always	Usually	Occasionally	Never or Rarely
By care/motor vehicle				

By works or public transport				
By bicycle				
Walking				

What is the postcode for your main place of work during the last 4 weeks?

Postcode:

If not known, please give your workplace address:

What is the postcode for your home address?

Recreation

The following questions ask about how you spent your leisure time.

Please indicate how often you did each activity on average over the last 4 weeks

Please indicate the length of time that you spent doing the activity on each occasion.

Example

If you went walking for pleasure for 40 minutes once a week.

If you had done weeding or pruning every fortnight and took 1 hour and 10 minutes on each occasion.

You should complete the table as follows:

Please give an answer for the NUMBER OF TIMES you did the following activities in the past 4 weeks and the AVERAGE TIME you spend on each activity.

Please tick (✓) one box only per line.

	Number of times you did the activity in the last 4 weeks	Average time per episode

	None	Once in the last 4 weeks	2 to 3 times in the last 4 weeks	Once a week	2 to 3 times a week	4 to 5 times a week	Every day	Hours	Minutes
Weeding and pruning			✓					1	10
Walking for pleasure				✓					40

Please give an answer for the average time you spent on each activity and the number of times you did that activity in the past 4 weeks. Please tick (✓) one box only per line.

	Number of times you did the activity in the last 4 weeks							Average time per episode	
	None	Once in the last 4 weeks	2 to 3 times in the last 4 weeks	Once a week	2 to 3 times a week	4 to 5 times a week	Every day	Hours	Minutes
Swimming-competitive									
Swimming leisurely									
Backpacking or mountain climbing									
Walking for pleasure (not as a means of transport)									
Racing or rough cycling terrain									
Cycling for pleasure (not as a means of									

transport)									
Mowing the lawn									
Watering the lawn or garden									
Digging, shovelling or chopping wood									
Weeding or pruning									
DIY eg. Carpentry, home or car maintenance									
High impact aerobics or step aerobics									
Other types of aerobics									
Exercise with weights									
Conditioning exercises e.g. using a bike or rowing machine									
Floor exercises e.g. stretching, bending, pilates, yoga									
Dancing e.g. ballroom or disco									
Competitive running									

Jogging									
Bowling-indoor lawn or 10 pin									
Tennis or badminton									
Squash									
Table tennis									
Golf									
Football, rugby or hockey									
Cricket									
Rowing									
Netball, volleyball or basketball									
Fishing									
Horse-riding									
Snooker, billiards, or darts									
Musical instrument playing or singing									
Ice-skating									
Sailing, wind-surfing or boating									
Martial arts, boxing or wrestling									

APPENDIX O

Kessler Psychological Distress Scale (K10)

The next 10 questions ask you about your psychological distress experienced in your everyday life over the last 4 weeks. Please tick (✓) one box only per line.

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
In the past 4 weeks, about how often did you feel tired out for no good reason?					
In the past 4 weeks, about how often did you feel nervous?					
In the past 4 weeks, about how often did you feel so nervous that nothing could calm you down?					
In the past 4 weeks, about how often did you feel hopeless?					
In the past 4 weeks, about how often did you feel restless or fidgety?					
In the past 4 weeks, about how often did you feel restless or could not sit still?					
In the past 4 weeks, about how often did you feel depressed?					
In the past 4 weeks, about how often did you feel that everything was an effort?					
In the past 4 weeks, about how often did you feel so sad that nothing could cheer you up?					
In the past 4 weeks, about how often did you feel worthless?					

APPENDIX P

Study 2 Federation University Ethics Approval -2018

Principal Researcher:	Dr Christopher Mesagno
Other/Student Researcher/s:	Samantha Armstrong
School/Section:	**School of Health Sciences and Psychology / Faculty of Health**
Project Number:	**A17-114**
Project Title:	**Exploring Stress Resilience within Emergency Medical Service Personnel**
For the period:	14/11/2017 **to** 31/12/2019

Quote the Project No: A17-114 in all correspondence regarding this application.

Approval has been granted to undertake this project in accordance with the proposal submitted for the period listed above.

Please note: It is the responsibility of the Principal Researcher to ensure the Ethics Office is contacted immediately regarding any proposed change or any serious or unexpected adverse effect on participants during the life of this project.

In Addition: Maintaining Ethics Approval is contingent upon adherence to all Standard Conditions of Approval as listed on the final page of this notification.

COMPLIANCE REPORTING DATES TO HREC:

Annual project report:
14 November 2018
14 November 2019

Final project report:
31 January 2020

[redacted]

Fiona Koop
Ethics Officer
14 November 2017

Study 2 Federation University Ethics Approval -2021

Principal Researcher:	Christopher Mesagno
Co-Researcher/s:	Brendan O'Brien Joanne Porter Samantha Armstrong
School/Section:	School of Health and Life Sciences
Project Number:	**A20-011**
Project Title:	Exploring Resilience within Emergency Service Personnel - A COVID-19 Study
For the period:	24/07/2020 **to** 31/03/2021

Quote the Project No: A20-011 in all correspondence regarding this application.

Approval has been granted to undertake this project in accordance with the proposal submitted for the period listed above.

Please note: It is the responsibility of the Principal Researcher to ensure the Ethics Office is contacted immediately regarding any proposed change or any serious or unexpected adverse effect on participants during the life of this project.

In Addition: Maintaining Ethics Approval is contingent upon adherence to all Standard Conditions of Approval as listed on the final page of this notification.

[redacted]

Jill Boatman
On behalf of Fiona Koop
Coordinator, Research Ethics
28/07/2020

APPENDIX Q

Study 2 CENA Ethics Approval (2018 and 2021)

CENA
College of Emergency Nursing Australasia

ACN 102 951 799
228 Liverpool Street
HOBART TAS 7000
Tel: 03 6231 2722

Email: national@cena.org.au
Website: www.cena.org.au

21st February 2018

Dr Christopher Mesagno,
Federation University.

Dear Dr Mesagno,

On behalf of the Board of Directors and the Research Committee of the College of Emergency Nursing Australasia (CENA) I write to advise you of our support to access the CENA membership for your study entitled; Exploring Stress Resilience among Emergency Personnel

In view of this support, CENA gives formal permission to place an advertisement via our e-blast system, which is emailed to our membership. You are also entitled to one reminder e-blast. The appropriate contact regarding circulating your call to participate is via Nikki, CENA Secretariat. Nikki's email is: national@cena.org.au.

The appropriate contact to publish the findings from this study is via Professor Ramon Shaban, Editor-in-Chief, Australasian Emergency Nursing Journal. Ramon's contact details are: editor@cena.org.au.

I would like to remind you that all publication outputs arising from CENA approved studies must include the following statement:

> *"This study was generously supported by the College of Emergency Nursing Australasia (CENA). The views of these researchers do not necessarily represent the views of CENA"*

It is the responsibility of the researcher(s) to maintain contact with the CENA Research committee Chair regarding any publications or presentations that arise out of the study. In addition, CENA require submission of annual and final reports for this study. Reports submitted to your HREC will suffice for these.

We wish you well with this study and look forward to the findings and welcome future publications. If you have further questions please do not hesitate to contact me. Please quote the reference: **CENA/RC/2018/02** in future communication.

Kind Regards,

[redacted]

Dr Julia Morphet
CENA National Board / Chair, CENA Research Committee

Leading Emergency Nursing and Care.

ACN 102 951 799
PO Box 7345, Beaumaris
VICTORIA 3193
Tel: 03 9586 6090

Email: national@cena.org.au
Website: www.cena.org.au

15th December 2020

Samantha Armstrong,
Federation University

Dear Miss Armstrong,

On behalf of the Board of Directors and the Research Committee of the College of Emergency Nursing Australasia (CENA) I write to advise you of our support to access the CENA membership for your study entitled: 'Exploring resilience among emergency personnel: A COVID-19 study'.

In view of this support, CENA gives formal permission to place an advertisement via our e-blast system, which is emailed to our membership. You are also entitled to one reminder e-blast. The appropriate contact regarding circulating your call to participate is via Shona, CENA Secretariat. Shona's email is: national@cena.org.au.

CENA encourages researchers to publish research findings relevant to emergency care in Australasian Emergency Care, an international peer-reviewed journal dedicated to supporting emergency nurses, physicians, paramedics and other professionals in advancing the science and practice of emergency care: https://www.journals.elsevier.com/australasian-emergency-care

It is the responsibility of the researcher(s) to maintain contact with the CENA Research committee Chair regarding any publications or presentations that arise from this study. In addition, CENA require submission of annual and final reports for this study. Reports submitted to your HREC will suffice for these.

We wish you well with this study and look forward to the findings. If you have further questions please do not hesitate to contact me. Please quote the reference: **CENA/RC/2020/10** in future communication.

Kind Regards,

[redacted]

Associate Professor Julia Morphet
Chair, CENA Research Committee

APPENDIX R

Study 2- Plain Language Information Statements (2018 and 2021)

SCHOOL OF HEALTH SCIENCES & PSYCHOLOGY- 2018

PROJECT TITLE:	Exploring Stress Resilience among Emergency Personnel
PRINCIPAL RESEARCHER:	Dr. Christopher Mesagno
ASSOCIATE RESEARCHER:	Dr. Joanne Porter
ASSOCIATE RESEARCHER:	Dr. Brendan O'Brien
OTHER/STUDENT RESEARCHER:	Miss Samantha Armstrong

You are invited to participate in a research project conducted by Samantha Armstrong, a PhD student, under the supervision of Dr. Christopher Mesagno, Senior Lecturer in the Faculty of Health at Federation University Australia, Dr. Joanne Porter, Senior Lecturer in the School of Nursing, Midwifery and Healthcare at Federation University and Dr. Brendan O'Brien, Senior Lecturer in the Faculty of Health at Federation University. *Please note that you must be aged 18 and over to be eligible to participate in this study.

Aim of the study:

The purpose of this study is to compare self-reported stress resilience and levels of physical activity among emergency personnel (emergency department nurses). The study also aims to identify the association between the amount of service time within a stress-driven clinical environment and stress resilience. This project aims to compare stress resilience levels among emergency department nurses working in regional and metropolitan areas.

What you will be asked to do:

If you agree to participate in this study, you will be asked to complete a short online survey, which will take approximately 10-15 minutes to complete. Upon completing and submitting the survey this will be considered as implied consent to participate. As the survey has no time limit, you can take as long as you would like to complete it. The survey will have questions about resilience, stress, appraisal of stress, physical activity, psychological wellbeing, and burnout, as well as some general questions about your age, gender and workplace duration and workplace status within the emergency department.

No information that could be used to identify you (such as your name) will be collected, as such, it will not be possible for the researchers to identify which answers are yours, or who took part in the study, therefore your identity will remain anonymous. Participation is completely voluntary and there is no obligation to complete and submit the survey upon commencement. Similarly, if there are questions that you feel uncomfortable answering, you may leave the question unanswered or discontinue the survey. However, please note that once you have submitted the survey, it will not be possible to withdraw your results, as we will be unable to identify them. Data from this study will be stored only on a password-protected computer, with access only by the named researchers, and will be destroyed after 5 years.

There are limited perceived risks in this study, however if you do have any concerns or feel uneasy about any of the questions asked either during or after completing the survey, you are encouraged to contact Lifeline on 13 11 14. Lifeline can be contacted at any time. Alternatively, you can contact the Nursing and Midwifery Health Program Victoria (www.nmhp.org.au) or email for further support admin@nmhp.org.au.

The results from the study will be reported in the form of a PhD thesis and may also be published in scientific journals. It will not be possible to present participants with their individual results, as they cannot be identified. You may contact the Principal Researcher, Dr Christopher Mesagno, after study completion for an electronic summary of the findings. He can be contacted via the details provided below.

If you have any questions, or you would like further information regarding the project titled ***Exploring Stress Resilience within Emergency Medical Service Personnel,*** please contact the Principal Researcher, **Dr. Christopher Mesagno** of the School of Health Sciences and Psychology:
Should you (i.e. the participant) have any concerns about the ethical conduct of this research project, please contact the Federation University Ethics Officers, Research Services, Federation University Australia, P O Box 663 Mt Helen Vic 3353 or Northways Rd, Churchill Vic 3842. Telephone: (03) 5327 9765, (03) 5122 6446 Email: research.ethics@federation.edu.au CRICOS Provider Number 00103D

SCHOOL OF SCIENCES, PSYCHOLOGY AND SPORT- 2021

PROJECT TITLE:	Exploring Resilience among Emergency Personnel: A COVID-19 Study
PRINCIPAL RESEARCHER:	Dr. Christopher Mesagno
ASSOCIATE RESEARCHER:	Dr. Joanne Porter
ASSOCIATE RESEARCHER:	Dr. Brendan O'Brien
OTHER/STUDENT RESEARCHER:	Miss Samantha Armstrong

You are invited to participate in a research project conducted by Samantha Armstrong, a PhD student, under the supervision of Dr. Christopher Mesagno, Senior Lecturer in the School of Sciences, Psychology and Sport at Federation University Australia, Dr. Joanne Porter, Associate Professor in the School of Nursing, Midwifery and Healthcare at Federation University and Dr. Brendan O'Brien, Senior Lecturer in the School of Sciences, Psychology and Sport at Federation University. *Please note that you must be aged 18 and over to be eligible to participate in this study.]

Aim of the study:

The purpose of this study is to compare self-reported resilience and levels of physical activity among emergency department nurses during COVID19. The data will be compared to pre-COVID-19 data to access the impacts of a pandemic on psychological wellbeing. The study also aims to identify the association between the amount of service time within a stress-driven clinical environment and resilience.

What you will be asked to do:

If you agree to participate in this study, you will be asked to complete a short online survey, which will take approximately 15-20 minutes to complete. Upon completing and submitting the survey this will be considered as implied consent to participate. As the survey has no time limit, you can take as long as you would like to complete it. The survey will have questions about resilience, stress, appraisal of stress, physical activity, psychological wellbeing, and burnout, as well as some general questions about your age, gender and workplace duration and workplace status within the emergency department.

No information that could be used to identify you (such as your name) will be collected, as such, it will not be possible for the researchers to identify which answers are yours, or who took part in the study, therefore your identity will remain anonymous. Participation is completely voluntary and there is no obligation to complete and submit the survey upon commencement. Similarly, if there are questions that you feel uncomfortable answering, you may leave the question unanswered or discontinue the survey. However, please note that once you have submitted the survey, it will not be possible to withdraw your results, as we will be unable to identify them. Data from this study will be stored only on a password-protected computer, with access only by the named researchers, and will be destroyed after 5 years.

There are limited perceived risks in this study, however if you do have any concerns or feel uneasy about any of the questions asked either during or after completing the survey, you are encouraged to contact Lifeline on 13 11 14. Lifeline can be contacted at any time. Alternatively, you can contact the Nursing and Midwifery Health Program Victoria (www.nmhp.org.au) or email for further support admin@nmhp.org.au.

The results from the study will be reported in the form of a PhD thesis and may also be published in scientific journals. It will not be possible to present participants with their individual results, as they cannot be identified. You may contact the Principal Researcher, Dr Christopher Mesagno, after study completion for an electronic summary of the findings. He can be contacted via the details provided below.

If you have any questions, or you would like further information regarding the project titled ***Exploring Stress Resilience within Emergency Medical Service Personnel,*** please contact the Principal Researcher, **Dr. Christopher Mesagno** of the School of Sciences, Psychology and Sport:
Should you (i.e. the participant) have any concerns about the ethical conduct of this research project, please contact the Federation University Ethics Officers, Research Services, Federation University Australia, P O Box 663 Mt Helen Vic 3353 or Northways Rd, Churchill Vic 3842. Telephone: (03) 5327 9765, (03) 5122 6446 Email: research.ethics@federation.edu.au CRICOS Provider Number 00103D

APPENDIX S

Adult Pre-Exercise Screening System

ADULT PRE-EXERCISE SCREENING TOOL

This screening tool does not provide advice on a particular matter, nor does it substitute for advice from an appropriately qualified medical professional. No warranty of safety should result from its use. The screening system in no way guarantees against injury or death. No responsibility or liability whatsoever can be accepted by Exercise and Sports Science Australia, Fitness Australia or Sports Medicine Australia for any loss, damage or injury that may arise from any person acting on any statement or information contained in this tool.

Name: ______________________

Date of Birth: ______________ Male ☐ Female ☐ Date: ______________

STAGE 1 (COMPULSORY)

AIM: to identify those individuals with a known disease, or signs or symptoms of disease, who may be at a higher risk of an adverse event during physical activity/exercise. This stage is self administered and self evaluated.

Please circle response

1.	Has your doctor ever told you that you have a heart condition or have you ever suffered a stroke?	Yes	No
2.	Do you ever experience unexplained pains in your chest at rest or during physical activity/exercise?	Yes	No
3.	Do you ever feel faint or have spells of dizziness during physical activity/exercise that causes you to lose balance?	Yes	No
4.	Have you had an asthma attack requiring immediate medical attention at any time over the last 12 months?	Yes	No
5.	If you have diabetes (type I or type II) have you had trouble controlling your blood glucose in the last 3 months?	Yes	No
6.	Do you have any diagnosed muscle, bone or joint problems that you have been told could be made worse by participating in physical activity/exercise?	Yes	No
7.	Do you have any other medical condition(s) that may make it dangerous for you to participate in physical activity/exercise?	Yes	No

IF YOU ANSWERED 'YES' to any of the 7 questions, please seek guidance from your GP or appropriate allied health professional prior to undertaking physical activity/exercise

IF YOU ANSWERED 'NO' to all of the 7 questions, and you have no other concerns about your health, you may proceed to undertake light-moderate intensity physical activity/exercise

I believe that to the best of my knowledge, all of the information I have supplied within this tool is correct.

Signature ______________________ Date ______________

EXERCISE INTENSITY GUIDELINES

INTENSITY CATEGORY	HEART RATE MEASURES	PERCEIVED EXERTION MEASURES	DESCRIPTIVE MEASURES
SEDENTARY	< 40% HRmax	Very, very light RPE# < 1	• Activities that usually involve sitting or lying and that have little additional movement and a low energy requirement
LIGHT	40 to <55% HRmax	Very light to light RPE# 1-2	• An aerobic activity that does not cause a noticeable change in breathing rate • An intensity that can be sustained for at least 60 minutes
MODERATE	55 to <70% HRmax	Moderate to somewhat hard RPE# 3-4	• An aerobic activity that is able to be conducted whilst maintaining a conversation uninterrupted • An intensity that may last between 30 and 60 minutes
VIGOROUS	70 to <90% HRmax	Hard RPE# 5-6	• An aerobic activity in which a conversation generally cannot be maintained uninterrupted • An intensity that may last up to about 30 minutes
HIGH	≥ 90% HRmax	Very hard RPE# ≥ 7	• An intensity that generally cannot be sustained for longer than about 10 minutes

= Borg's Rating of Perceived Exertion (RPE) scale, category scale 0-10

ADULT PRE-EXERCISE SCREENING TOOL

STAGE 2 (OPTIONAL)

Name: ______________________________

Date of Birth: ____________________ Date: ____________________

AIM: To identify those individuals with risk factors or other conditions to assist with appropriate exercise prescription. This stage is to be administered by a qualified exercise professional.

		RISK FACTORS
1. Age ______ Gender ______	≥ 45yrs Males or ≥ 55yrs Females +1 risk factor	
2. Family history of heart disease (eg: stroke, heart attack) Relative / Age / Relative / Age ☐ Father ___ ☐ Mother ___ ☐ Brother ___ ☐ Sister ___ ☐ Son ___ ☐ Daughter ___	If male < 55yrs = +1 risk factor If female < 65yrs = +1 risk factor Maximum of 1 risk factor for this question	
3. Do you smoke cigarettes on a daily or weekly basis or have you quit smoking in the last 6 months? Yes No If currently smoking, how many per day or week? ______	If yes, (smoke regularly or given up within the past 6 months) = +1 risk factor	
4. Describe your current physical activity/exercise levels: Sedentary ☐ Light ☐ Moderate ☐ Vigorous ☐ Frequency (sessions per week) ___ ___ ___ Duration (minutes per week) ___ ___ ___	If physical activity level < 150 min/ week = +1 risk factor If physical activity level ≥ 150 min/ week = -1 risk factor (vigorous physical activity/ exercise weighted x 2)	
5. Please state your height (cm) ______ weight (kg) ______	BMI = ______________ BMI ≥ 30 kg/m² = +1 risk factor	
6. Have you been told that you have high blood pressure? Yes No	If yes, = +1 risk factor	
7. Have you been told that you have high cholesterol? Yes No	If yes, = +1 risk factor	
8. Have you been told that you have high blood sugar? Yes No	If yes, = +1 risk factor	

Note: Refer over page for risk stratification.

STAGE 2 Total Risk Factors = ______

9. Have you spent time in hospital (including day admission) for any medical condition/illness/injury during the last 12 months? Yes No	If yes, provide details
10. Are you currently taking a prescribed medication(s) for any medical conditions(s)? Yes No	If yes, what is the medical condition(s)?
11. Are you pregnant or have you given birth within the last 12 months? Yes No	If yes, provide details. I am ______ months pregnant or postnatal (circle).
12. Do you have any muscle, bone or joint pain or soreness that is made worse by particular types of activity? Yes No	If yes, provide details

STAGE 3 (OPTIONAL)

AIM: To obtain pre-exercise baseline measurements of other recognised cardiovascular and metabolic risk factors. This stage is to be administered by a qualified exercise professional. (Measures 1, 2 & 3 – minimum qualification, Certificate III in Fitness; Measures 4 and 5 minimum level, Exercise Physiologist*).

	RESULTS		RISK FACTORS
1. BMI (kg/m²)		BMI ≥ 30 kg/m² = +1 risk factor	
2. Waist girth (cm)		Waist > 94 cm for men and > 80 cm for women = +1 risk factor	
3. Resting BP (mmHg)		SBP ≥140 mmHg or DBP ≥90 mmHg = +1 risk factor	
4. Fasting lipid profile*		Total cholesterol ≥ 5.20 mmol/L = +1 risk factor	
Total cholesterol		HDL cholesterol >1.55 mmol/L = -1 risk factor	
HDL		HDL cholesterol < 1.00 mmol/L = +1 risk factor	
Triglycerides		Triglycerides ≥ 1.70 mmol/L = +1 risk factor	
LDL		LDL cholesterol ≥ 3.40 mmol/L = +1 risk factor	
5 Fasting blood glucose*		Fasting glucose ≥ 5.50 mmol = +1 risk factor	
		STAGE 3 Total Risk Factors =	

RISK STRATIFICATION

Total stage 2

or

Total stage 3
Plus stage 2 (Q1 - Q4)

≥ 2 RISK FACTORS – MODERATE RISK CLIENTS

Individuals at moderate risk may participate in aerobic physical activity/exercise at a light or moderate intensity (Refer to the exercise intensity table on page 2)

< 2 RISK FACTORS – LOW RISK CLIENTS

Individuals at low risk may participate in aerobic physical activity/exercise up to a vigorous or high intensity (Refer to the exercise intensity table on page 2)

Note: If stage 3 is completed, identified risk factors from stage 2 (Q1-4) and stage 3 should be combined to indicate risk. If there are extreme or multiple risk factors, the exercise professional should use professional judgement to decide whether further medical advice is required.

APPENDIX T

Connor-Davidson Resilience Scale 10 (CD-RISC-10)

For the next 10 questions please indicate how much you agree with the following statements as they apply to you over the last month. If a particular situation has not occurred recently, answer according to how you think you would have felt.

	Not true at all	Rarely true	Sometimes true	Often true	True nearly all the time
I am able to adapt when changes occur					
I can deal with whatever comes my way					
I try to see the humorous side of things when I am faced with problems					
Having to cope with stress can make me stronger					
I tend to bounce back after illness, injury, or other hardships					
I believe I can achieve my goals, even if there are obstacles					
Under pressure, I stay focused and think clearly					
I am not easily discouraged by failure					
I think of myself as a strong person when dealing with life's challenges and difficulties					
I am able to handle unpleasant or painful feelings like sadness, fear, and anger					

APPENDIX U

Online Diary

Input:

- Date
- Unique Code
- Intervention Group

Abbreviations

TRP. The Resilience Project
PA. Physical Activity

Intervention Session

- *What time of the day did you engage in the intervention session?* (If you are part of the TRP group please record exact time so that we can match data with the Suunto watch. If you did not engage in the session, please write "Did not complete". If you are part of the PA group, please indicate when you engaged in the PA session. For the 4 days of the week that you did not engage in the session, please write "rest day". If you are part of the control group, you do not need to complete this section.
- *Did you have any troubleshooting when it came to engaging in the intervention session? (yes, or no)*. If yes, please explain and contact the lead researcher).

Physical Activity

- *Have you engaged in any leisure time physical activity outside of the intervention sessions?*
- *How long did you engage in this physical activity*? (how many minutes?)
- *Was the physical activity of low, moderate or high intensity?*

Sleep

- *How many hours of sleep have you had in the last 24hrs?*
- *Do you feel like the sleep quality was on a scale of one to ten, one being low quality and ten being high quality.*

Work

- *Did you work in the last 24hrs?* (If yes, please answer the following question, if you did not work, please write "day off")
- *Was your last shift a day shift or night shift? And how long was that shift?*
- *Please indicate how stressful your previous shift was- not very stressful, moderately stressful or very stressful*. (Please circle)

Stress

- *What is your level of stress on a scale of 1 to 10. 1 being not stressed at all, 5 being moderately stressed and 10 being very stressed.*

1	2	3	4	5	6	7	8	9	10

Nutrition

- *How would you rate your diet over the past 24 hours? 1 being poor to 10 being very good.*

1	2	3	4	5	6	7	8	9	10

- For all intervention groups, please sit for 30 minutes, in a quiet setting, wearing the HRV wrist watch and chest belt. Please indicate here the time that you completed this task. (Please refrain from caffeine intake at least 3 hours prior to completing this task).

- Please upload data from the watch and submit to researchers at the end of weeks 2, 4, 6 and 8.

Please upload your heart rate, blood pressure and weekly fit file here.

APPENDIX V

Study 3- Ethics Approval

Principal Researcher:	Christopher Mesagno
Co-Researcher/s:	Brendan O'Brien Joanne Porter Samantha Armstrong
School/Section:	School of Science, Psychology and Sport
Project Number:	A18-116
Project Title:	Exploring Stress Resilience within Emergency Service Personnel
For the period:	2/09/2020 to 31/12/2021

Quote the Project No. A18-116 in all correspondence regarding this application.

Amendment Summary: Changes, as per request, to: consent, recruitment, fitness test, questionnaires, stress test and replacing focus groups with individual interviews.

Extension: Project extended from 31/12/2020 to 31/12/2021

Personnel: N/A

Please note: Approval has been granted to undertake this project in accordance with the proposal and amendments submitted for the period listed above. Ongoing ethics approval is contingent upon adherence to the Standard Conditions of Approval on Page 2 of this notification.

COMPLIANCE REPORTING TO HREC:

Annual report due:

19/11/2020

19/11/2021

Final report due:

31/1/2022

https://federation.edu.au/research/support-for-students-and-staff/ethics/human-ethics/human-ethics3

[redacted]

Jill Boatman
On behalf of Fiona Koop
Coordinator, Research Ethics
2/09/2020

APPENDIX W

Study 3- Plain Language Information Statement

SCHOOL OF SCIENCES, PSYCHOLOGY, AND SPORT

PROJECT TITLE:	Exploring Stress Resilience among Emergency Personnel
PRINCIPAL RESEARCHER:	Dr. Christopher Mesagno
ASSOCIATE RESEARCHER:	A/P. Joanne Porter
ASSOCIATE RESEARCHER:	Dr. Brendan O'Brien
STUDENT RESEARCHER:	Miss Samantha Armstrong

You are invited to participate in a research project conducted by Samantha Armstrong, a PhD student, under the supervision of Dr. Christopher Mesagno, Senior Lecturer in the School of Sciences, Psychology, and Sport, Dr. Joanne Porter, Associate Professor in the School of Health and Dr. Brendan O'Brien, Senior Lecturer in the School of Sciences, Psychology, and Sport at Federation University. *Please note that you must be aged 18 and over to be eligible to participate in this study.

Aim of the study:

Firstly, to investigate the role of physical activity as a facilitator in the promotion of stress resilience among post graduate paramedic, and undergraduate nursing, students. Secondly, to compare a psychological resilience to a physical activity program on psychological and physiological outcomes of stress resilience. Lastly, to improve the mental health and wellbeing of post graduate paramedic, and undergraduate nursing, students.

What you will be asked to do?

If you agree to participate, you will undergo medical clearance via an online physiological assessment questionnaire in order to assess eligibility for participation in this study. As a participant you will undergo fitness testing in the form of a 1-mile (1.6 km) walk whilst wearing heart rate monitor equipment.

Secondly, you will complete an online survey, which will have questions about resilience, stress, appraisal of stress physical activity, psychological wellbeing, burnout, sleep quality, as well as some general questions about your age, gender and any medications you might be currently taking.

You will also undergo an online stress test (via recorded video conferencing) that will involve tasks designed to elicit physiological and psychological stress symptoms and these stress response outcomes will be measured via heart rate equipment before, during and after the stress test.

You will then be randomly allocated to one of three experimental groups 1) The Resilience Project's psychological resilience 'app', 2) an app-delivered high-intensity physical activity program or 3) a wait-list control group. The Resilience Project intervention group will engage in mindfulness meditation via an app on their phone for 10 minutes a day over an 8-week intervention period. The physical activity intervention group will engage in an app-based high-intensity training program, three times per week at 20 minutes per physical activity session. The control group will continue their life as per normal. Participants in the control group will be given access to either the psychological or physiological intervention at conclusion of the study.

If you are allocated to group 1) or 2) you will be emailed information session on how to use the intervention phone apps. This is particularly crucial for individuals involved in the physical activity intervention as they will be given instruction on the types of exercises involved in the high-intensity workout sessions designed by a qualified personal trainer. During the 8-week intervention period, you will wear heart-rate assessment equipment in the form of a chest belt and wrist watch. You will wear this equipment whilst engaging in any intervention activities (if applicable). The researchers will provide you with instructions about how to use this equipment and upload data from the watches to a computer.

You will also keep a survey-based diary. Within this diary, you will record times that you engaged in physical activity once, each week of the 8-week intervention, what days and how many hours you have worked, what day, time and duration you engaged in the intervention activities. Each week of the 8-week intervention the researchers of the study will send you a text message to assess your health, wellbeing and adherence to the program.

At the end of the 8-week intervention, you will undergo fitness testing, complete psychological questionnaires and a stress test similar to at the start of the study. You will also be invited to attend a one-on-one virtual (via video conferencing) interview for no longer than1 hour, which aims to assess the effectiveness of the interventions. This will be audio recorded.

All involvement in the study will be conducted through online delivery, as such anonymity amongst participants is upheld throughout the study, the researchers will be aware of participant identity throughout the study. This will be facilitated through Federation University nursing faculty staff and the researchers of the study. Any app-based intervention activities can be conducted at a place of your choosing and at a time that is convenient to you.

You will be given a unique code so that researchers can match your data throughout the intervention process, your name will not be used within the data collection process and your data will be strictly confidential (subject to legal limitations). Participation is completely voluntary and there is no obligation to complete the intervention upon commencement of the study, in addition you may withdraw any unprocessed data previously supplied. Similarly, if there are activities within the interventions or questions within the survey that make you feel uncomfortable (either psychological or physiologically), you may discontinue the activity or leave the question unanswered. Data from this study will be stored only on a password-protected computer, with access only by the named researchers, and will be destroyed after 5 years.

Are there any risks in this study?

There are risks involved in this study, firstly you will engage in the fitness test, thus physical injury is a possibility. Participants allocated to the physical activity intervention group have the possibility of a physical injury. If any injury occurs (during fitness tests or intervention group activities), you should seek assistance or call '000' Ambulance Victoria depending on the extent of the injury. Should you agree to participate, it will be your responsibility and duty of care for any injury sustained whilst participating in this study and not the responsibility of the researchers, Federation University Australia. Secondly, you may feel psychologically distressed about the difficulty of the stress test and physical activity intervention. These programs are designed to be difficult therefore may raise psychological concerns about your own level of fitness. If these concerns continue, please contact the named researchers of the project or alternatively you are encouraged to contact Lifeline on 13 11 14 at any time. You can also contact the Federation University counselling service on (03) 5327 9470 for further support.

The results from this study will be reported in the form of the PhD thesis and may also be published in scientific journals. It will not be possible to identify participants or their corresponding data within the dissertation and throughout any publications. Your data, which will be matched to a unique identification code, will only be accessible to the named researchers and will be stored on a password-locked computer. You may contact the Principal Researcher, Dr. Christopher Mesagno, at any time throughout the research process and after study completion for an electronic summary of the findings. He can be contacted via the details provided below.

This research has been approved by Federation University Human Research Ethics Committee and the National Human Research Ethics Committee Australia.

If you have any questions, or you would like further information regarding the project titled ***Exploring Stress Resilience within Emergency Medical Service Personnel,*** please contact the Principal Researcher, **Dr. Christopher Mesagno** of the School of Sciences, Psychology and Sport:
Should you (i.e. the participant) have any concerns about the ethical conduct of this research project, please contact the Federation University Ethics Officers, Research Services, Federation University Australia, P O Box 663 Mt Helen Vic 3353 or Northways Rd, Churchill Vic 3842. Telephone: (03) 5327 9765, (03) 5122 6446 Email: research.ethics@federation.edu.au CRICOS Provider Number 00103D

APPENDIX X

Study 3- Consent Form

PROJECT TITLE:	Exploring Stress Resilience among Emergency Personnel
PRINCIPAL RESEARCHER:	Dr. Christopher Mesagno
ASSOCIATE RESEARCHER:	Dr. Joanne Porter
ASSOCIATE RESEARCHER:	Dr. Brendan O'Brien
STUDENT RESEARCHER:	Miss Samantha Armstrong

Code number allocated to the participant:	

Consent – Please complete the following information:

I ____ of

____

hereby consent to participate as a subject in this research study.

The research program in which I am being asked to participate has been explained fully to me, verbally and in writing, and any matters on which I have sought information have been answered to my satisfaction.

I understand that: all information I provide (including questionnaires and physiological parameters) will be treated with the strictest confidence (subject to legal limitations) and data will be stored separately from any listing that includes my name and address.

- I understand that in order to be eligible to participate in this study, I must meet the requirements of a physiological assessment.
- I understand that by participating in this study there is the possibility of sustaining a physical injury. I understand that any injury sustained whilst participating in the research study is my own responsibility and the duty of care to that injury is my responsibility and not that of the researchers of this project, nor Federation University's.
- I am aware that during the stress test, there will be audio and video recording of my responses.
- I am aware that by participating in the interview at conclusion of the study my verbal responses to questions will be recorded and transcribed.
- Aggregated results will be used for research purposes and may be reported in scientific and academic journals. Be aware that in participating in this research, your de-identified data may be used to inform future research.
- I am free to withdraw my consent at any time during the study in which event my participation in the research study will immediately cease and information/data obtained from it will not be used.

SIGNATURE:__________________________________ **DATE:** ___________________.

APPENDIX Y

Interview Guide

General questions for all intervention groups

Start with the definition of stress resilience. Resilience is the ability to bounce back and positively adapt in the face of adversity. It emphasises both physiological and psychological stress processes that are changeable and can be developed through training, preparation and experience.

1. Can you describe your levels of self-esteem from before and after the intervention?
2. Can you describe the level of control over your emotions before and after the 8-intervention?
3. Can you give an example of a stressful situation you had prior to the 8-week intervention and one after the 8-week intervention? Were there any differences on how you felt (also ask about thoughts) in those stressful situations?
    a. In comparison to before the 8-week intervention to now, can you describe any changes in relation to your ability to stop thinking about a stressful situation quickly after it has occurred.
    b. Since completing the 8-week intervention, do you think about stressors that occurred on placement when you leave the ward more or less often compared to pre-intervention. What do you take home?
4. Has anything in your life changed in the last 8 weeks that has improved your mental health? (for PA and TRP- outside the intervention?)

Control Group

1. In the past 8 week do you feel you have changed physically and mentally? Control group.
2. Do you deal with stressful situations better now than you did 8 weeks ago?
3. Has anything in your life changed in the last 8 weeks that has improved your mental health? (Could go above)
4. Have you done any physical activity or mindfulness training in the last 8 weeks?

Physical activity intervention group

1. How did you feel the day you completed the workout in Week 8 of the intervention?
    a. Psychologically?
    b. Physiologically?
2. Have your university work/placement stress levels changed as a result of the 8-week intervention? If so, in what way?
3. During the intervention, were there times that you felt too drained or too tired to engage in the exercises?
    a. If yes, what helped you overcome the fatigue?
    b. If not, what were your thoughts related to not doing the exercises?
4. How did you feel about using a completely online-based intervention program at the beginning of the intervention? (application-wise), emotionally. What were some of the emotions experienced?
    a. How did you feel about using the online program at the end of the intervention?
5. Were there any barriers that stopped you from engaging in the exercises in the online intervention?
6. What were the advantages in the delivery of the intervention? (Focus on the intervention, rather than weekly surveys, the app itself is important). Bring it back to the exercises (not emailing me every week, even the watches, don't get side tracked on the data collection)

7. What were the disadvantages?
8. How can we improve this type of intervention?

Psychological intervention group

1. How did you feel the day you completed the mindfulness session in Week 8 of the intervention?
    a. Psychologically?
    b. Physiologically?
2. Have your university work/placement stress levels changed as a result of the 8-week intervention? If so, in what way?
9. How did you feel about using a completely online-based intervention program at the beginning of the intervention? (application-wise), emotion-focused.
    a. What were some of the emotions experienced?
    b. How did you feel about using the online program at the end of the intervention?
3. Were there any barriers that stopped you from engaging in the meditations?
4. What were the advantages of the delivery of the intervention?
5. What were the disadvantages?
6. What did you like most about using TRP app?
7. What did you like the least about using TRP app?
    a. Do you believe the app to be user-friendly?
8. How can we improve this type of intervention?

Additional question for physical activity and psychological intervention group

1. Can you describe your resilience to stress as it is now and how do you think it has changed as a result of the 8-week intervention? (A feeler for whether people can answer it or not).

APPENDIX Z

Study 3: Supplementary Results

Psychological parameters

A 2 (pre- and post-intervention) x 3 (group) mixed-model ANOVA indicated no pre- and post-intervention main effects amongst groups for BRS F (2, 8) = 1.20, p = .351, partial η^2 = .23, CD-RISC F (2, 8) = 1.35, p = .313, partial η^2 = .25, PSS F (2, 8) = 1.14, p = .368, partial η^2 = .22, SMBM F (2, 8) = .73, p = .510, partial η^2 = .551, or the K10 F (2, 8) = .74, p = .506, partial η^2 = .16. There were no main effects for BRS F (1, 8) = 2.39, p = .161, partial η^2 = .01, CD-RISC F (1, 8) = .22, p = .649, partial η^2 = .03, PSS F (1, 8) = .06, p .817, partial η^2 = .01, SMBM F (2, 8) = .01, p = .909, partial η^2 = .00, or the K10 F (2, 8) = .94, p .360, partial η^2 = .11. There were no significant interaction effects for BRS F (2, 8) = 1.40, p = .301, partial η^2 = .26, CD-RISC F (2, 8) = .04, p = .957, partial η^2 = .01, PSS F (2, 8) = .07, p = .930, partial η^2 = .02, SMBM F (2, 8) = .43, p = .664, partial η^2 = .10 or the K10 F (2, 8) = .05, p = .953, partial η^2 = .01.

Assessment of physical activity

RPAQ. A significant Group main effect for light physical activity hours per day, F (2, 9) = 4.43, p = .046, partial η^2 = .50, whereby Bonferroni post-hoc test indicated the physical activity and the control groups were significantly different (*mean difference* = -2.70, *significance* = .05). A significant pre- to post- intervention main effect was obtained, F (1, 9) = 6.19, p = .035, partial η^2 = .41, showing that engagement in moderate physical activity increased from pre- (M = 1.08, SD = 1.18) to post- intervention (M = 2.26, SD = 1.60) for all groups. There were no main effects amongst groups for sedentary hours per day, F (2, 9) = .40, p = .682, partial η^2 = .08, moderate hours per day, F (2, 9) = .47, p = .639, partial η^2 = .10, total physical activity per day F (2, 9) = .18, p = .837, partial η^2 = .04, total awake METS per day, F (2, 9) = = .99, p .409, partial η^2 = .18, or total METS per day, F (2, 9) = .87, p = .452, partial

η^2 = .16. There were no main effects for pre- to post-intervention for sedentary hours per day, F (1, 9) = .70, p = .425, partial η^2 = .07, light hours per day, F (1, 9) = .27, p = .619, partial η^2 = .03, total physical activity per day F (1, 9) = .01, p = .929, partial η^2 = .00, total awake METS per day, F (1, 9) = .06, p = .815, partial η^2 = .01, or total METS per day, F (1, 9) = .00, p = .99, partial η^2 = .00. There were no interaction effects for sedentary hours per day, F (2, 9) = .60, p = .571, partial η^2 = .12, light hours per day, F (2, 9) = .35, p = .716, partial η^2 = .07, moderate hours per day, F (2, 9) = .38, p = .696, partial η^2 = .08, total physical activity per day F (2, 9) = .13, p = .884, partial η^2 = .03, total awake METS per day, F (2, 9) = 1.68, p = .240, partial η^2 = .27, or total METS per day, F (2, 9) = 1.70, p = .236, partial η^2 = .274.

Fitness test. There were no pre- to post-intervention main effects for MET scores, F (1, 9) = .86, p = .379, partial η^2 = .09, Rockport rating scores, F (1, 9) = .71, p = .709, partial η^2 = .02, or $VO2_{max}$ scores, F (1, 9) = 1.60, p = .238, partial η^2 = .151. There were no group main effects for MET scores, F (2, 9) = .41, p = .676, partial η^2 = .08, Rockport rating scores, F (2, 9) = 1.52, p = .270, partial η^2 = .25, or $VO2_{max}$ scores, F (2, 9) = 2.00, p = .191, partial η^2 = .31. There were no interaction effects for MET scores, F (2, 9) = 2.58, p = .130, partial η^2 = .36, Rockport rating scores, F (2, 9) = 1.52, p = .270, partial η^2 = .253, or $VO2_{max}$ scores, F (2, 9) = .417, p = .671, partial η^2 = .09.

APPENDIX AA

Study 3 Supplemental Results: Cardiovascular Parameters

Significant and non-significant results have been included in the section to provide clarity and context.

Heart Rate (HR)

One-way ANOVA comparing HR at during the pre-intervention phase stress test (based on each time point within the stress test) did not indicate any significant findings ($p > .05$ in all analyses). Important patterns (though non-significantly) throughout the pre-intervention stress phase time-points revealed that the T1 (baseline) scores were higher for PA compared to the MIND and CG (see Figure 3.3 and Appendix AA for means and standard deviations). As expected, all three experimental groups increased their HR from T2 to T3. The PA and CG groups had elevated HR during T4, similar to T3 and is an expected outcome of the TSST, though the MIND HR decreased during T4. All three experimental groups showed a return to baseline 30-minutes after the stress test.

A significant finding was evident within the post-intervention phase stress test. A one-way ANOVA on HR was statistically significant for T4, $F\ (2, 10) = 4.62$, $p < .04$, partial $\eta^2 = .48$, with Tukey's HSD post hoc comparisons indicating significant higher scores for the PA compared to the MIND and CG. Non-significant results of T3 of the post-intervention phase stress test revealed participants across all groups showed similar HR scores, yet during T4 physical activity demonstrated the greatest HR reactivity to the speech task. Though the PA indicated the highest HR reactivity directly after the task. PA shows a steep decline in HR during T5 and dropped in HR to a similar level found during T2 (enter the interview), and the decline in HR did not occur as dramatically in the MIND or CG. Whilst non-significant but noteworthy, the MIND showed limited HR reactivity during T3 (prior to speech task), compared to PA and CG.

Inspection of HR at the pre- and post-intervention stress test for the PA using paired samples t-tests indicated that participants had a lower HR at T1 during the post-intervention stress test compared to the pre-intervention stress test at T1 with participants indicating an average 9.20 HR unit decline, 95% [.760, 17.640] from pre- to post-intervention. This difference was statistically significant, $t(4) = 3.03$, $p < .04$, and large, $d = 1.35$. observing non-statistically significant data during the post-intervention stress test showed that PA indicated a sharp decline in HR from T4, though this did not occur during the pre-intervention stress test. PA also showed lower HR units during T6, T7 and T8 (recovery periods) at post-intervention.

Inspection of HR at pre- and post-intervention for the mindfulness group using pair-samples t-tests indicated non-significant results ($p > .05$). At T4, T5, T6 and T7 the MIND group indicated a lower HR at post-intervention, compared to pre-intervention.

Multiple paired sample t-tests at pre- and post-intervention of the CG also highlighted non-significant results concerning HR ($p > .05$). Non-significantly, CG showed greater variability in scores compared to PA and MIND during both pre- and post-intervention stress tests. There was a steep drop in HR during T6 at post-intervention, compared to the other experimental groups and compared to pre-intervention.

Systolic Blood Pressure (SBP)

Multiple one-way ANOVA's comparing SBP during the pre-intervention stress test (based on each time-point within the stress test) did not indicate any significant findings ($p > .05$; see Figure 3.4 and Appendix AB for means and standard deviations). Non-significant data for the pre-intervention stress across time-points showed that all groups behaved similarly in their reactivity and recovery of SBP across timepoints. PA showed slightly higher SBP during T4 and T5 compared to CG and MIND and MIND indicated slightly lower SBP at T3 compared to PA and CG.

At the post-intervention stress test, there were no significant results for the one-way ANOVAs conducted ($p > .05$), although PA indicated higher SBP at T2, T3, T4, T5 and T6 compared to MIND and CG.

Analysis of SBP at the pre- and post-intervention phase stress tests for the physical activity group using paired samples t-tests indicated participants had a statistically significant difference, $t(4) = -2.96$, $p < .04$, and large, $d = -1.33$ (Cohen, 1988) and lower SBP during the post-intervention phase stress test compared to pre-intervention phase, with participants averaging a -3.8 SBP unit decrease, 95% [-7.356, -.244].

Inspection of SBP at pre- and post-intervention for MIND indicated similar data over phases, indicating that the mindfulness intervention SBP did not change ($p > .05$). Review of the CG at pre- and post-intervention stress tests shows variation across time points and before and after the intervention. During both the pre- and post-intervention stress tests, CG increased their SBP during T3, T4 and T5, however recovery (during T6, T7 and T8) is limited at post-intervention.

Diastolic Blood Pressure (DBP)

Multiple one-way ANOVAs comparing DBP during the pre-intervention stress tests (across time points) did not indicate any statistically significant results ($p > .05$). Observation of graphs (non-significant data) indicated that MIND showed greater variability (and reactivity) for DBP during the speech and mental arithmetic tasks whereas PA illustrated higher DBP throughout the TSST. The CG indicated a sharp increase in DBP during T5, followed by a steep decline during T6.

There were no statistically significant one-way ANOVAs for DBP across the post-intervention stress test time points ($p > .05$). Non-significantly, PA indicated the highest increase in DBP reactivity during T4, and greater recovery during T5 in comparison to MIND and CG.

Analysis of DBP at the pre- and post-intervention phase stress tests for the PA using paired samples t-tests indicated a statistically significant difference at T3, PA indicated higher DBP at post-intervention, compared to pre-intervention stress test, $t(4) = -3.20$, $p < .03$, and large, $d = 4.62$ (Cohen, 1988). The PA participants demonstrated an average 6.60 DBP unit increase, 95% [-12.331, -.869] from pre- to post-intervention. During the recovery phase (T6, T7 and T8), participants in PA showed higher DBP during T7, $t(4) = -9.436$, $p < .001$, and large, $d = -4.22$ (Cohen, 1988) and T8, $t(4) = -3.074$, $p < .04$, and large, $d = -1.38$ (Cohen, 1988) compared to the pre-intervention stress test. There was a 12.80 DBP unit increase, 95% [-16.566, -9.034] at T7, and a 11.80 DBP unit increase, 95% [-22.460, -1.140] for T8 from pre- and post-intervention. Non-significant data demonstrates a sharp decline in DBP from T4 to T5.

There were no significant paired sample t-tests when comparing the MIND group from pre- to post-intervention ($p > .05$). Non-significantly, MIND during post-intervention indicated a further 'flat-lining' in comparison to the pre-intervention stress test, during the recovery phase of the stress task. No significant paired samples t-tests were found for CG for DBP comparing pre- and post-intervention stress tests. From baseline all the way through to T8, CG illustrated a higher DBP during post-intervention compared to pre-intervention (see Figure 3.5 for graphical information and Appendix AC for means and standard deviations).

Standard Deviation of NN Intervals (SNDD)

Multiple one-way ANOVA's comparing SDNN during the pre-intervention stress test across time points did not reveal significant findings ($p > .05$). Referring to graphical data (Figure 3.6) and means and standard deviations (see Appendix AD) of non-significant data highlights that the three experimental groups indicated similar patterns throughout the stress test time points. The PA and MIND groups indicated a decline in SDNN during T3, whereas

CG indicated a decline in SDNN at T4. All participants increased in SDNN back to baseline levels during the recovery time points (T6, T7 and T8).

Multiple one-way ANOVAs comparing SDNN during the post-intervention stress test for SDNN did not discover significant results ($p > .05$). PA showed higher HRV through SDNN units compared to MIND and CG throughout each stress test time point. Additionally, MIND indicated greater SDNN compared to CG.

Non-significantly, SDNN scores for both PA and MIND were higher across all time-points at the post-intervention stress test compared to the pre-intervention stress test, whereas CG indicated lower scores for SDNN at the post-intervention stress test.

Multiple paired samples t-tests comparing the pre- and post-intervention scores on SDNN across stress test time points did not indicate significant results for PA, MIND nor CG ($p > .05$). Non-significantly, PA indicated a greater reactivity during T3 at post-intervention, compared to pre-intervention, though at post-intervention demonstrated a steep recovery at T4 for SDNN suggesting physiological adaptations to psychological stressors from pre- to post-intervention. However, PA did not return to baseline SDNN units at post-intervention. MIND showed higher SDNN scores overall at post-intervention, compared to the pre-intervention stress test. Interestingly, MIND appears to have 'flat-lined' at post-intervention, CG had lower SDNN at post-intervention, compared to pre-intervention across all time points, and SDNN results across pre- to post-intervention time-points were mirrored in their reactivity and recovery.

Root Mean Square of Successive Differences between Normal Heartbeats (RMSSD)

Multiple one-way ANOVA's comparing RMSSD during the pre-intervention stress test across all time-points did not illuminate any significant results ($p > .05$). Non-significantly, CG showed higher RMSSD across all time-points compared to PA and MIND during the pre-intervention stress test. PA appeared to have 'flat-lined' throughout the stress tasks (mental arithmetic and speech). MIND demonstrates reactivity towards the two stress tasks (T3, T4 and T5) and also indicated recovery of RMSSD at T6, T7 and T8.

Multiple one-way ANOVA's comparing RMSSD during the post-intervention stress test across all time points did not procure significant results ($p > .05$). Non-significantly, PA demonstrated the highest RMSSD units amongst the three experimental groups with greatest reactivity responses to the stress task in comparison to MIND and CG. MIND and CG demonstrated a 'flat-lining' effect towards the stress tasks within the TSST. Though, MIND indicated higher RMSSD across all time-points compared to CG at the post-intervention stress test.

Multiple paired samples t-tests comparing the pre- and post-intervention scores on RMSSD across stress test time points did not indicate significant results for PA, MIND or CG ($p > .05$). Non-significantly, PA and MIND showed higher RMSSD levels at post-intervention, compared to the pre-intervention stress test, whereas CG indicated lower RMSSD from pre- to post-intervention. For graphical data of RMSSD see Figure 3.7 and for means and standard deviations of SDNN see Appendix AE.

APPENDIX AB

Table 3.4

Means (M) and Standard Deviations (SD) for HR for Pre- and Post-Intervention Time Points amongst the Experimental Groups

	Pre-Intervention Phase Scores		Post-Intervention Phase Scores	
Stress Test- HR	M	SD	M	SD
T1 (Baseline)				
Physical Activity	82.00	10.30	72.00	6.75
Mindfulness	70.83	6.11	70.50	5.26
Control	80.67	8.85	73.25	12.04
T2				
Physical Activity	80.88	9.54	78.00	12.53
Mindfulness	68.83	7.60	70.25	8.77
Control	80.00	12.38	78.75	14.22
T3				
Physical Activity	93.25	12.03	88.40	11.22
Mindfulness	83.69	15.33	79.00	15.66
Control	105.33	41.75	88.25	21.41
T4				
Physical Activity	92.25	12.37	101.60	17.16
Mindfulness	76.83	11.97	68.50	7.94
Control	107.33	43.92	94.50	21.93
T5				
Physical Activity	81.50	18.25	77.60	11.70
Mindfulness	77.00	9.17	67.00	7.62
Control	89.50	15.67	83.75	17.60
T6				
Physical Activity	80.88	9.03	74.20	12.62

	Mindfulness	71.33	12.29	65.75	12.95
	Control	73.33	10.89	84.00	7.55
T7					
	Physical Activity	75.88	8.24	72.80	12.97
	Mindfulness	70.17	5.98	64.75	9.03
	Control	78.17	11.05	75.00	14.70
T8					
	Physical Activity	74.13	12.52	66.20	13.76
	Mindfulness	65.33	3.72	68.25	11.18
	Control	72.10	10.56	75.50	19.05

APPENDIX AC

Table 3.5

Means (M) and Standard Deviations (SD) for SBP for Pre- and Post-Intervention Time Points amongst the Experimental Groups

	Pre-Intervention Scores		Post-Intervention Scores	
Stress Test- SBP	M	SD	M	SD
T1 (Baseline)				
Physical Activity	127.50	19.77	124.80	11.37
Mindfulness	122.67	4.97	121.75	4.35
Control	121.17	15.51	126.75	20.839
T2				
Physical Activity	131.25	21.24	130.20	25.917
Mindfulness	129.00	12.67	131.75	19.41
Control	121.83	15.11	124.50	14.18
T3				
Physical Activity	140.00	21.607	148.00	24.07
Mindfulness	130.50	12.93	131.00	15.03
Control	134.60	20.80	128.25	9.91
T4				
Physical Activity	140.88	17.81	150.60	18.270
Mindfulness	138.00	22.21	139.50	17.71
Control	133.33	20.44	138.00	15.64
T5				
Physical Activity	134.13	14.74	141.60	16.55
Mindfulness	133.50	10.99	127.25	19.14
Control	138.17	31.15	130.00	12.65
T6				
Physical Activity	125.75	12.27	135.40	21.44

	Mindfulness	124.5	8.09	126.50	18.41
	Control	119.83	12.64	126.33	6.43
T7					
	Physical Activity	121.88	15.62	125.00	14.30
	Mindfulness	124.50	8.09	128.25	14.93
	Control	119.33	14.36	134.00	19.22
T8					
	Physical Activity	122.63	12.33	124.60	18.42
	Mindfulness	121.17	9.79	124.00	12.83
	Control	113.17	8.01	132.75	11.15

APPENDIX AD

Table 3.6

Means (M) and Standard Deviations (SD) for DBP for Pre- and Post-Intervention Time Points amongst the Experimental Groups

	Pre-Intervention Scores		Post-Intervention Scores	
Stress Test- DBP	M	SD	M	SD
T1 (Baseline)				
Physical Activity	83.88	13.51	78.10	8.56
Mindfulness	77.00	8.22	78.25	5.12
Control	74.00	10.68	82.00	10.41
T2				
Physical Activity	84.88	15.66	85.20	11.56
Mindfulness	84.00	5.29	90.75	12.41
Control	76.00	14.79	85.25	10.01
T3				
Physical Activity	88.25	14.32	90.40	12.19
Mindfulness	81.67	7.39	81.25	10.11
Control	81.33	15.53	88.25	2.87
T4				
Physical Activity	88.25	10.63	99.60	13.52
Mindfulness	86.00	11.40	84.25	3.30
Control	77.17	20.65	92.50	6.25
T5				
Physical Activity	87.75	9.18	87.20	10.76
Mindfulness	81.50	13.14	85.50	7.14
Control	88.50	10.13	95.25	13.15
T6				
Physical Activity	85.25	7.09	90.00	23.97
Mindfulness	76.17	10.85	81.00	6.38

	Control	77.83	9.33	90.33	13.58
T7					
	Physical Activity	83.25	9.97	92.60	6.23
	Mindfulness	76.17	7.39	82.50	5.07
	Control	75.50	12.25	95.00	12.99
T8					
	Physical Activity	83.38	12.84	88.00	9.98
	Mindfulness	79.97	10.00	82.50	5.26
	Control	77.67	9.24	90.25	8.96

APPENDIX AE

Table 3.7

Means (M) and Standard Deviations (SD) for SDNN for Pre- and Post-Intervention Time Points amongst the Experimental Groups

	Pre-Intervention Scores		Post-Intervention Scores	
Stress Test- SDNN	M	SD	M	SD
Pre-Intervention				
T1 (Baseline)				
Physical Activity	25.48	12.91	77.34	38.37
Mindfulness	20.94	6.42	43.92	23.07
Control	36.58	22.89	24.25	3.94
T2				
Physical Activity	32.17	14.17	67.25	44.80
Mindfulness	32.10	8.57	41.18	19.61
Control	40.93	33.43	25.25	4.10
T3				
Physical Activity	26.80	13.54	47.28	17.62
Mindfulness	18.40	6.37	73.33	24.92
Control	39.13	34.73	25.40	6.21
T4				
Physical Activity	29.18	17.30	57.40	47.50
Mindfulness	22.74	3.16	45.43	17.59
Control	32.35	18.93	22.95	10.33
T5				
Physical Activity	33.85	15.21	55.70	30.60
Mindfulness	27.02	7.54	43.03	25.91
Control	41.35	20.07	28.98	11.18
T6				

	Physical Activity	34.18	21.48	55.80	13.72
	Mindfulness	32.08	10.07	45.50	25.75
	Control	44.48	27.28	29.15	6.66
T7					
	Physical Activity	29.57	16.61	51.30	24.47
	Mindfulness	33.06	11.06	45.68	19.60
	Control	47.75	27.14	29.30	9.32
T8					
	Physical Activity	32.20	14.53	53.28	1.88
	Mindfulness	31.00	6.89	44.76	25.05
	Control	47.08	28.16	29.50	6.58

APPENDIX AF

Table 3.8

Means (M) and Standard Deviations (SD) for RMSSD for Pre- and Post-Intervention Time Points amongst the Experimental Groups

	Pre-Intervention Scores		Post-Intervention Scores	
Stress Test- RMSSD	M	SD	M	SD
T1 (Baseline)				
Physical Activity	25.48	12.91	67.58	48.02
Mindfulness	20.94	6.42	34.95	24.05
Control	38.58	22.79	25.93	11.23
T2				
Physical Activity	23.10	12.66	64.45	55.39
Mindfulness	21.16	5.79	34.33	19.37
Control	36.83	34.04	18.38	1.91
T3				
Physical Activity	21.43	14.39	36.16	20.87
Mindfulness	13.68	4.56	37.20	23.11
Control	33.53	37.04	19.00	3.86
T4				
Physical Activity	22.02	17.03	52.13	50.86
Mindfulness	14.60	5.44	41.40	17.64
Control	24.90	23.96	17.90	7.86
T5				
Physical Activity	23.55	16.22	48.04	38.77
Mindfulness	18.44	3.48	40.75	20.95
Control	29.05	21.54	19.35	8.27
T6				
Physical Activity	25.63	19.52	40.84	17.37
Mindfulness	25.76	8.73	42.25	26.25

	Control	35.26	26.26	22.58	5.37
T7					
	Physical Activity	24.72	16.59	49.58	21.94
	Mindfulness	31.18	24.72	43.18	24.04
	Control	41.50	27.52	24.85	10.47
T8					
	Physical Activity	25.27	12.95	26.20	13.71
	Mindfulness	29.76	15.93	42.00	26.70
	Control	15.30	30.91	26.40	7.76

APPENDIX AG

Reciprocal (Mirror) Approval from Victoria University HREC

VICTORIA UNIVERSITY

MEMO

TO	Dr Chris Mesagno Victoria University	DATE	26/09/2023
FROM	Associate Professor Deborah Zion Chair Victoria University Human Research Ethics Committee		
SUBJECT	Ethics Application – HREC Approved Application External to Victoria University		

Dear Chris,

Thank you for submitting this request for reciprocal ethical approval of the projects entitled:

2020-16 HREA (Approved by Latrobe Regional Hospital HREC)
Exploring Stress Resilience and Burnout during COVID-19; An Assessment of Psychological Health in an Australian Hospital.

A17-114 (Approved by Federation University HREC)
Exploring Stress Resilience within Emergency Medical Service Personnel

A18-116 (Approved by Federation University HREC)
Exploring Stress Resilience within Emergency Service Personnel

A20-011 (Approved by Federation University HREC)
Exploring Resilience within Emergency Service Personnel - A COVID-19 Study

The proposed research project has been accepted and deemed to meet the requirements of the National Health and Medical Research Council (NHMRC) 'National Statement on Ethical Conduct in Human Research (2018)' by the Chair of the Victoria University Human Research Ethics Committee. Approval has been granted on the 26th September 2023 and is consistent with the approvals provided by the host HRECs. Any variations to the protocol must be approved through the original approving HREC and notified to VUHREC.

Please note that the Human Research Ethics Committee must be informed of the following: any changes to the approved research protocol, project timelines, any serious events or adverse and/or unforeseen events that may affect continued ethical acceptability of the project. In these unlikely events, researchers must immediately cease all data collection until the Committee has approved the changes. Researchers are also reminded of the need to notify the approving HREC of changes to personnel in research projects via a request for a minor amendment. It should also be noted that it is the Chief Investigators' responsibility to ensure the research project is conducted in line with the recommendations outlined in the National Health and Medical Research Council (NHMRC) 'National Statement on Ethical Conduct in Human Research (2018).'

On behalf of the Committee, I wish you all the best for the conduct of the project.

Kind regards,

Associate Professor Deborah Zion
Chair
Victoria University Human Research Ethics Committee