Prevalence of Insomnia, Nightmares and PTSD Symptoms: Development and Testing of a Multi-Component Cognitive Behavioural Treatment in Australian, Canadian, and American Wildfire Survivors

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Abstract

Wildfires are now recognised as a global crisis, posing significant threats to the economy, the environment, wildlife, physical and mental health, and human wellbeing. Sleep difficulties and trauma symptoms following the fires are highly prevalent, yet they are often neglected and inadequately treated. If left untreated, sleep and trauma symptoms can perpetuate and become unresponsive to treatment causing more complex health conditions. Therefore, the first aim of the thesis was to establish prevalence rates of sleep and trauma symptoms in an international sample of wildfire survivors. A total of 126 (23 males, 102 females, and 1 nonbinary individual, *M*age = 52 years, *SD* = 14.4) wildfire survivors from Australia, Canada, and the United States of America (USA) took part in an online survey. Participants completed a demographic questionnaire and self-report measures including the Insomnia Severity Index (ISI), PTSD Checklist for DSM-5 (PCL-5), and Disturbing Dream and Nightmare Severity Index (DDNSI). Nearly half (49.2%) of the sample reported clinical insomnia, 28.7% reported nightmares, and 77.8% reported PTSD symptoms. In response to these alarming prevalence rates, this thesis addressed its second objective by designing and evaluating the feasibility of a digital, self-paced intervention for the treatment of sleep and trauma symptoms. Sleep Best-i, a digital and self-paced intervention, comprising of cognitive behavioural therapy for insomnia (CBT-I), and exposure, relaxation, and rescripting therapy (ERRT) was evaluated in a four-week clinical trial, targeting wildfire survivors from Australia, Canada, and the USA presenting with sleep difficulties and/or trauma symptoms. To qualify for the study, wildfire survivors had to meet at least one of the following criteria: a score of ≥ 8 on the Insomnia Severity Index (ISI), and/or a score of ≥ 3 on the Nightmare Disorder Index (NDI), and/or a score of ≥ 31 on the PTSD Checklist – Civilian Version (PCL-5). Thirty

wildfire survivors were allocated to either the treatment group (n = 16) or the waitlist control group (n = 14) in a sequential manner. Participants' ages ranged from 18 to 79 years, with a mean age of 52.5 years (SD = 16.26). The study sample consisted of 19 females (63.3%) and 11 males (36.7%). They completed self-report secondary outcome measures, including the Generalized Anxiety Disorder Questionnaire (GAD-7), the Patient Health Questionnaire (PHQ-9), and the Pittsburgh Sleep Quality Index (PSQI), via the HealthZone digital platform. Study participants were informed about the purpose, allocation, and the structure of the study. Assessments were conducted at baseline, post-treatment, and 3-months follow-up, with the waitlist group providing an additional assessment at pre-treatment, after 4 weeks of waiting, and prior to crossing over to treatment. The study employed Intention-To-Treat (ITT), and Per Protocol (PP) analyses. Mixed-effects linear regression models and difference-in-difference analyses were utilised to assess the intervention's effect. The ITT analysis revealed significant improvements over time (main effect of time) with a 1.64 point reduction (p = .001) on the NDI and 10.64 point reduction (p = .009) on the PCL-5 at post-intervention. No significant changes were observed in insomnia symptoms. On the secondary measures, there was an interaction effect of condition x time with a 2.22 point reduction (p <.001) on the PSQI and a main effect of time with a 6.48 point reduction (p <.001) on the PHQ-9. No significant changes were detected on the GAD-7. The PP analysis yielded comparable results on both the primary and the secondary measures. The findings of the pilot trial demonstrated a reduction in nightmares and trauma symptoms. Future research studies should aim at evaluating Sleep Best-i in a more definitive trial with a larger sample size.

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I dedicate this thesis to the memory of my father, whose passing has left a profound impact on my life. I hope that this work honours your legacy, reflecting the high standards and unwavering dedication that you exemplified. Your love continues to inspire me, and I strive to make you proud every day. I miss you, Dad.

Statement of Authorship and Originality

Except where explicit reference is made in the text of the thesis, this thesis contains no materials published elsewhere or extracted in whole or in part from a thesis by which I have qualified for or been awarded another degree or diploma. No other person's work has been relied upon or used without due acknowledgement in the main text and the list of references of the thesis. No editorial assistance has been received in the production of the thesis without due acknowledgement. Except where duly referred to, the thesis does not include materials with copyright provisions or requiring copyright approvals.

Print name: FADIA ISAAC

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Activities During Candidature

Publications

- **Isaac, F**., Toukhsati, S. R., Di Benedetto, M., & Kennedy, G. A. (2021). A systematic review of the impact of wildfires on sleep disturbances. *International Journal of Environmental Research and Public Health*, *18*(19), 10152. 10.3390/ijerph181910152
- **Isaac, F**., Toukhsati, S. R., DiBenedetto, M., & Kennedy, G. A. (2022). Cognitive behavioral therapy-based treatments for insomnia and nightmares in adults with trauma symptoms: a systematic review. *Current Psychology*, *42*(27), 23495-23505. https://doi.org/10.1007/s12144-022-03512-1
- **Isaac, F**., Toukhsati, S. R., Di Benedetto, M., & Kennedy, G. A. (2022). Assessment of the effectiveness of online and face-to-face cognitive behavioural therapy for insomnia/ nightmares in adults exposed to trauma using self-report and objective measures: Preliminary findings. *Trends in Telemedicine & E-Health*, *3*(2), 1-7. doi:10.31031/TTEH.2022.03.000559
- **Isaac, F**., Toukhsati, S. R., Klein, B., Di Benedetto, D., & Kennedy, G. (2023). Prevalence and predictors of sleep and trauma symptoms in wildfire survivors. *Journal of Sleep Epidemiology*, *3*, 100052. https://doi.org/10.1016/j.sleepe.2022.100052
- **Isaac, F**., Toukhsati, S. R., Klein, B., Di Benedetto, D., & Kennedy, G. (2023). Pre-existing depression, anxiety and trauma are risk factors for the development of post-traumatic stress disorder symptoms following the trauma of wildfires. *Psychiatry Research Communications*, *4*(2), 100161. https://doi.org/10.1016/j.psycom.2024.100161

- **Isaac, F**., Toukhsati, S. R., Klein, B., Di Benedetto, D., & Kennedy, G. (2024). Differences in anxiety, insomnia, and trauma symptoms in wildfire survivors from Australia, Canada and United States of America. *International Journal of Environmental Research and Public Health*, *21*(1), 38. 10.3390/ijerph21010038
- **Isaac, F**., Klein, B., Nguyen, H., Watson, S., & Kennedy, G. (In press). Digital cognitive-behavioral therapy-based treatment for insomnia, nightmares and post-traumatic stress disorder symptoms in wildfire survivors: A randomized feasibility pilot trial. *JMIR Human Factors*. *12*, e65228.

Conferences and Presentations

- Isaac, F., Klein, B., Toukhsati, S. R., Di Benedetto, D., & Kennedy, G. (2023). Sleep Best-i, an online psychological intervention. *Research Cooperative Research Australia Conference. Adelaide Convention and Exhibition Centre, Adelaide, Australia, 10-12 July 2023.*
- Isaac, F., Klein, B., Toukhsati, S. R., Di Benedetto, D., & Kennedy, G. (2023). Online, self-administered treatment for insomnia, nightmares and trauma symptoms in bushfire survivors. *Sleep Downunder Conference 2023. Adelaide Convention and Exhibition Centre, Adelaide, Australia, 11th of November 2023.*
- Isaac, F., Klein, B., Toukhsati, S. R., Di Benedetto, D., & Kennedy, G. (2023). Sleep Best-i, an online psychological intervention. *Federation University Annual Conference. Online 20th of July 2023.*
- Isaac, F., Klein, B., Toukhsati, S. R., Di Benedetto, D., & Kennedy, G. (2023). Digital psychological treatment for insomnia, nightmares and PTSD in bushfire survivors: A mixed design. *Natural Hazard Research Australia Webinar*. *Online 26th of September 2023.*

- Isaac, F., Klein, B., Toukhsati, S. R., Di Benedetto, D., & Kennedy, G. (2023). Digital psychological treatment for insomnia, nightmares & trauma symptoms in bushfire survivors. *Red Cross Recovery and Resilience Community of Practice Meeting. Online, 16th of November 2023.*
- Isaac, F., Klein, B., Toukhsati, S. R., Di Benedetto, D., & Kennedy, G. (2023). Online psychological treatment for insomnia, nightmares and PTSD in bushfire survivors. *Presentation at the narcolepsy & overwhelming daytime sleep society, including idiopathic hypersomnia & other sleep disorders. Online 18th of September 2023.*
- Isaac, F., Klein, B., Di Benedetto, D., Toukhsati, S. R., & Kennedy, G. (2024). Bushfires, trauma and sleep: Help me sleep please. *Presentation at the Natural Hazards Research Australia Board Meeting in Canberra on the 30th of April 2024.*
- Isaac, F., Klein, B., Di Benedetto, D., Toukhsati, S. R., & Kennedy, G. (2024). Bushfires, trauma and sleep: Help me sleep please. *Presentation at the Natural Hazards Research Australia Forum, Adelaide 14-16th May 2024.*
- Isaac, F., Klein, B., Di Benedetto, D., Toukhsati, S. R., & Kennedy, G. (2024). Bushfires, trauma and sleep: Help me sleep please. *Monthly Emergency Services Foundation meeting, 4th of June 2024.*
- Isaac, F., Klein, B., Di Benedetto, D., Toukhsati, S. R., & Kennedy, G. (2024). Bushfires, trauma and sleep: Help me sleep please. *Federation University Annual Conference, 11th of July 2024.*

Poster Presentations

- Isaac, F., Klein, B., Toukhsati, S. R., Di Benedetto, M., & Kennedy, G. A. (2023). The treatment of insomnia, nightmares and PTSD in bushfire survivors using an online intervention: A pilot study. *The Natural Hazard Centre Forum. RMIT*

University, Melbourne, Australia May 1-3rd 2023.

- Isaac, F., Toukhsati, S. R., Klein, B., Di Benedetto, M., & Kennedy, G. A. (2023). Bushfires, sleep & trauma: psychological treatment for insomnia, nightmares and post-traumatic stress disorder. *The Natural Hazard Centre Forum. Adelaide, Australia 14-16th May 2024.*
- Isaac, F., Toukhsati, S. R., Klein, B., Di Benedetto, M., & Kennedy, G. A. (2024). Online psychological intervention for insomnia, nightmares and PTSD in bushfire survivors: A pilot study. AFAC24 Conference. Sydney, Australia 3-6th of September 2024.

Workshop Presentations

Sleep Well Workshop: the workshop offers psychoeducation about sleep, neurobiology of sleep, and consequences of poor sleep, psychoeducation about insomnia and nightmares and strategies to improve poor sleep.

The workshop has been offered to the following communities:

- Bairnsdale Neighbourhood house 17/6/2023
- Swifts Creek Bush Nursing Centre 23/6/2023
- Swifts Creek Bush Nursing Centre 21/7/2023
- Buchan Bush Nursing Association 13/9/2023

Media Interviews

The aim of the media interviews was to recruit participants for the clinical trial.

The media interviews were conducted with the following radio stations:

- ABC Radio Canberra 12/7/2023
- ABC Radio Southeast NSW 14/8/2023
- ABC Southern Queensland 15/8/2023
- BBC Sydney recorded interview 15/8/2023

- ABC Radio Newcastle and the Hunter 15/8/23
- Cosmos Science magazine 15/8/23
- ABC Radio Illawarra 17/8/2023
- ABC Radio New England NSW-Tamworth 18/8/2023
- ABC Gippsland Radio 30/8/2023

Achievements and Awards

- Scholarship awarded in 2022 from Natural Hazards Research Australia
- 1st place winner of the Early Career Researcher of the year 2023 awarded by Cooperative Research Australia, July 2023
- 2nd place winner of the three-minute thesis presentation 2022/Federation University
- Honourable mention of a verbal presentation 2023/Federation University
- 1st place winner of best abstract 2023/Federation University

Contributions to Published Chapters

Thesis chapter	Paper title	Status	Structure and % of student contribution	Co-author name(s), structure and % of co-authors contribution
2	A systematic review of the impact of wildfires on sleep disturbances	Published	70%. Conceptualisation, reviewing literature, assessing collected articles, writing of manuscript, review of manuscript in response to reviewers' comments, reviewing and rewriting of final proofs	15%. Professor Kennedy, concept conceptualisation, reviewing and providing feedback 10%. Dr Toukhsati, concept conceptualisation, reviewing manuscript and providing feedback 5%. Dr Di Benedetto, reviewing manuscript
3	Prevalence and predictors of sleep and trauma symptoms in wildfire survivors	Published	70%. Conceptualisation, ethics application, collection of data, reviewing literature, writing of manuscript, review of manuscript in response to reviewers' comments, reviewing and rewriting of final proofs	15%. Professor Kennedy, concept conceptualisation, reviewing and providing feedback 10%. Dr Toukhsati, concept conceptualisation, reviewing manuscript and providing feedback 4%. Professor Klein, reviewing manuscript and providing feedback 1%. Dr Di Benedetto, reviewing manuscript
4	Differences in anxiety, insomnia, and trauma	Published	70%. Conceptualisation, ethics application,	12%. Professor Kennedy, concept conceptualisation, reviewing and providing feedback

	symptoms in wildfire survivors from Australia, Canada and United States of America		collection of data, reviewing literature, writing of manuscript, review of manuscript in response to reviewers' comments, reviewing and rewriting of final proofs	10%. Dr Toukhsati, concept conceptualisation, reviewing manuscript and providing feedback 6%. Professor Klein, reviewing manuscript and providing feedback 2%. Dr Di Benedetto, reviewing manuscript
5	Pre-existing depression, anxiety and trauma are risk factors for the development of post-traumatic stress disorder symptoms following the trauma of wildfires	Published	70%. Conceptualisation, ethics application, data collection, reviewing literature, writing of manuscript, review of manuscript in response to reviewers' comments, reviewing and rewriting of final proofs	12%. Professor Kennedy, concept conceptualisation, reviewing and providing feedback 10%. Dr Toukhsati, concept conceptualisation, reviewing manuscript and providing feedback 6%. Professor Klein, reviewing manuscript and providing feedback 2%. Dr Di Benedetto, reviewing manuscript
6	Cognitive behavioral therapy-based treatments for insomnia and nightmares in adults with trauma symptoms: a systematic review	Published	70%. Conceptualisation, reviewing literature, assessing collected articles, writing of manuscript, review of manuscript in response to reviewers' comments, reviewing and rewriting of final proofs	15%. Professor Kennedy, concept conceptualisation, reviewing and providing feedback 12%. Dr Toukhsati, concept conceptualisation, reviewing manuscript and providing feedback 3%. Dr Di Benedetto, reviewing manuscript
7	Assessment of the effectiveness of online	Published	70%. Conceptualisation, reviewing literature, assessing collected articles,	15%. Professor Kennedy, concept conceptualisation, reviewing and providing feedback

	and face-to-face cognitive behavioural therapy for insomnia/ nightmares in adults exposed to trauma using self-report and objective measures: Preliminary findings		writing of manuscript, review of manuscript in response to reviewers' comments, reviewing and rewriting of final proofs	12%. Dr Toukhsati, concept conceptualisation, reviewing manuscript and providing feedback 3%. Dr Di Benedetto, reviewing manuscript
8	Digital cognitive-behavioral therapy-based treatment for insomnia, nightmares and post-traumatic stress disorder symptoms in wildfire survivors: A randomized feasibility pilot trial.	Published	70%. Conceptualisation, ethics application, data collection, reviewing literature, writing of manuscript, reviewing of manuscript	12%. Professor Kennedy, concept conceptualisation, reviewing and providing feedback 10%. Professor Klein, reviewing manuscript, training in using HealthZone, and providing feedback 6%. Dr Nguyen, statistical analysis and reviewing of methods 2%. Dr Watson, reviewing manuscript and providing feedback

Preface

My interest in wildfires began following the devastating 2019-2020 Black Summer fires in Australia. The decision to explore the relationship between wildfires, trauma, and sleep emerged from a collaborative discussion with Professor Gerard Kennedy.

This project has been a rewarding experience, marked by more successes than challenges. Nevertheless, recruitment for the pilot clinical trial proved difficult, with the enrolment of only 24 participants instead of the targeted 50 individuals. The recruitment process had to be ceased prematurely due to my thesis submission timeline.

Chapters two through to seven of this thesis comprised papers that have been published in peer-reviewed journals, including three systematic reviews and three original research papers based on data collected from an international survey. Consequently, some repetition within the thesis was inevitable. Additionally, the referencing style of certain chapters has been adjusted to ensure consistency throughout the document.

Note on spelling conventions: This thesis combines published and unpublished work. To maintain consistency, previously published chapters (2-7) preserve their original spelling, while unpublished sections and Chapter 8, currently in press, adhere to Australian English spelling conventions.

Foreword to Thesis

The temperature of planet Earth is rising, oceans are becoming warmer, Summers are getting hotter, and the polar ice continues to melt. Global warming, thus far, has impacted the environment and humans in multiple ways. Threats to animals by destruction of habitable environment, and threats to humans by limiting sources of food and water are hard to ignore. Another significant threat as a result of global warming is the occurrence of weather-related disasters. Natural disasters such as floods, droughts, storms, heatwaves, and wildfires are becoming more frequent and are increasing in intensity.

Wildfires and other natural disasters not only affect the environment, but also impact humans in many ways including causing injury and death, and damaging crops, housing, and other infrastructure. They can also trigger mental health conditions including trauma symptoms, sleep difficulties, anxiety, depression, and suicide. This research focuses on the impact of wildfires on sleep difficulties and trauma symptoms. Guided by the literature in the field of sleep, trauma and wildfires, recent research revealed two major gaps: firstly, a notable knowledge gap has been identified regarding the prevalence of sleep disturbances in wildfire survivors; and secondly, a lack of evidence-based psychological interventions exists to treat insomnia and nightmares in those presenting with wildfire-related trauma.

In addressing the gaps outlined above, the following areas were explored in this thesis: (1) studies about the prevalence of insomnia and nightmares in wildfire survivors were systematically reviewed; (2) an international survey examining the prevalence of insomnia, nightmares and trauma symptoms in wildfire survivors from Australia, Canada and the United States of America was carried out; (3) cognitive behavioural therapy-

based treatments for insomnia and nightmares in adults presenting with trauma symptoms were systematically reviewed; and (4) a digital, self-paced intervention (Sleep Best-i), comprising cognitive behavioural therapy for insomnia (CBT-I), and exposure, relaxation, and rescripting therapy (ERRT) treatment for nightmares was developed and trialled in wildfire survivors from Australia, Canada and the United States of America.

Chapter 1: Introduction

1.1 Wildfires

The combination of ignition (i.e., lightning), suitable weather conditions (i.e., wind and high temperatures), fuel (i.e., plant growth and decomposition), and drought lead to the occurrence of wildfires (Pausas & Keeley, 2021). Wildfires play a major role in restoring the environment by providing room for fresh nutrients to seep into the soil leading to the establishment of new habitats for plants and animals. In addition, smaller fires play an important role in controlling diseases and harmful insects, promoting a healthy ecosystem, clearing dry logs, leaves, and dense shrubs, and preventing the occurrence of larger and more destructive wildfires (Pausas & Keeley, 2019; Western Fire Chiefs Association, 2022). However, prolonged burning by larger wildfires can disrupt the ecosystem recovery and lead to severe repercussions (Western Fire Chiefs Association, 2022). In recent years, wildfires have affected the globe in unprecedented ways, affecting almost all continents, specifically Australia and North America (Climate Reality Project, 2020; Flannigan et al., 2013; United Nations Environment Programme, 2022, Western Fire Chiefs Association, 2022).

1.1.1 Wildfires in Australia, Canada and the USA

Wildfires have affected Australia and North America, with each region facing unique challenges and consequences. Notably, Australia has experienced two devastating wildfires in the past two decades. In February 2009, the Black Saturday fires claimed 173 lives and destroyed more than 2,000 homes in the State of Victoria (Williams, 2011). This devastating event was preceded by a prolonged period of intense drought, high temperatures and strong winds. Ten years later, between July 2019 and March 2020**,** the Black Summer fires ravaged over 20 million hectares of land causing major biodiversity

losses. In addition, 33 were killed, over 2,500 dwellings were burnt, and 3 billion animals perished raising concerns about the extinction of many animal and plant species. These calamities caused adverse effects on tourism and agricultural industries, as well as air and water quality (Diaz, 2012; The International Disaster Database, 2023; Western Fire Chiefs Association, 2022; Williams, 2011; World Metrological Organisation, 2020). Notably, the resulting smoke from the 2019 fires was responsible for the death of nearly 450 individuals, compromising air quality in Australia, New Zealand and South America (Williams, 2011; World Metrological Organisation, 2020).

Similarly, in the last decade, Canada, has also experienced intense and devastating wildfires. The 2016 Fort McMurray fires burnt 590,000 hectares of land, forcing the evacuation of nearly 88,000 people within two days (The Canadian Press, 2020). The fires also destroyed 2,400 dwellings and incurred damages of approximately $9.9 billion (The Canadian Press, 2020). The following year, wildfires in British Columbia burnt 1.2 million hectares of land, led to the evacuation of 65,000 people, and $649 million was spent fighting the fires. The continent was also subjected to over 100 different fires in a single day in July 2017, caused by lightning strikes (The Canadian Press, 2020). A year later, in 2018, British Columbia faced its most severe wildfire season on record with fires burning over 2,000 homes, destroying over one million hectares of land, and costing the country $615 million (The Canadian Press, 2020).

The USA has also been greatly affected by wildfires, mirroring the destruction seen in Australia and Canada. Following many years of draught, in November of 2018, the Camp Fire in Butte County/California led to the destruction of 18,804 buildings, destroyed almost 14,000 homes, 30,000 people lost their homes, 85 people were killed and 62,079 hectares of land were burnt, making it the most damaging wildfire in the County’s history (Boghani, 2019; Western Fire Chiefs Association, 2022). North

California was hit again by the 2020 August Complex fires that spread through Tehama, Lake, Mendocino, Glenn, Humboldt, Trinity, and Colusa Counties. Particularly, the August Complex fires were labelled as the largest wildfires that the state has ever witnessed. They caused poor air quality, destroyed over 8,000 structures, burnt 1,618,742 hectares of land, 31 individuals lost their lives, and tens of thousands of people were evacuated with evacuation orders remaining active for four months following the start of the fires (Boghani, 2019; Western Fire Chiefs Association, 2022).

The three countries show similar trajectories in losses associated with wildfires including financial, biodiversity and wildlife losses as well as the loss of human lives. However, the scale of each wildfire is unique in the way it impacts the environment and associated communities.

1.1.2 Losses as a Result of Wildfires

As demonstrated earlier, wildfires have severe economic implications with annual financial losses fluctuating between USD $71.1 and $347.8 billion (Thomas et al., 2017). The year 2019 alone accounted for an estimated economic loss of USD 30 billion dollars globally. Prominent fires included the California fires with an estimated damage of USD $1.3 billion, and the 2019-2020 Summer fires in Australia with an estimated damage of USD $23 billion (Diaz, 2012; OECD, 2023; The International Disaster Database, 2023; Western Fire Chiefs Association, 2022).

In addition to the economic losses, wildfires lead to other losses including loss of lives, displacement of people, property damage, destruction of social networks, loss of housing, loss of employment, eye and throat irritation, burns, different types of cancers, alcohol and substance abuse, lack of access to medical care and medical resources, housing instability, higher risk of heart disease, respiratory conditions, and suicidal ideations and premature death (Grant & Runkle, 2022; Liu et al., 2015; OECD, 2023;

Popescu et al., 2022; Rodney et al., 2021; Rosenthal et al., 2021). The magnitude of these losses demands immediate attention and an international action to address the devastating impacts of wildfires.

1.1.3 Wildfires, Mental Health and Sleep Disturbances

Considering the devastating losses highlighted above, it is understandable that wildfires have an enduring and profound impact on survivors' mental wellbeing. Research by To et al. (2021) revealed elevated rates of mental health disorders both immediately after wildfires and even a decade later. Notably, wildfires increase the risk of developing various mental health conditions including mood and anxiety disorders, sleep disturbances, and post-traumatic stress disorder (PTSD) (Agyapong et al., 2019; Lowe et al., 2019; Willis, 2020). For example, following the 2009 Black Saturday wildfires, researchers found alarming rates of depression (33%), PTSD (60%), anxiety (27%), and alcohol misuse (17%), just three months following the fires (To et al., 2021). Moreover, a study of 1,017 wildfire survivors conducted three to four years following the fires found persistent mental health issues, with 18.2% of participants experiencing generalised PTSD, 12.1% suffering from fire-related PTSD, 10.9% experiencing major depressive episodes, 22.1% engaging in problematic alcohol use, and 7.8% struggling with serious mental illness (Bryant et al., 2018). These studies collectively underscore the profound and enduring effects of wildfires on mental health.

Additionally, a study examining 25 wildfires that occurred between 2011 and 2012 with 819 participants revealed significant emotional and psychological impacts with reported challenges (Paveglio et al., 2016). These challenges included disconnection from the land, decreased motivation for recreational activities, feelings of helplessness, sleep disturbances, and anxiety related to property damage. In addition, the study found that disruption to daily routines, loss of attachment to the land, loss of income, displacement

from one's home, and sustaining injuries were significantly associated with lower levels of wellbeing (Paveglio et al., 2016).

Further studies have contributed to a broader understanding of wildfires' impact on overall health, including physical and mental health outcomes. For example, a study investigating the aftermath of the 2019 Gangwon wildfire in South Korea revealed significant distress among survivors with approximately 76% (n = 206) of participants experiencing insomnia, fatigue, changes in appetite, pain, tension, indigestion, and nausea. Survivors, 71.8%, also reported emotional struggles including grief, shame, guilt, anger, helplessness, hopelessness, fear, depression, and unhappiness. Furthermore, 50% of participants reported poor concentration, poor memory and judgment, suicidal ideation, flashbacks, and nightmares. Finally, 16.5% of survivors experienced isolation, confusion, substance use, avoidance, violence, smoking, and self-harm. Notably, the most prevalent symptoms in this sample were insomnia followed by anxiety, flashbacks, grief, and depression (Hong et al., 2022).

Mental health consequences related to wildfires include both direct traumatic effects and indirect consequences of prolonged smoke exposure, with comparable harmful impacts on psychological wellbeing. Studies examining prolonged exposure to smoke have highlighted a range of mental health challenges including high levels of worry, stress, PTSD, fear, substance abuse, social isolation, panic attacks, feelings of hopelessness, exhaustion, depression, anxiety, lack of motivation and poor quality and quantity of sleep (Eisenman & Galway, 2022; Humphreys et al., 2022). The available literature underscores the critical impact of wildfire smoke exposure on physical and mental health, with notable consequences on sleep quality.

It is evident that wildfires significantly disrupt sleep patterns among those exposed. Research reveals alarming consequences for firefighters and civilians alike. In a

review of studies assessing the impact of extended shift work among firefighters, it was found that prolonged and early shifts during operations compromised the quality and quantity of sleep. Consequently, firefighters experienced short and poor-quality sleep, leading to impaired physical and cognitive wellbeing (Vincent et al., 2018). A survey of 1,250 adults across the USA found that individuals were losing approximately 88 minutes of sleep each night or 135 hours of sleep a year when the fires were active (Yasinski, 2023). Moreover, research on 1,358 victims of natural disasters, including wildfires, found that 23% of participants reported poor sleep quality (Kim & Lee, 2021).

Considering the severe impact of wildfires on sleep, a comprehensive understanding of sleep's physiological and behavioural mechanisms is essential for informing evidence-based treatment approaches. The subsequent section elaborates on these mechanisms.

1.2 Sleep

Sleep is a complex physiological and behavioural process characterised by reduced responsiveness to the external environment and altered states of consciousness, which vary across different sleep stages. Behavioural changes observed during sleep include closing of the eyes, recumbent posture, and a sense of calmness. Other behaviours such as teeth grinding, sleepwalking and talking, dreaming and muscle weakness may also occur during sleep (Carskadon & Dement, 2000; Kenrick et al., 2010; Kumar, 2008). Sleep changes with age in duration and quality. For example, babies sleep approximately 16 hours a day, teenagers sleep between 8 and 10 hours, and adults sleep nearly 8 hours a day (Ohayon, 2002; Suni & Singh, 2024). Notably, humans spend one third or what is equivalent to 27 years of their lives sleeping, underscoring the importance of sleep research (Kumar, 2008; Ohayon, 2011).

Understanding sleep, as outlined above, is also important for accurately evaluating sleep stages, which relies on a combination of electrophysiological recordings. These include electroencephalogram (EEG), electromyogram (EMG), and electrooculogram (EOG). Among these, the EEG is widely recognised as the most critical parameter for sleep analysis, providing an important distinction between non-rapid eye movement (NREM) and rapid eye movement (REM) sleep stages (Kumar, 2008; Pandi-Perumal et al., 2014). NREM sleep is subdivided into stages 1, 2, and 3. Stage 1(N1), lasting between one and five minutes, signifies the shift from wakefulness to sleep. It is characterised by low-voltage, mixed EEG activity, low EMG activity, cessation of blinking, absence of saccadic eye movements, and slow rolling of the eyes (Carskadon & Dement, 2000; Chokroverty, 2010; Kumar, 2008; Pandi-Perumal et al., 2014; Walker & van der Helm, 2009). Stage 2 (N2), lasting between 10 and 25 minutes, marks the onset of sleep, absence of slow waves, high submental EMG levels, and the presence of sleep spindles as measured by the EEG (Pandi-Perumal et al., 2014). Finally, stage 3 (N3) is marked by slow-wave- delta activity representing deep sleep and it usually lasts 20-40 minutes (Carskadon & Dement, 2000; Chokroverty, 2010; Kumar, 2008; Pandi-Perumal et al., 2014; Suni, & Singh, 2023; Walker & van der Helm, 2009). About three-quarters (75%) of our sleep is spent in NREM sleep.

In contrast, REM sleep is distinguished by rapid eye movements under the eyelids, muscle immobility, emotional processing, dreaming, and a desynchronised EEG (Carskadon & Dement, 2000; Chokroverty, 2010; Kumar, 2008; Pandi-Perumal et al., 2014; Walker & van der Helm, 2009). REM sleep occurs periodically 4-5 times a night and accounts for 20-25% of total sleep time. Both NREM and REM states change during the night in approximately 90-minute cycles (Carskadon & Dement, 2000; Chokroverty, 2010; Kumar, 2008; Pandi-Perumal et al., 2014; Walker & van der Helm, 2009). When

sleep is compromised, individuals may develop a range of health issues such as insomnia, psychiatric and psychological health conditions, anxiety, depression, substance dependency, epilepsy, cognitive impairments, degenerative disorders, headaches, dementia, poor quality of life, employment difficulties and susceptibility to road and work-related accidents (Chokroverty, 2010; Kumar, 2008, Walker & van der Helm, 2009).

1.2.1 Tools to Measure Sleep

Given the complexity of sleep architecture and the consequences of compromised sleep, accurate measurement of sleep stages is essential, and this is achieved through the utilisation of tools such as polysomnography (PSG). PSG is an objective tool used to study sleep and it assists in diagnosing sleep disorders by measuring sleep quality and quantity. Conducted in a sleep laboratory overnight, PSG provides measures of brain waves activity, breathing, oxygen level, muscle tone, electrocardiogram, and eye movement (Morin & Espie, 2007; Pandi-Perumal et al., 2014). The 10-20 system serves as a guideline for positioning EEG electrodes on the scalp, enabling accurate recordings. The numbers “10” and “20” suggest that the distance between the electrodes and the underlying cerebral cortex area is either 10% or 20 % of the total dimension of the skull (Pandi-Perumal et al., 2014). Undergoing a sleep study using PSG requires a sleeping laboratory, a trained health professional, it can be costly, and it can cause discomfort and anxiety associated with the process and the environment in which it is performed (Haghayegh, Khoshnevis, Smolensky, Diller, et al., 2019; Pandi-Perumal et al., 2014).

As an alternative to PSG, other measures are employed, including actigraphy, a wearable device commonly placed on the wrist or ankle (Chokroverty, 2010). Actigraphy is a non-intrusive device that is used to diagnose certain sleep disorders, and it also measures the progress of people who undergo treatment for sleep problems. Using an

accelerometer technology to measure movement, the actigraphy assesses the time before falling asleep, time of falling asleep, wake up time, total sleep time, and any awakenings during the night (Pacheco & Singh, 2023). Although the actigraphy offers a comprehensive sleep data, its cost can limit accessibility. Therefore, other devices such as Fitbits (Fitbit, Inc) have been used in measuring sleep stages and transition between sleep stages. The new generation of Fitbits such as the Fitbit Charge 2 and 3, Fitbit Alta HR, Fitbit Inspire HR, and Fitbit Versa 1 and 2 use body movements and heart rate to provide sleep parameters and sleep staging (Haghayegh, Khoshnevis, Smolensky, & Diller, 2019). Notably, the new generation Fitbits provide more accurate measure for sleep efficiency (SE), waking after sleep onset (WASO), and total sleep time (TST) than the first-generation Fitbits (Haghayegh, Khoshnevis, Smolensky, Diller, et al., 2019). Accuracy, sensitivity, and specificity of Fitbits have also been studied. For example, research found that Fitbit's sleep tracking accuracy compared favourably to polysomnography (PSG), with sleep epoch accuracy ranging from 0.81 to 0.93. Sensitivity and specificity ranged from 0.87-0.99 and 0.10-0.52, respectively. Fitbits also accurately detected light (0.69-0.81), deep (0.36-0.89), and REM sleep (0.62-0.89) stages (Haghayegh, Khoshnevis, Smolensky, Diller, et al., 2019).

Subjective measures are also essential for gathering information about the quality and quantity of sleep. One commonly used self-report measure is the sleep diary. The sleep diary is considered the gold standard for measuring sleep subjectively as it provides information about various sleep parameters such as SE, TST, sleep onset latency (SOL), WASO, satisfaction with sleep, total time spent in bed (TIB), and sleep quality (Carney et al., 2012). However, despite their wide use, sleep diaries have some limitations, such as relying on personal experiences and potentially overestimating TST, TIB, and SE compared to objective measures like the PSG and actigraphy (Haghayegh, Khoshnevis,

Smolensky, Diller, et al., 2019; Lehrer et al., 2022). Notwithstanding, they are economic, easy to administer, and do not require a sleep centre, making them more viable for public use (Ibáñez et al., 2018; Lawrence & Muza, 2018).

The diagnosis of the 10 sleep disorders listed in the Statistical Manual of Mental Disorders (DSM-5) typically involves a combination of subjective and objective measures (American Psychiatric Association [APA], 2013). This research will focus exclusively on insomnia and nightmares, discussed in the subsequent section.

1.3 Insomnia

Insomnia is the most reported sleep disorder, and it affects around 30% of adults. It is characterised by difficulties in falling asleep, waking up too early, frequent night awakenings, poor quality and quantity of sleep, and/or suffering from nonrestorative sleep that leads to daytime sleepiness, stress, and fatigue (APA, 2013; Roth & Ancoli-Israel, 1999; Sateia et al., 2000). The DSM-5 classifies the above symptoms as insomnia disorder when the sleep difficulties occur three or more times a week for at least three months (APA, 2013). Ultimately, the disorder leads to impairments in professional, vocational education, social and personal functioning (APA, 2013; Roth & Ancoli-Israel, 1999; Sateia et al., 2000). Insomnia causes significant distress as individuals report high levels of anxiety about not being able to sleep leading to increased arousal at bedtime, and concerns about the effects of sleep deprivation (Riedel & Lichstein, 2000).

The repercussions of insomnia are far-reaching, encompassing detrimental effects on both physical and psychological well-being. Moreover, insomnia's economic implications are substantial, with estimated annual costs reaching approximately $13 billion. These costs are primarily associated with regular physician visits, difficulty in concentration and task completion, reduced work productivity, memory and cognitive decline, anxiety, PTSD, hypertension, diabetes, heart disease, decreased quality of life,

strained relationships, workplace and traffic accidents, stress, depression, and suicidal thoughts (Drake et al., 2003; Ohayon, 2002; Ohayon, 2011; Ohayon, & Smirne, 2002; Pigeon, 2010; Roth & Ancoli-Israel, 1999).

1.3.1 Precursors of Insomnia

Incidents of insomnia are dictated by factors such as age and gender. A systematic review comprising 13 articles and involving a total of 326,908 participants (187,559 males and 139,349 females) revealed that females exhibited a higher prevalence rate of insomnia than males (p <.0001) (Zeng et al., 2020). The authors attributed these higher rates among females to lower levels of education and income, as well as elevated rates of depression and anxiety (Zeng et al., 2020). Additionally, insomnia prevalence increases with age, particularly among adults over the age of 65, due to spending more time in stages 1 and 2 or light sleep and less time in stage 3 or deep sleep (Ohayon, 2002).

While age and gender may make individuals more vulnerable to developing insomnia, other factors may also play a significant role in the onset of insomnia including physical and psychological determinants (Bastien et al., 2004). For example, a study exploring trauma types and their impact on triggering insomnia in a sample of African Americans adults revealed that 20% (n = 465) developed insomnia symptoms subsequent to physical assault, sexual trauma, sudden violent death, accidents, and natural disasters (Brown et al., 2015). Childhood trauma, including sexual abuse, was also found to predict the onset and the trajectory of insomnia. For instance, a longitudinal study of 533 female survivors of childhood sexual abuse found that those who experienced penetrative abuse or physical violence during the abuse reported increased insomnia symptoms (Steine et al., 2019). Additionally, natural disasters significantly contribute to insomnia onset. Survivors of the Great East 2011 Japan Earthquake from Tokyo and Osaka (n = 5053 adults and children) residing between 375 and 750 km from the epicentre reported a

significant increase in insomnia incidents (p <.001) (Li et al., 2018; Sugiura et al., 2013). Notably, insomnia prevalence increased even in areas distant from the epicentre. Other natural disasters, such as wildfires, also increase insomnia onset (Belleville et al., 2021; Psarros et al., 2017; To et al., 2021).

1.3.2 Aetiology of Insomnia

Insomnia stems from a combination of underlying vulnerabilities (predisposing), triggering events (precipitating), and maintaining (perpetuating) factors. Predisposing factors, such as a family history of insomnia, variations in neurotransmitters, abnormal brain morphology, disrupted GABA functioning and family genetics increase the risk of insomnia development (Levenson et al., 2015; Perlis et al., 2010; Roberge & Bryan, 2021). These genetic vulnerabilities can be activated by precipitating factors such as childhood trauma, divorce, death of loved ones, natural disasters, stressors, or significant life changes. Subsequently, perpetuating factors, including compensatory behaviours like spending more time in bed, and relying on sleep substances or medications maintain insomnia (Spielman et al., 1987).

The above compensatory behaviours contribute, to some extent, to the development of neurophysiological hyperarousal. This in turn leads to the emergence of new behaviours including heightened focus on sleep, intensified efforts to initiate or resume sleep, and worries and fears about sleep (Levenson et al., 2015; Germain et al., 2008; Sinha, 2016). Our understanding about insomnia has shifted from viewing it solely as a sleep disorder to recognising it as a 24-hour hyperarousal disorder related to cognitive, emotional, and physiological domains (Dressle & Riemann, 2023; Perlis et al., 2001). Recent advancements in research show that hyperarousal is now considered a marker of insomnia observed before sleep as well as throughout the day in people who develop insomnia (Dressle & Riemann, 2023). Hyperarousal causes impaired sensory

inhibition leading to rumination and emotional distress. This interplay between cognition and emotions perpetuates insomnia symptoms, creating a self-reinforcing cycle (Dressle & Riemann, 2023; Kalmbach et al., 2018). The growing recognition of insomnia as a condition characterised by hyperarousal may be linked to the consistently high levels of arousal observed in individuals with insomnia. This understanding is supported by diverse theoretical frameworks, including neurobiological, cognitive, and behavioural models, underscoring hyperarousal's crucial role in insomnia maintenance (Buysse et al., 2011; Dressle & Riemann, 2023; Harvey, 2002; Kalmbach et al., 2018; Riemann et al., 2010; Spielman et al., 1987).

1.3.3 Treatments for Insomnia

Given the critical role of hyperarousal in maintaining insomnia, effective treatments should aim to target this underlying factor. Pharmacological therapies have been effective in addressing insomnia, particularly in reducing hyperarousal, and aiding sleep onset and/or maintenance. Benzodiazepines like temazepam and zolpidem, antidepressants such as mirtazapine, doxepin, trazodone, and other medications like suvorexant and ramelteon, target various systems including orexin, melatonin, and antihistamine pathways to promote sleep (Amar, 2018; Neubauer et al., 2018). These drugs control neurotransmitters' activity by reducing hyperarousal in the nervous system and their efficacy has been established through randomised clinical trials in comparison to placebo (Amar, 2018; Erman et al., 2001; Labrecque, 1980; Levenson et al., 2015; Neubauer et al., 2018). However, while pharmacotherapy is effective for short-term use (4 weeks or less) (Riemann et al., 2017), long-term use indicates limitations associated with diminished effectiveness, dependence risk, and adverse side-effects such as headaches, dizziness, and impaired coordination (Amar, 2018; Levenson et al., 2015; Neubauer et al., 2018).

Psychological treatments such as cognitive behavioural therapy for insomnia (CBT-I) has gained substantial attention, primarily owing to its cognitive and behavioural approaches (Bootzin et al., n.d.; Miller et al., 2014; Morin & Espie, 2007). CBT-I treatment comprises various components, including psychoeducation, sleep hygiene practices, cognitive restructuring, stimulus control techniques, and relaxation training. These interventions target multiple aspects, including fostering healthy sleep habits, restricting the bedroom to sleep only, establishing a regular sleep schedule, challenging negative beliefs about sleep, and reducing intrusive thoughts related to sleep by minimising hyperarousal (Levenson et al., 2015; Morin & Espie, 2007). A systematic review of 89 randomised controlled trials assessing behavioural and psychological interventions for treating insomnia found that CBT-I was highly effective in treating insomnia (Edinger et al., 2021).

1.4 Nightmares

In the aftermath of wildfires, another condition that may emerge is nightmare disorder. Nightmares, affecting between 2 and 45% of the population, are repeated, vivid, and easily remembered dreams leading to awakening with elevated anxiety levels and difficulty resuming sleep (APA, 2013; Rek et al., 2017; Sateia, 2014). Importantly, two types of nightmares are reported in the literature including idiopathic and traumatic (McNamara et al., 2021). While the aetiology of idiopathic nightmares is unknown, trauma related nightmares or post-traumatic nightmares are likely to occur following traumatic events. Post-traumatic nightmares are particularly distressing, involving unexpected recall of traumatic events, characterised by intense negative emotions and themes of fear and lack of safety (APA, 2013; McNamara et al., 2021; Rek et al., 2017; Youngren et al., 2020). Consequently, nightmares cause distress, functional impairments, intense levels of worry, hallucinatory experiences, paranoia, depersonalisation, poor

sleep, diminished daytime performance, and emotional consequences such as fear, sadness, confusion, and anger (Gieselmann et al., 2018; Pagel, 2000; Phelps et al., 2008; Rek et al., 2017; Robert & Zadra, 2014; Solms, 2000).

1.4.1 Precursors of Nightmares

Certain variables can increase the likelihood and frequency of post-traumatic nightmares such as gender, age, and previous history of trauma (Nielsen & Levin, 2007). A survey of 23,990 adults revealed that females reported more nightmares than males, with a noticeable peak between the ages of 10 and 39 years and a significant decline between the ages of 50 and 59 (Nielsen et al., 2006). The study also explored the frequency of nightmares before and after the 9/11 attack, revealing a higher frequency of nightmares following the attack with symptoms persisting for up to two years (Nielsen et al., 2006).

The severity and frequency of nightmares are also dependent on the severity of the experienced trauma. For example, research shows that increased exposure to trauma leads to more repeated nightmares (Milanak et al., 2019). Additionally, stress plays a significant role in exacerbating nightmare susceptibility. This is evident in the context of COVID-19, with individuals experiencing elevated stress levels being more likely to have nightmares with themes of war, anxiety, sickness, death, captivity, and separation from loved ones (Kennedy et al., 2022). Similarly, individuals who experience natural disasters also report an increased rate of nightmares. A study examining the frequency of nightmares following the 1989 San Francisco earthquake found that nightmares were reported frequently with a replay of the earthquake trauma (Wood & Bootzin, 1992).

1.4.2 Aetiology of Nightmares

Similar to the insomnia model, nightmares also develop as a result of an interplay between predisposing, precipitating, and perpetuating factors (Davis et al., 2009). Predisposing factors such as mental health conditions prior to trauma, genetic make-up, coping style, and personality traits like type A personality, can increase an individual's vulnerability to nightmares. Traumatic events, circumstances surrounding the trauma, emotional involvement, and negative appraisals of the event serve as precipitating factors, triggering the development of nightmares (Davis et al., 2009). Once nightmares develop, perpetuating factors such as prolonged activation of the fight flight response leading to hyperarousal, maintain the nightmares (Davis et al., 2009). In turn, sleep deprivation resulted from elevated arousal levels lead to impairments in memory, concentration, fatigue and irritability. Consequently, cognitive shifts such as experiencing fear about falling asleep, worry and negative self-talk, can further exacerbate negative emotions, resulting in what Davis and colleagues describe as a "stuck point" within the nightmare. Therefore, the nightmare is maintained as there is no opportunity for processing of the nightmare and the correction of the experience. Safety behaviours such as watching TV in bed and using substances such as medications and/or alcohol, may initially enhance slow wave sleep, however people are more likely to experience rapid REM rebound increasing the chances of having nightmares as a result of that (Davis et al., 2009). Understanding this complex interplay is crucial for identifying and addressing the underlying causes of nightmares and developing targeted interventions to alleviate their frequency and severity. The following section explores current therapeutic approaches and available treatments for nightmares.

1.4.3 Treatments for Nightmares

A number of pharmacological medications are used in the treatment of post-trauma nightmares. Specifically, alpha-1 adrenergic receptor antagonists, such as prazosin and terazosin, and alpha-2 adrenergic receptor agonists like clonidine, have been shown to be effective in treating post-trauma nightmares (El-Solh, 2018; Raskind et al., 2003, 2007). The medications work by targeting the processing of emotional memory, such as lack of safety and fear, and strengthening new and positive emotional memories (El-Solh, 2018). Additionally, antipsychotics such as olanzapine, quetiapine and risperidone, and antidepressants such as paroxetine and citalopram have also been used in the treatment of nightmares due to their strong connection with serotonin receptors and a lower connection with dopamine-2 receptor (El-Solh, 2018). A retrospective study of 327 veterans' chart reviews from 2009 to 2013 found success rates, in the treatment of nightmares, ranging from 49% for prazosin to 100% for olanzapine, with other medications showing varying degrees of efficacy (Detweiler et al., 2016). Despite this, methodological limitations such as limited numbers of large randomised clinical trials, lengthy treatment ranging between 7-26 weeks, and potential concerns about loss of consciousness, weight gain, cognitive impairments, and restless leg syndrome have been reported (El-Solh, 2018). Nevertheless, pharmacological interventions remain a valuable treatment option for post-traumatic nightmares, emphasising the need for careful consideration and monitoring in clinical practice (Detweiler et al., 2016; El-Solh, 2018; Raskind et al., 2003, 2007).

Similarly, psychotherapies have been effective in the treatment of trauma related nightmares by empowering individuals to gain control over their experiences. During psychological treatment, individuals potentially gain more self-efficacy, process

unresolved emotions, adjust fear responses, alter negative beliefs, minimise physiological arousal, and improve sleep quality (Rousseau & Belleville, 2018). Imagery Rehearsal Therapy (IRT), a cognitive imagery treatment involving re-scripting a nightmare, and rehearsing the re-scripted dream, has gained support as a successful intervention for treating chronic nightmares and reducing the associated overall PTSD symptoms (Germain & Nielsen, 2003; Krakow et al., 2001; Krakow & Zadra, 2006). For example, a clinical trial revealed that the application of a brief IRT led to a significant reduction in PTSD symptoms, significantly improved quality of sleep, and reduced the frequency of nightmares per week (Krakow et al., 2001).

Exposure, relaxation and rescripting therapy (ERRT) has gained equal attention in the literature as another successful non-pharmacological therapy for the treatment of nightmares. ERRT is a more comprehensive therapeutic approach than IRT and it combines a number of therapies in its treatment protocol. The treatment protocol includes trauma education, sleep hygiene, relaxation techniques, nightmare exploration, themes identification, and rescripting, followed by practice of revised dreams (Davis & Wright, 2007). A study published by Swanson et al. (2009) investigated the therapeutic benefits of combining three sessions of ERRT with CBT-I. The findings suggested that this integrated approach yielded significant improvements in sleep efficiency and sleep quality and a reduction of nightmare frequency and severity.

1.5 Post-Traumatic Stress Disorder (PTSD)

Post-traumatic stress disorder, PTSD, is one of the most reported mental health conditions following an experience of a traumatic event, affecting 1.3% to 12.2% of the general population (Atwoli et al., 2015; Karam et al., 2014). Affected individuals report re-experiencing or reliving the trauma, they may experience flashbacks and/or nightmares about the trauma, they tend to avoid reminders of the traumatic event such as situations,

conversations, people and places, they also report feeling numb, detachment from self and other people, increased arousal, sweating, increased heart rate, rapid breathing and impairment in personal and professional life (APA, 2013). Most affected individuals feel the need to scan their environment for danger and may struggle with falling asleep or staying asleep (Davis, 2009).

Adverse health consequences associated with PTSD include higher usage of health and social services, backpain, headaches, irritable bowel syndrome, arthritis, hypertension, asthma, heart disease, stroke, reduced quality of life, depression, chronic bodily pain, substance abuse, anxiety, and suicide attempts (Atwoli et al., 2015; Pacella et al., 2013; Pietrzak et al., 2011; Scott et al., 2013). Considering the complexity of PTSD and its close affinity with sleep, it is essential to investigate the underlying mechanisms of its development to identify the contributing factors that lead to its onset. Understanding these factors is vital for developing effective intervention strategies to mitigate the adverse consequences of PTSD and the associated sleep problems.

1.5.1 Precursors of PTSD

Similar to insomnia and nightmares, both age and gender were found to be related to rates of PTSD. A review of published studies between 2013 and 2015 revealed that being a female, being younger than 65 years, having low education, being married, or being retired were associated with higher rates of PTSD (Atwoli et al., 2015; Pacella et al., 2013; Sayed et al., 2015). Pre-existing psychopathology before the trauma and peri-trauma factors including family history of mental health, anxiety, personal and maternal depression, severity of trauma, sexual and physical abuse, or being bullied were also found to increase the risk of developing PTSD (Nielsen et al., 2015; Sayed et al., 2015).

Between 2001 and 2013, a prospective longitudinal study monitored 2,409 veterans diagnosed with PTSD at baseline, providing valuable insights into the factors

associated with persistent PTSD. Over the 12-year period, participants completed regular surveys every three years, enabling researchers to identify predictive factors. On the first follow up, 47% (*n* = 1,132) of participants had persistent PTSD. Factors such as being older, having high exposure to trauma during operation, baseline severity of PTSD, history of physical assault, depression, sleep deprivation and somatic symptoms predicated ongoing PTSD (Armenta et al., 2018). Upon the second follow-up, 71% (*n* = 804) of participants screened positive for persistent PTSD with sleep deprivation, separation from military and limited social support being associated with persistent PTSD (Armenta et al., 2018). The study's results emphasise the importance of addressing co-occurring mental health conditions, promoting social connections, and providing targeted interventions to mitigate the effects of trauma exposure.

1.5.2 Aetiology of PTSD

Several theoretical frameworks have attempted to explain the development of PTSD, with the Social Cognitive theory offering a particularly influential and widely recognised explanation. The theory asserts that PTSD surfaces if a traumatic event reinforces negative beliefs leading to a probable cognitive discord (Resick et al., 2006). The presence of a negative belief system causes heightened arousal or hypervigilance, which can ultimately lead to difficulties in relaxation, sleeping difficulties, and potentially, the development of PTSD (Resick et al., 2016). This theory underscores the significance of addressing arousal levels, sleep problems and negative belief systems when treating PTSD.

Another theoretical framework that attempts to explain PTSD is Emotional Processing Theory by Foa and Kozak (1986). This theory draws from the framework of Lang's theoretical paradigm of "fear of an image" (Lang, 1977). The theory proposes that experiencing fear during a traumatic event will lead to avoidance of reminders related to

the trauma. When chronic avoidance develops overtime, arousal and high levels of anxiety emerge and the opportunity to remain in a situation long enough for the anxiety to subside is diminished. This hyperarousal will then lead to experiencing repeated images of the actual trauma causing the development of PTSD. Therefore, Prolonged Exposure Therapy addresses this by promoting emotional processing through imaginal and in vivo exposure, reducing stress and anxiety associated with trauma reminders (Foa et al., 2007). It appears that activation of the fear network to address avoidance behaviour is likely to reduce symptoms in PTSD.

Recent advances in research have led to the proposal of a neurobiological model for PTSD focusing on the dysregulation of the hypothalamic-pituitary-adrenal HPA axis in the development and maintenance of PTSD. Studies have consistently shown that individuals with PTSD exhibit abnormal HPA axis functioning, characterised by altered cortisol secretion patterns and impaired stress response regulation. Notably, a review by Roberge and Bryan (2021) found that individuals with PTSD typically display lower basal cortisol levels, yet exhibit hyperreactivity to traumatic triggers, leading to exaggerated responses and prolonged recovery times (Roberge & Bryan, 2021; Ross et al., 2017; Southwick et al., 2005). During the fight-flight response, the medial prefrontal cortex (mPFC) becomes less active, allowing instinctual responses to take over. Once the threat fades, the mPFC communicates with the fear centre, the amygdala, to allow for recovery through the activation of the nervous system (Dong et al., 2012; Kessler 2010; Roberge & Bryan, 2021). However, for a minority of individuals the amygdala continues to be activated due to disruption in communication with the mPFC (Liberzon & Sripada, 2007; Roberge & Bryan, 2021). This dissonance then leads to failure in acknowledging that the threat is no longer present leading to increased and prolonged hyperarousal. When dysfunctional thoughts and beliefs are paired with the prolonged hyperarousal, they

obstruct the normal functioning of mPFC and amygdala, perpetuating PTSD symptoms (Sripada et al., 2013). In turn, this increases fear, worry and dysfunctional thoughts leading to disturbed sleep.

1.5.3 Treatments for PTSD

Despite guidelines suggesting psychotherapy as the primary treatment for PTSD, pharmacotherapies are commonly used as the first line approach. For example, antidepressants including venlafaxine, paroxetine, fluoxetine and sertraline are frequently prescribed and are found to be effective in the treatment of PTSD due to their success in reducing symptoms of hyperarousal, avoidance and re-experiencing (Ehret, 2019; Hoskins et al., 2021). Furthermore, notwithstanding the controversy associated with using antipsychotics such as risperidone and olanzapine for the treatment of PTSD, they are still prescribed and recommended as second or third-line treatments (Ehret, 2019). Mood stabilisers, including divalproex, topiramate, and lamotrigine, have yielded mixed results, with some studies finding no efficacy and others reporting adverse effects such as kidney stones, metabolic acidosis, cognitive impairment, polycystic ovarian syndrome, weight gain, and hyperammonemia (Ehret, 2019). Specific medications such as prazosin, aripiprazole, and olanzapine are used for the treatment of PTSD-associated nightmares, and many guidelines recommend their use. However, they do not contribute to the treatment of the overall PTSD symptomology. Furthermore, even though benzodiazepines are used for anxiety and insomnia associated with PTSD, their use is discouraged because of the lack of evidence associated with their effectiveness and risks related with their use (Ehret, 2019). Some concerns have been reported in the literature in relation to the use of pharmacotherapy for PTSD including confusion about guidelines related to the use of antidepressants, which means that people are not receiving evidence-based treatment for

PTSD, and concerns associated with clinical trials being non-transparent about randomisation and associated effect sizes (Hoskins et al., 2021).

Therefore, psychotherapy is recommended as the first line treatment for PTSD (Hoskins et al., 2021; Polak et al., 2012; Wampold et al., 2010). Trauma-focused cognitive behavioural therapy (TFCBT), originally designed for children presenting with sexual abuse, demonstrated effectiveness in treating PTSD in adults (Bisson et al., 2013; Mannarino et al., 2014). TFCBT is a variant of cognitive behavioural therapy (CBT). Its primary aim is to modify unhelpful or negative cognitions and beliefs associated with traumatic experiences, change harmful behaviours linked to trauma, and gradually expose individuals to previously avoided trauma reminders (Mannarino et al., 2014).

Eye movement desensitisation and reprocessing (EMDR) has also been found to be effective in the treatment of the PTSD (Chen et al., 2014; Shapiro, 1989). EMDR encourages thinking about trauma related images while the therapist guides eye movements from side to side (Shapiro, 1989). A comprehensive meta-analysis of 70 studies involving 4,761 participants revealed that EMDR and TFCBT demonstrated significant efficacy in reducing PTSD symptoms compared to waitlist/usual care. Moreover, EMDR and TFCBT were found to be superior to non-TFCBT treatments at follow-up assessments (Bisson et al., 2013).

Psychoeducation has also emerged as a valuable component in the treatment of PTSD. A study conducted with 41 Libyan patients investigated the effectiveness of a concise psychoeducational program, comprising of three workshops administered over a three-day period. Psychoeducation included information about PTSD symptoms, stress management, relaxation, and teaching communication skills. Only 15% met the diagnostic criteria for PTSD following the treatment in comparison to 39% at pre-intervention (Mughairbi et al., 2020). There was a significant reduction (p <.001) of

symptoms on the re-experiencing, avoidance, and hyperarousal symptoms. It appears that psychoeducation about PTSD can alter a person's appraisal of the traumatic event influencing his/her coping level (Mughairbi et al., 2020). Similarly, Yeomans (2007) conducted a randomised control trial with 124 participants who were assigned to three groups, workshops with psychoeducation about PTSD (n = 39), a waitlist group (n = 46), and workshops without psychoeducation (n = 39). The intervention significantly reduced symptoms of PTSD in the group receiving psychoeducation in comparison to the waitlist and the group without psychoeducation (p = .002) (Yeomans, 2007).

In summary, insomnia, nightmares, and PTSD are complex mental health conditions that require ongoing research into their development and progression. A key finding from the above literature is that hyperarousal serves as a common underlying factor across all three disorders. This shared symptomology underscores the interconnectedness of these conditions, emphasising the importance of targeting hyperarousal in diagnosis and treatment. The subsequent sections will explore the relationships between insomnia, nightmares, and PTSD, examining their prevalence and treatment in the context of wildfire disaster.

1.6 Prevalence of Insomnia, Nightmares and PTSD Symptoms in Wildfire Survivors

The prevalence of PTSD, insomnia and/or nightmares in wildfire survivors have been researched to different extents, with PTSD receiving significantly more attention than insomnia and nightmares (Agyapong et al., 2019; Belleville et al., 2021; Mao et al., 2022; To et al., 2021). For example, a study of 486 wildfire survivors six months after the 2016 Fort McMurray fires revealed a PTSD prevalence rate of 12.8%, with significantly higher rates among females (14.9%) compared to males (8.7%) (Agyapong et al., 2019). Notably, a follow-up study five years later found a substantial increase in PTSD prevalence reaching 39.6% among 186 survivors, indicating a lasting impact of the

trauma of wildfires (Mao et al., 2022). Additionally, a study conducted six months after the 2003 Canberra/Australia fires among children and adolescents (n = 222) revealed a significant prevalence of PTSD symptoms with 28.6% reporting mild symptoms, 12.1% reporting moderately severe symptoms, 7.5% reporting severe symptoms, and 1.5% reporting very severe symptoms (McDermott et al., 2005). Similarity, North and colleagues (2008) found that 5% of participants (n = 62) received clinical diagnosis of PTSD following the 1991 Oakland/ California firestorm.

The above literature shows that PTSD rates in wildfire survivors range from 5% to 39.6%. This significant disparity may be attributed to differences in the severity and magnitude of traumatic experiences endured by survivors. For instance, Bryant and colleagues found that the rates of PTSD in highly affected communities (i.e., greater losses) were significantly higher (15.6%) than those classified as medium and low impacted communities (7.2% and 1%, respectively, p = <.001) (Bryant et al., 2014).

While the prevalence of PTSD in wildfire survivors is well researched, the prevalence of insomnia and nightmares has not received as much attention. Both insomnia and nightmares have always been viewed as part of the PTSD symptomology rather than independent disorders (APA, 2013). Belleville and colleagues found that 43.6% (n = 55) of wildfire survivors were diagnosed with clinical insomnia and this rate was associated with the trauma of the fires (Belleville et al., 2019). Similarly, one month following the fires in the province of Ilia Greece, 63% (n = 92) of survivors reported symptoms of insomnia. In this study both insomnia and nightmares were found to be significantly more prevalent in those with PTSD than those without (Psarros et al., 2017).

Despite limited research about prevalence of insomnia and nightmares, available studies indicate high rates of both conditions (Belleville et al., 2019; Psarros et al., 2017). There is a major gap in the literature about prevalence rates of insomnia and nightmares

in wildfire survivors. High disorder prevalence may reflect insufficient treatment access, highlighting the need for improved mental health services (The WHO Mental Health Survey Consortium, 2004). To address this, providing accurate and reliable prevalence rates are vital for gaining valuable insights about the effectiveness of treatments in reducing the incidence of the disease, guiding health authorities in assessing population health needs, prioritising resource allocation, and implementing targeted interventions to enhance public health (Jorm et al., 2017; Kessler et al., 2005; Ormel et al., 2022; Vos et al., 2020).

1.7 Sleep Disturbances and PTSD

Sleep disturbances are recognised as fundamental features of and are the hallmark symptoms of PTSD (Germain et al., 2007). For example, 70-91% of individuals with PTSD have difficulty initiating sleep, staying asleep and may experience chronic nightmares (Davis & Wright, 2007; Neylan et al., 1998; Ohayon & Shapiro, 2000; Phelps et al., 2008). There is a premise that both trauma related insomnia and nightmares are associated with the development of PTSD (Koren et al., 2002). More importantly, sleep difficulties have been found to have a significant impact on maintaining and/or exacerbating PTSD severity (Belleville et al., 2011; Spoormaker & Montgomery, 2008). Evidence suggests that neurobiological alterations, interruption of emotional processing of events, and repeated re-sensitisation to trauma cues during nightmares contribute to the development of PTSD (Germain et al., 2008; Pace-Schott et al., 2009; Rothbaum & Mellman, 2001; Walker & van der Helm, 2009). The aforementioned mechanism explains the ways in which nightmares and insomnia can disrupt and alter normal recovery from highly disturbing experiences (Babson & Feldner, 2010). Roberge and Bryan (2021) state that when insomnia is considered a hyperarousal disorder, then an underlying shared mechanism between insomnia and PTSD can be assumed, because

hyperarousal is a major component of PTSD. Similarly, research indicates that PTSD is associated with compromised REM sleep. This relationship is supported by studies conducted by Harvey et al. (2003) and Mellman & Hipolito (2006). Additionally, research by Koren et al. (2002) and Mellman et al. (2002) suggests that sleep disturbances occurring in the immediate aftermath of trauma exposure are predictive of an increased risk of meeting PTSD diagnostic criteria at 12-month following the exposure.

Nightmares and PTSD also show a similar strong connection, mirroring the link between insomnia and PTSD. Notably, in a longitudinal study of 453 military personnel, the initial presence of nightmares in this sample predicted the development of PTSD after being deployed (van Liempt et al., 2013). Research shows that the development of PTSD leads to further sleep interruption and decreased growth hormone secretion causing more frequent nightmares, whereby fear extinction and synaptic plasticity processes are compromised, this in turn interferes with recovery leading to a vicious cycle (van Liempt, 2012).

Despite the negative impact of trauma-related insomnia and nightmares, they are considered secondary to PTSD, and as a result, their treatment has received little attention in the literature (Harvey et al., 2003). If the consensus of sleep disturbances being secondary symptoms of PTSD was true, then an effective treatment of PTSD should fully eliminate symptoms of sleep disturbance and nightmares (Belleville et al., 2011). Evidence does not support this theory. The following section explores this in more details.

1.8 Psychological Treatment for Sleep Disturbances in Those Presenting With PTSD

As stated earlier, the efficacy of utilising pharmacotherapy/medications for insomnia and other sleep disturbances is well established for short-term use (4 weeks or less) (Riemann et al., 2017). However, the long-term effects of hypnotic medications for

the treatment of insomnia shows a decreased effect over time. More specifically, some sleep medications are associated with risks of tolerance, dependency and high rates of suicidality (Lavigne et al., 2019; National Institute of Health, 2005). Unfortunately, limited attention has been given to the development and refinement of non-pharmaceutical interventions (Harvey et al., 2003).

CBT-I is considered the gold standard for the treatment of insomnia in military personnel with comorbid health conditions, including PTSD (Edinger et al., 2009; Perlman et al., 2008). Notably, sleep-specific interventions for insomnia, such as cognitive and behavioural therapies, have proven equally effective as medication in the short-term and more effective in the long-term (Sivertsen et al., 2006). For example, in a clinical trial comparing zopiclone/medication and CBT-I, participants who received CBT-I experienced an increase in their sleep efficiency compared to those who received zopiclone (Sivertsen et al., 2006). Whilst CBT-I is effective in improving insomnia in military population with comorbidities, its helpfulness is questionable in reducing nightmares. A recent meta-analysis of studies for insomnia suggests that CBT-I treatment is not effective for the treatment of nightmares (Lancee et al., 2008).

One line of research assessed the effectiveness of CBT-I + IRT for the treatment of nightmares. Krakow et al. (2001) found that the combination of the two treatments resulted in significant enhancement in quality of sleep, decreased symptoms of depression and anxiety disorders, and significantly reduced insomnia and PTSD severity. Similarly, Germain and colleagues (2007) found that combining CBT-I + IRT for victims of violent crimes led to clinically significant decrease in PTSD daytime symptoms, and significantly enhanced sleep quality.

Another line of research by Long et al. (2011), utilised ERRT with 37 veterans, providing them with exposure to their nightmares, re-writing the new script and

rehearsing the new revised dreams. The treatment led to a reduction in PTSD symptoms and nightmare frequency. The same treatment protocol was also used by Wanner and colleagues (2010) in two case studies of Vietnam veterans and found improvements in sleep, PTSD, nightmare frequency and depressive symptoms. More recent research supported the above findings in relation to combining CBT-I and ERRT and reported that improvements were maintained at two months follow-up (Balliett et al., 2016).

Even though sleep specific interventions are successful in treating nightmares, research indicates that the reported effect sizes are small in comparison to other effect sizes for the treatment of other mental health conditions. Furthermore, concerns have been raised about the poor quality of methodologies used for sleep specific interventions in those presenting with PTSD symptomology (Augedal et al., 2013; Niet et al., 2009). Thus, there is an immediate need for non-pharmacological therapeutic interventions with modified, revised protocols and high-quality methodologies for the treatment of insomnia and nightmares in individuals presenting with PTSD (Morin et al., 2006; Okajima et al., 2011; Sivertsen et al., 2006; Smith et al., 2002).

There is also consensus amongst researchers that treating sleep impairment in those presenting with PTSD may motivate individuals to engage in subsequent treatment for PTSD and trauma symptoms (Nappi et al., 2012). In fact, individuals may be more inclined to seek help for sleep disturbances by perceiving less stigma in addressing sleep issues over trauma. Moreover, research suggests that prioritising sleep treatment can lead to better outcomes for trauma symptoms, indicating a potential benefit in addressing sleep difficulties first. Studies implementing psychological interventions for the treatment of PTSD have shown that insomnia and nightmares often linger as persistent issues following a successful resolution of PTSD symptoms (Pruiksma et al., 2016). For example, research conducted by Pruiksma et al. (2016) involving 108 US military

veterans undergoing PTSD treatment revealed alarming prevalence rates of insomnia and nightmares at baseline (92% and 69%, respectively) and persisting high rates at post-treatment (77% and 52%, respectively).

Building on this idea, research shows that addressing sleep disturbances in PTSD patients leads to improved sleep and reduced trauma symptoms (Colvonen et al., 2018; Germain, 2013). For example, Ulmer and colleagues (2011) randomised 22 veterans diagnosed with PTSD, insomnia, and nightmares to either a treatment group (n = 12) or a waitlist group (n = 9). The treatment group received CBT-I and IRT and reported reduction in nightmare frequency (p <.05, d = 0.89), reduction of PTSD symptoms and significant improvement on sleep efficiency (all p < .01) from pre- to post-intervention in comparison to treatment as usual (Ulmer et al., 2011).

1.8.1 Face-to-Face vs Online CBT-Based Treatments for Sleep Disturbances

Despite the proved efficacy of CBT-I, accessing this treatment can be challenging due to associated costs, the need for specialised professionals, and the inability to access treatment in a timely manner in remote communities where large number of people are affected by trauma. Utilisation of online or digital therapies is on the rise, demonstrating promising efficacy in treating sleep disturbances (Belleville et al., 2023; Siengsukon et al., 2020; Wogan et al., 2021).

Consistent with this, online-based treatments were found to be effective in reducing insomnia symptoms (Lancee et al., 2016; Nazem et al., 2023; Putois et al., 2019). For instance, Arnedt and colleagues randomised 65 participants to either face-to-face (n = 32) or online CBT-I (n = 33). Both groups received six CBT-I sessions, each lasting 30-60 minutes. Those receiving online CBT-I showed a reduction of insomnia symptoms similar to those receiving face-to-face (8.80 points on the Insomnia Severity Index vs 9.34 points, respectively, p < 0.001). This study concluded that online was non-

inferior to face-to-face CBT-I at post treatment and at 3-months follow-up (Arnedt, 2021).

Nightmare symptoms were also found to decrease following an online treatment. Notably, in a study of 399 participants presenting with at least one nightmare a week, researchers assigned participants to one of four groups: recording (n = 106), IRT (n = 103), waiting list (n = 95), or exposure therapy (n = 95). Those receiving exposure therapy were advised to write down their dream and perform an imagery exposure to the dream, while those who were enrolled in the recording group were asked to provide a record of their nightmares throughout the duration of the study. The results showed that six sessions of self-help IRT was superior to the recording and to the waitlist groups in ameliorating anxiety, distress, subjective sleep quality, depression and nightmare frequency (p = <.05). Notably, self-help IRT demonstrated comparable efficacy to exposure therapy, highlighting its potential as an effective online treatment for nightmare symptoms (Lancee et al., 2010).

Research on treating sleep disorders in those presenting with PTSD symptoms is primarily focused on clinical trials involving veterans, utilising face-to-face modalities (Margolies et al., 2013; Taylor et al., 2018; Ulmer et al., 2011). However, face-to-face approaches face significant challenges in reaching affected communities due to infrastructure damage, resource limitations, and stigma concerns following natural disasters (Rosenthal et al., 2021). Therefore, there is an urgent need to develop online treatments for communities affected by the trauma of wildfires. The trauma of wildfires is unique in that its consequences extend beyond the directly affected communities to those located at a distance from the fires. Such impact manifests in enduring losses for both individuals and communities with effects persisting for years underscoring the need for specialised and evidence-based treatments (Kulig & Townshend, 2013; Malhi &

Marwaha, 2023). Despite the pressing need, only two randomised clinical trials addressed the treatment of PTSD and sleep disturbances in wildfire survivors, applying CBT-based therapies (Belleville et al., 2023; Krakow et al., 2002). To address these obstacles, online/digital therapies offer a promising solution, demonstrating equivalent efficacy to face-to-face modalities (Gehrman et al., 2020; Isaac et al., 2022, 2023; Palmqvist et al., 2007; Seyffert et al., 2016). Moreover, brief online therapies (four sessions) have shown effectiveness in treating insomnia and PTSD symptoms, potentially enhancing long-term compliance (Edinger et al., 2007). Therefore, a shift towards online/digital therapies is crucial to provide timely, accessible, and stigma-free evidence-based treatment for wildfire-affected communities.

1.9 Problem Statement

Taken together, the above literature review highlighted two major gaps. Firstly, prevalence of insomnia and nightmares in wildfire survivors is underreported and further research is needed to bridge this gap. Acquiring prevalence rates will not only increase understanding about a disorder, but it will also guide the development of appropriate treatments (Kessler et al., 2005). Furthermore, determining prevalence rates of insomnia and nightmares in wildfire survivors can potentially guide health bodies in assessing health needs for affected individuals including providing treatment, planning prevention campaigns, and delivering needed resources (Vos et al., 2020). Secondly, innovative treatment strategies are needed in an environment where access to treatment is costly, restricted, delayed, and challenging. However, prior to implementing digital, self-paced and integrated therapeutic modalities, the efficacy and usability of such interventions should be examined in clinical trials (Belleville et al., 2023; Miller et al., 2020).

1.10 Aims

This project aimed to address the complex needs of wildfire survivors by pursuing four primary objectives. Firstly, it conducted a systematic literature review to assess the prevalence of sleep disturbances, including insomnia and nightmares, in wildfire survivors. Secondly, a survey across Australia, Canada, and the USA evaluated the prevalence of insomnia, nightmares, and trauma symptoms among those who experienced wildfires in the past decade. Thirdly, the project reviewed randomised controlled trials examining the effectiveness of psychological treatments for insomnia and nightmares in individuals with PTSD. Finally, a clinical pilot trial was conducted to test the feasibility of a brief, digital, self-paced, multicomponent therapeutic approach combining CBT-I, ERRT, and psychoeducation for PTSD.

1.11 Research Questions

The thesis addressed the following five research questions:

1. What is the prevalence of sleep disturbances reported in the literature in wildfire survivors?
2. What is the prevalence of insomnia, nightmares and trauma symptoms in wildfire survivors from Australia, Canada and the USA?
3. How effective are sleep-specific psychological interventions for treating insomnia and nightmares in those presenting with PTSD as reported in the literature?
4. Is a digital program integrating CBT-I and ERRT feasible in reducing insomnia and nightmare symptoms in wildfire survivors- the intervention group - in comparison to a waitlist group?

5. Is a digital CBT-I and ERRT treatment program feasible in reducing PTSD or trauma related symptoms as a result of treating insomnia and nightmares in wildfire survivors - the intervention group - in comparison to a waitlist group?

1.12 Significance of This Research

This research addressed two critical knowledge gaps by investigating the prevalence of insomnia, nightmares and trauma symptoms among wildfire survivors in Australia, Canada, and the USA, and developed and evaluating the feasibility of a digital treatment for sleep disturbances and trauma symptoms. By exploring the scope of sleep disturbances and trauma symptoms in this population and assessing the effectiveness of a targeted digital intervention, this research aimed to inform the development of evidence-based treatments and improve the mental health outcomes of wildfire survivors.

1.13 Structure of Thesis

This thesis is organised into nine chapters, most of which have been published in peer-reviewed journals. Chapter 1 introduces the research, highlighting two critical gaps in the existing literature: the unknown prevalence of insomnia, nightmares, and trauma symptoms among wildfire survivors, and the scarcity of effective treatments for these issues. The chapter also presents the research objectives, questions, and significance, setting the stage for the remainder of the thesis.

Chapter 2 provides a systematically comprehensive literature review that aims to establish new knowledge regarding the prevalence of insomnia and nightmares among survivors of wildfires. This chapter highlights the critical associations between various sleep disturbances and trauma symptoms, particularly focusing on the severity and proximity to wildfires.

Chapter 3 builds on the groundwork laid in Chapter 2 by establishing prevalence rates of insomnia, nightmares and PTSD symptoms in a sample of 126 wildfire survivors

from Australia, Canada and the USA. It also provides novel findings related to the association between smoke and the occurrence of insomnia, nightmares and PTSD symptoms.

As discussed earlier, Australia, Canada and the USA are the most impacted countries by the trauma of wildfires. Thus, Chapter 4 explores differences in anxiety, insomnia, and PTSD rates in the three countries utilising data from our international survey. The chapter, again, adds novel findings to the existing literature by showing that the three countries differ on rates and severity of anxiety, trauma and insomnia symptoms. Furthermore, it contextualises these disparities within the framework of differing land management practices, wildfire season preparedness, and resource allocation strategies employed by each country.

The introductory chapter explored precursors of insomnia, nightmares, and PTSD. Understanding the factors that contribute to the onset of a disorder is instrumental in devising effective treatment strategies for these conditions. Therefore, Chapter 5 utilises data from our international survey to further explore the impact of pre-existing mental health conditions on the likelihood of developing PTSD symptoms in wildfire survivors.

Chapter 6 systematically reviews the literature about the efficacy of CBT-I, IRT, and ERRT treatments in reducing the frequency and severity of insomnia and nightmare disorders in individuals exposed to trauma. The chapter also investigates whether successful treatment of insomnia and/or nightmares using CBT-based approaches leads to a reduction in PTSD symptoms.

Chapter 7 conducts a literature review to investigate the comparative effectiveness of face-to-face and digital CBT-based interventions for insomnia and nightmares in individuals presenting with PTSD. The primary objective of this chapter is to determine

whether online CBT-based therapies demonstrate equivalent efficacy to traditional in-person modalities in alleviating insomnia and nightmare symptoms.

Following the development of a digital, brief and self-paced intervention, Chapter 8 presents a pilot investigation examining the feasibility of Sleep Best-i, compromising CBT-I and ERRT treatments in addressing insomnia, nightmares, and PTSD symptoms in wildfire survivors from Australia, Canada, and the USA. The innovative treatment contributes significantly to the emerging literature on the treatment of sleep and trauma symptoms in this population.

To conclude, Chapter 9 demonstrates the advances made through this research. I integrate my findings from Chapters 2 to 8 and discuss their contribution and potential implications on the understanding and treatment of insomnia, nightmares, and PTSD symptoms. Limitations and future directions are also discussed.

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Foreword to Chapter 2

Despite the significant impact of wildfires on mental health, particularly concerning sleep as discussed in the previous chapter, there is a notable lack of research focusing on the prevalence of insomnia and nightmares among wildfire survivors. Moreover, the majority of studies examining the prevalence of sleep disturbances have typically been conducted either immediately or a few months following the trauma of wildfires. This timing may introduce bias, leading to potentially inflated rates of sleep disturbances and obscuring the true extent of these issues. This could result in misguided decisions regarding treatment and the provision of services following a disaster. Therefore, Chapter 2 systematically reviewed the available literature to gain a better understanding of the prevalence of sleep disturbances among survivors exposed to wildfires.

The introduction chapter also reported an association between mental health and the severity of being exposed to wildfires. While this relationship is expected, research about sleep disturbances and its connection with severity of wildfires has been overshadowed by studies focusing on the association between Post-Traumatic Stress Disorder (PTSD) and severity of wildfires. PTSD is perhaps more frequently reported by affected individuals, possibly because they remain in shock following a significant trauma, causing sleep disturbances to go unnoticed or unreported. Consequently, Chapter 2 also explored the association between sleep disturbances and severity of wildfires to provide further insights into this relationship.

Chapter 2: A Systematic Review of the Impact of Wildfires on Sleep Disturbances

The content of Chapter 2 is identical to my previous publication "Isaac, F., Toukhsati, S. R., Di Benedetto, M., & Kennedy, G. A. (2021). A systematic review of the impact of wildfires on sleep disturbances. *International Journal of Environmental Research and Public Health*, *18*(19), 10152. 10.3390/ijerph181910152", except for citation style changes to match this thesis's convention. The reproduction of this chapter's content is permitted under the journal's copyright agreement, with permission granted (refer to Appendix H).

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2.1 Abstract

Wildfires present a serious risk to humans as well as to the environment. Wildfires cause loss of lives, economic losses, expose people to personal as well as collective trauma, and compromise the mental health of survivors. Sleep disturbances are highly prevalent following a traumatic event; however, their prevalence is not well established amongst those confronted by natural disasters such as wildfires. The aim of this systematic review is to synthesise the empirical findings pertaining to wildfires and the prevalence of sleep disturbances in the general community affected by this natural disaster. We searched EBSCO, PsychINFO, Medline, SpringerLink, CINAHL Complete, EMBASE, PubMed, Scopus and Cochrane Library between January 2012 and March 2021. Five studies met the inclusion criteria. Findings from this systematic review suggest that sleep disturbances, assessed one to ten months following the fires, are highly prevalent in wildfire survivors, with insomnia (ranging between 63–72.5%) and nightmares (ranging between 33.3–46.5%), being the most prevalent sleep disturbances reported in this cohort. Results also highlight the significant associations between sleep disturbances and post-traumatic symptoms following the trauma of wildfires. There is a possible link between sleep disturbance prevalence, severity of, and proximity to fires.

Keywords: bushfires, sleep disturbances, trauma, psychopathology, bushfire survivors

2.2 Introduction

Climate change is posing serious threats to humans and the environment and may be increasing the frequency and intensity of droughts, floods, tornadoes, hurricanes, wildfires, and other extreme weather events. Such weather-related events cause human fatalities, loss of property, massive disruption to infrastructure, economic losses, displacement of those impacted, and negative physical and mental health sequalae (Agyapong et al., 2019; Change Science Program, 2014; Pengilley, 2020).

Wildfires are natural phenomena that deleteriously affect most continents around the world including: Australia, Europe, Asia, and North and South America (Bowman et al., 2017; Mcrae, 2015; Strauss et al., 1989; Williams, 2013). In Australia, approximately 20 million hectares were burnt and more than 3000 homes were destroyed in the 2019 Summer fires (Willis, 2020). In the USA, wildfires pose a similar risk to the economy with an annual average loss of $2677 million (USD) (Guha-Sapir, 2015). Wildfires also result in injury and the loss of many human lives. Data extracted from the Emergency Event Database shows that fires contributed to the loss of 3753 lives between the year 1901 and 2014, and a further six million peoples' lives were negatively affected between 1984 and 2013 globally as a result of fires (Guha-Sapir, 2015).

In addition to injury, loss of lives and economic losses, trauma resulting from wildfires causes disruption to community cohesion and people's sense of belonging, safety, and wellbeing (Berry et al., 2010). Collective trauma takes place when a traumatic event damages the ties that bind community members together and shatters the social fabric of society (Hirschberger, 2018; Smith & Burkle, 2020). Hirschberger refers to collective trauma as a loss of identity, affirming that the collective memory persists

beyond the single generation within in which it occurs and is remembered by those who are far removed from the traumatic events in space and time (Hirschberger, 2018).

Consequently, wildfires result in increased prevalence of mental health disorders such as depression, anxiety, post-traumatic stress disorder (PTSD), and sleep disturbances (Agyapong et al., 2019; Lowe et al., 2019; Willis, 2020). One of the most noted mental health conditions in the literature following trauma is PTSD. PTSD occurs in people who experience and/or witness, either directly or indirectly (i.e., vicariously), traumatic events such as accidents, natural disasters and personal assaults (American Psychiatric Association, 2013). In the DSM-5, sleep disturbances including recurrent trauma-related nightmares and difficulties falling or staying asleep are core features of PTSD, and their presentation is a prerequisite for a clinical diagnosis of PTSD (American Psychiatric Association, 2013; Germain et al., 2007). While some individuals may experience sleep disturbances following a traumatic experience, not everyone will develop PTSD.

Insomnia is a sleep disturbance present in 30% of the adult population, and is defined as difficulties in initiating and maintaining sleep, frequent nocturnal awakenings and/or suffering from nonrestorative sleep (Ancoli-Israel, 1999; Sateia et al., 2000). Notably, sleep disturbances were found to be the most prevalent symptoms amongst those surviving other traumatic events such as the earthquake in Japan in 1995 and the Jewish Holocaust (Kato et al., 1996; Kuch & Cox, 1992). Not only do people exposed to disasters show high rates of sleep disturbances, but also frontline and emergency workers who provide support and assistance to survivors. For example, in a sample of 9810 Korean firefighters, Jang and colleagues found that 50.9% of participants had insomnia (Jang et al., 2020). These results suggest that sleep disturbances are more prevalent in those who are repeatedly confronted with trauma than the rates observed in the general population. If left untreated, sleep disturbances can become difficult to treat.

Sleep disturbances can lead to poor physical and psychological health, poor quality of life, and impaired social relations. Further consequences include daytime sleepiness and fatigue, hypertension, diabetes, heart disease, dementia, stroke, migraines, and impaired cognitive functioning including poor concentration and memory, and suicidal ideation (Morgan et al., 2015; Nadorff et al., 2011; Roth & Ancoli-Israel, 1999; Simon et al., 1997; Uchmanowicz et al., 2019).

Despite the prevalence and negative consequences of sleep disturbances, the literature exploring the impact of wildfires on mental health has focused on mental health outcomes such as substance use, depression, anxiety, and PTSD (Fergusson et al., 2014; Goldmann & Galea, 2014; Laugharne et al., 2011). Sleep has been overlooked despite evidence showing that persistent sleep disturbances are a risk factor for the development of psychopathology following trauma (Babson & Feldner, 2010).

Furthermore, the terminology used in the literature describing sleep disturbances varies with terms such as sleep loss, sleep disturbances, and sleep deprivation all used to describe insomnia (Babson & Feldner, 2010). This creates a host of problems such as, lack of clarity in defining sleep disturbances and confusion about precision in relation to sleep disturbance estimates.

The aim of this review was to synthesise the literature and explore the prevalence of sleep disturbances in wildfire survivors in the general public. In doing so, this review provides information that is essential for appropriate planning for health care needs (Ward, 2013). Furthermore, detecting the prevalence of health conditions/sleep is important in revealing potential causes of the condition and uncovering the burden in relation to life expectancy, quality of life, morbidity, and other factors (Noordzij et al., 2010). Learning more about sleep disturbances in those exposed to traumatic events such as wildfires may inform policy makers navigating where investments in health care

should be targeted, such as the provision and timing of treatments (Siegel et al., 2004). Subsequently, this may reduce both the burden of sleep disturbances and the subsequent development of serious psychopathology in communities (Babson & Feldner, 2010; Colvonen et al., 2018).

2.3 Method

2.3.1 Protocol and Registration

Utilising the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, Berlin, Germany) we conducted a systematic review to synthesise empirical findings on the topic of wildfires and the prevalence of sleep disturbances in the general community (Liberati et al., 2009). A protocol for this systematic review was registered on PROSPERO on the 17 February 2021, CRD42021231659 (Isaac et al., 2021)

2.3.2 Search Strategy

Our search strategy was formulated following the PICO principle (population, intervention, comparison, outcome) (Methley et al., 2014). We searched EBSCO, PsychINFO, Medline, SpringerLink, CINAHL Complete, EMBASE, PubMed, Scopus and Cochrane Library between January 2021 and March 2021. In addition, Google Scholar and the reference lists of publications were also utilised. Table 2.1 shows the combination of search terms that were used to search the various databases. Search terms were specified prior to starting the search. The same search terms were used across all databases to optimise findings, with the exception of Scopus and SpringerLink databases (for which no results were obtained using the pre-determined search terms) and as such, search terms were modified but retained key terms (such as wildfires and sleep) across all search variations.

Table 2.1

Keywords and Databases Searches

Database	Keywords
EBSCO, PsychINFO, Medline, CINHAL Complete, EMBASE, PubMed, Cochrane Library	(sleep-wake disorder* OR insomnia OR insomniac OR delayed sleep phase disorder* OR sleep apnea OR sleep apnoea OR parasomnia sleep deprivation OR sleep paralysis OR night sweats OR REM sleep disorder* OR excessive sleep OR sleep walking OR hypersomnia OR circadian rhythm sleep disorder OR narcolepsy OR RLS OR restless leg syndrome OR REM sleep behaviour disorder* OR REM sleep behavior disorder* OR night terrors OR bruxism OR sleep movement disorder* OR sleep related breathing disorder* OR sleep onset OR sleep maintenance OR non-24-hour sleep wake disorder OR nightmare OR nightmares) AND (bushfires OR wildfires OR wildland fires OR forest fires OR brushfires)
Scopus	((bushfires OR wildfires OR wildland fires AND fires OR brushfires) AND (sleep AND disorders OR insomnia OR nightmares))
SpringerLink	Bushfires AND wildfires AND sleep disorders AND sleep difficulties AND PTSD

2.3.3 Inclusion Criteria

Literature published in English between January 1990 and March 2021 exploring the impact of wildfires on sleep was included. We decided to include children as well as adults in this systematic review. For our final analysis we only considered peer-reviewed articles.

2.3.4 Exclusion Criteria

Excluded studies were: (1) statements; (2) commentaries; (3) studies unrelated to wildfires; (4) studies excluding sleep disturbances; (5) animal studies; (6) published prior

to 1990; (7) not peer reviewed; (8) concerned with firefighters or emergency workers; and (9) studies published in a language other than English.

2.3.5 Study Selection

Initial assessment and screening of the title and abstract were performed by one reviewer (FI), and those deemed suitable, were then screened for a full text assessment. Reported data and background information for each study were extracted and summarised consistent with the PICO method. Upon the selection of final articles, data were checked by a second reviewer (GK). There was a 100% inter-rater agreement between the reviewers (FI and GK).

2.3.6 Quality Assessment

A risk of bias was performed utilising the Joanna Briggs Institute Critical Appraisal Checklist for studies reporting prevalence data (JBI) (Munn et al., 2015).

2.4 Results

A total of 314 studies were identified for screening by title and inclusion criteria. Following the exclusion of 53 duplicates, a total of 194 studies were further screened by title and abstract and were excluded for not meeting the inclusion criteria. Most of these articles did not address the prevalence of sleep disturbances, were not peer reviewed, fires were not due to natural disasters, and the study sample did not include the general public. Following this, 67 studies were screened by abstract and full article, of which, a further 61 were excluded leaving six studies. One additional study was located by checking reference lists and Google Scholar search. A total of seven studies met the inclusion criteria. However, two studies were excluded following correspondence with the authors in May 2021 (Krakow, 2002), due to data overlap in two different papers (Psarros et al., 2015). Five studies met the inclusion criteria, for which there was 100% inter-rater agreement (see Figure 2.1).

Figure 2.1

PRISMA Flow Diagram of the Databases Search and Selection of Final Studies

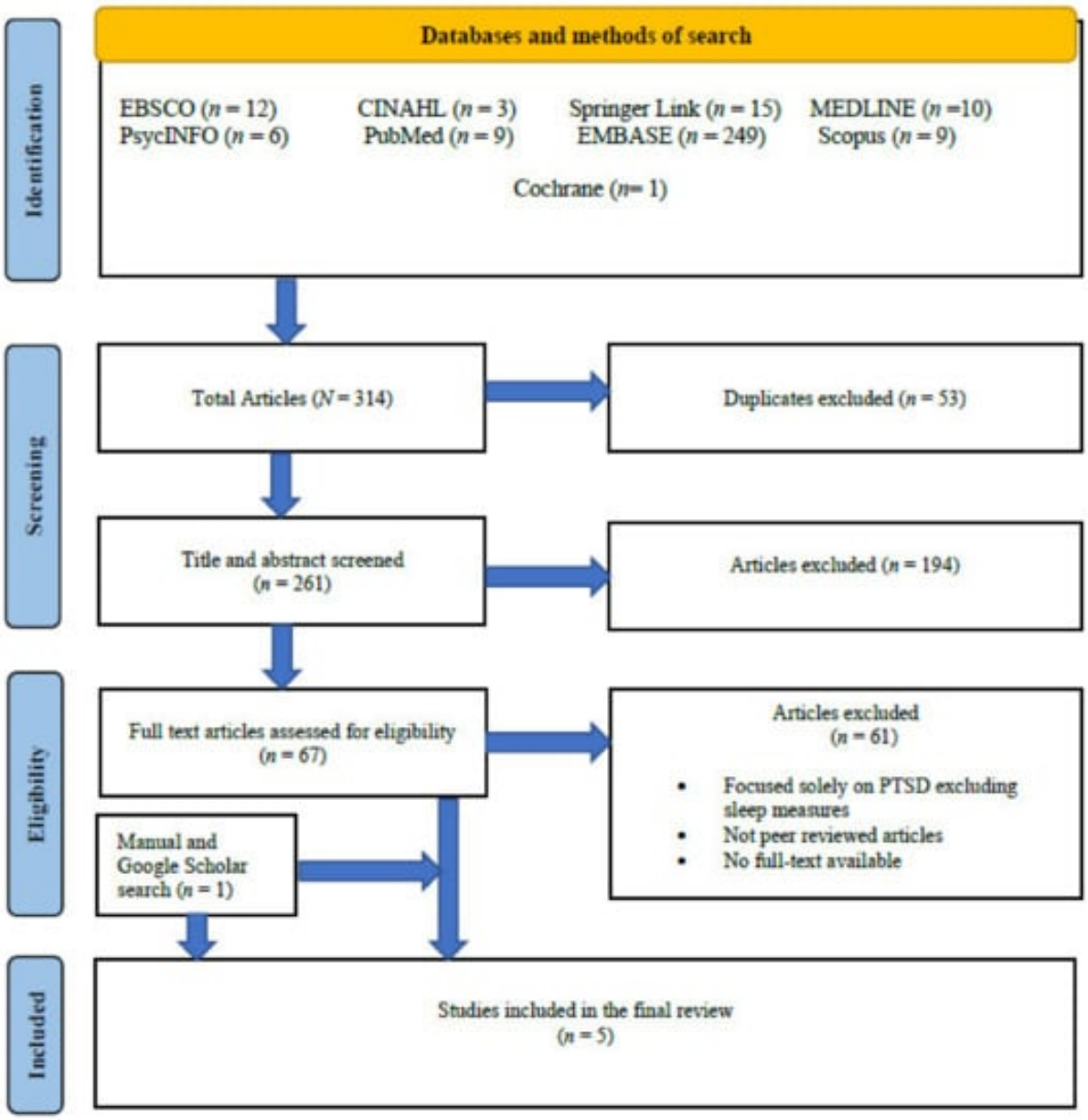

Table 2.2 provides a summary of the selected studies, published between 1990–2021, and includes the country of origin, timeline of sleep disturbance assessments following fires, how sleep disturbances were measured, and prevalence data of sleep disturbances. Further information was provided upon request via email correspondence with Dr Mishra Jyoti on the 12th of April 2021. Table 2.3 provides a detailed account of the risk of bias appraisal utilising the Joanna Briggs Institute JBI Checklist (Munn et al., 2015).

Table 2.2

Summary of Studies Published Between 1990 and 2021 Examining the Impact of Bushfires on Sleep Quality in Bushfire Survivors

Authors	Country	Period Following the Fires	Sample Size	Measures of Sleep	Summary of Findings
Belleville et al., 2019	Canada	Three months after the 2016 wildfires in Fort McMurray	379 adult evacuees (subsample of 55 adults completed diagnostic interview)	CAPS #E6 ISI PSQI-A PSQI	60% of the sample had a provisional diagnosis of PTSD. Repeated disturbing memories were reported by 77.4% [95% CI: 72.90–81.35] of their sample, 76.7% [95% CI: 72.13–80.65] reported feeling upset when reminded of the stressful experience and 72.5% [95% CI: 67.78–76.75] reported trouble falling or staying asleep. In a subsample of 55 individuals, 29.1% [95% CI: 18.77–42.14] met the clinical criteria for PTSD with 43.6% [95% CI: 31.38–56.73] of the sample receiving diagnosis of insomnia.
Jones et al., 2002	USA	Six weeks following the 1990 Wildfires Southern California	13 children in the High Loss group HL (M = 9.1 years) 9 children in the Low Loss group LL (M = 9.8 years)	Items derived from the Diagnostic Interview for Children and Adolescents	The measure of PTSD showed the following: item, “dreaming about it repeatedly” (HL 46.2% VS 33.3%LL). Item, “I had trouble falling asleep/staying asleep” (HL 69.2% VS 33.3% LL). Impact of Event Scale (IES) was administered a month following the first measurement. The two groups reported the following: item, I “had trouble falling asleep or staying asleep because of a picture or a thought about it that came into my mind” (HL 84.6% VS 44.4% LL). Item, “I had a dream about it” (HL 53.8% vs. 55.6% LL).

Krakow et al., 2004	New Mexico	Six to ten months following the 2000 Cerro Grande Fire	78 adult survivors of the fire	SMH SDBDC Autoset Portable II DDNSI FOSQ global ISI	Most participants, 98.7%, had psychophysiological insomnia, 94.8% of participants had presumptive sleep disordered breathing and 33.3% had chronic nightmare disorder. The insomnia symptoms were in the moderate to severe range. Sleep quality was rated fair to poor by those who suffered from insomnia. 92% of the sample reported morning dry mouth, morning headache. Nocturia was reported by 86% of the sample. Dry mouth upon awakening was reported by 51%. Morning headache was reported by 29%. Obstructive sleep apnoea was reported by 41% and 54% reported predominantly upper airway resistance 31% of the sample presented with classic snoring and obstructive sleep apnoea, and 69% presented with atypical symptom.
Psarros et al., 2017	Greece	One month following the fires of August 2007	92 adult survivors of the fires	AIS	63.0% [95% CI: 53.0–73.1%] of the sample reported symptoms of insomnia, with 57.6% of the sample reported awakenings during the night followed by 34.8% of the sample reporting delayed sleep induction Nightmares were found to be significantly different, $p = 0.002$, between those with PTSD 46.5% and those without PTSD 12.3%.
Silveira et al., 2021	USA	Six months post the 2018 Camp fire California	725 adult residents affected by the fires	PROMIS	Scores on the PCL-5 Post-Traumatic Stress Disorder were significantly higher in directly exposed individuals ($n = 124$ not exposed, $n = 201$ indirectly exposed, $n = 147$ directly exposed) with B regression weight reported to be (−3.88, 1.95 and 9.54, respectively) PTSD/PCL-5 scores were positively correlated with childhood trauma. Directly Exposes Sleep Quality (PROMIS) < indirectly Exposed < Nonexposed ($p < 0.001$) Higher sleep disturbance (PROMIS) scores predicted higher PCL-5 scores.

Note. AIS = The Athens Insomnia Scale; CAPS: The Clinician Administered PTSD Scale; DDNSI = Disturbing Dream and Nightmare Severity Index; FOSQ global = Functional Outcomes of Sleep Questionnaire; ISI = Insomnia Severity Index; PCL-5 = PTSD-Checklist; PROMIS = Patient-Reported Outcomes Measurement Information System Sleep disturbance scale; PSQI-A = The Pittsburgh Sleep Quality Index and its Addendum for PTSD; PSQI = Pittsburgh Sleep Quality Index; PTSD = Post Traumatic Stress Disorder; SDBDC = Sleep-Disordered Breathing Diagnostic Criteria; SMH = Sleep Medicine History.

Table 2.3

Risk of Bias Appraisal

JBI Checklist Appraisal Tool	Included Studies				
	Belleville et al., 2019	Jones et al., 2002	Krakow et al., 2004	Psarros et al., 2017	Silveira et al., 2021
Was the sample frame appropriate to address the target population?	Yes	Yes	Yes	Yes	Yes
Were study participants sampled in an appropriate way?	Yes	Yes	Yes	Yes	Yes
Was the sample size adequate?	Yes	No	Yes	Yes	Yes
Were the study subjects and the setting described in detail?	Yes	Yes	Yes	Yes	Yes
Was the data analysis conducted with sufficient coverage of the identified sample?	Yes	Yes	Yes	Yes	Yes
Were valid methods used for the identification of the condition?	Yes	No	Yes	Yes	No
Was the condition measured in a standard, reliable way for all participants?	Yes	No	Yes	Unclear	Yes
Was there appropriate statistical analysis?	Yes	Yes	Yes	Yes	Yes
Was the response rate adequate, and if not, was the low response rate managed appropriately?	Yes	Yes	Yes	Yes	Yes

2.4.1 Findings from the Included Studies

2.4.1.1 Prevalence of Sleep Disorders

Two studies provided prevalence data derived from clinical diagnosis of sleep disturbances. Clinical diagnosis entails a health professional undertaking a clinical interview with participants to establish diagnosis of sleep disorders. Following a clinical interview, insomnia rates ranged from approximately 43.6% to 98.7%, followed by presumptive sleep disordered breathing and chronic nightmare disorders (Belleville et al., 2019; Krakow et al., 2004). Both studies utilised highly reliable and valid measures to diagnose insomnia such as: The Clinician Administered PTSD Scale (CAPS #E6) (Blake, 1995), The Sleep Medicine History (Krakow et al., 2001), and Sleep-Disordered Breathing Diagnostic Criteria (Quan et al., 1999). The difference in prevalence between the two studies is perhaps attributable to the design of the two studies. The sample in

Krakow et al.'s (2004) study targeted participants with sleep complaints seeking treatment for post-traumatic sleep disturbances, whereas Belleville et al.'s study surveyed community members affected by the 2016 fires in Fort McMurray and assessed psychological and sleep disturbances following the fires (Belleville et al., 2019). Whilst, the sample selected by Krakow et al. (2004) is self-identified as being symptomatic hence participants were seeking treatment for their sleep disorders following the fires, the sample in Belleville and colleagues (2019) was randomly selected, by research assistants, from the community following the fires. One can argue that both samples are susceptible to selection bias, however the sample in Belleville et al.'s study seem to be more representative of the prevalence of sleep disorders in a community sample following the fires (Belleville et al., 2019).

Studies adopting a non-diagnostic approach, sleep disturbances were assessed using self-report scales or questionnaires, reported insomnia prevalence between 63% and 72.5% (Belleville et al., 2019; Psarros et al., 2017). These two studies utilised highly reliable and valid measures in the assessment of sleep disturbances such as, the Insomnia Severity Index ISI, the Athens Insomnia Scale ASI, The Pittsburgh Sleep Quality Index and its Addendum PSQI-A, and the Pittsburgh Sleep Quality Index PSQI (Bastien, 2001; Buysse et al., 1989, 2006; Germain et al., 2005; Soldatos et al., 2000). As highlighted in the assessment of risk of bias, all three studies providing prevalence data used valid and reliable measures to assess sleep disturbances (Table 2.3) (Belleville et al., 2019; Krakow et al., 2004; Psarros et al., 2017).

2.4.1.2 Prevalence of Sleep Disturbances in Children

One study in this systematic review provided prevalence of sleep disturbances in children. Jones et al. (2002) assessed 22 children following the 1990 wildfires in South

California. The researchers assessed the sample at six weeks and at ten weeks following the fires, and divided the participants into two group; children with high loss defined as those whose families sustained significant damage or loss to their homes, and children with low loss whose families sustained relatively little loss to their homes. Results revealed that at six weeks assessment, children who experienced high loss had higher rates of recurrent dreams about the fires and symptom of insomnia (46.2% and 69.2%, respectively), than those who were identified as low loss children (33.3% for both recurrent dreams and insomnia). At ten weeks, the high loss group also scored higher on insomnia (84.6%) and on recurrent dreams (53.8%), than children in the low loss group on insomnia (44.4%) and on recurrent dreams (55.6%) (Jones et al., 2002).

2.4.1.3 Most Prevalent Sleep Disturbances

In this systematic review, insomnia was found to be the most prevalent sleep disturbance (Belleville et al., 2019; Jones et al., 2002; Krakow et al., 2004; Psarros et al., 2017), followed by nightmares ranging between 33.3% and 46.5% (Krakow et al., 2004; Psarros et al., 2017, 2018). Only one study provided data on other sleep disorders such as sleep disordered breathing (94.8%) and sleep apnoea (41%) of the sample (Krakow et al., 2004).

2.4.1.4 Prevalence of Sleep Disturbances and PTSD

Four studies identified a significant correlation between sleep disturbances and post-traumatic stress symptoms or PTSD. Insomnia was present in 79.1% of those diagnosed with PTSD; likewise, nightmares were more prevalent in those with PTSD compared to those without PTSD (46.5% versus 12.3%, respectively) $p = 0.002$ (Psarros et al., 2017). Insomnia, nightmare severity, and impairment of sleep-disordered breathing were significantly correlated with post-traumatic symptoms of hyperarousal and intrusion ($p <$

0.001) (Krakow et al., 2004). Belleville and colleagues (2019) also found that sleep disturbances, sleep quality and insomnia were significantly associated with PTSD three months post-fires ($p < 0.01$). Furthermore, higher levels of sleep disturbances on the Patient-Reported Outcomes Measurement Information System (PROMIS) were associated with higher scores on the PTSD-Checklist (PCL-5, Blevins et al., 2015; Silveira et al., 2021).

2.4.1.5 Proximity to Fires, Gender, Age and Sleep Disturbances

Overall, studies in this systematic review indicated that sleep disturbances can be reactive to the experience of individuals and their proximity to fires. Sleep quality was significantly worse for those who were directly exposed to fires than for those who were indirectly exposed or who only heard about the fires, $p < 0.001$ (Silveira et al., 2021). Furthermore, scores on the PTSD-Checklist (PCL-5) (Blevins et al., 2015) were significantly higher for the directly exposed group than the indirectly affected group (Silveira et al., 2021). Similarly, insomnia was significantly more prevalent in participants who reported being in danger during the fires and those scoring higher on the "fear of imminent death" scale, $p = 0.005$ (Psarros et al., 2017). Additionally, children who experienced high personal loss experienced more difficulties in falling asleep than those who reported low loss (84.6% and 44.4%, respectively) (Jones et al., 2002). This suggests that those who had a more confronting experience with fires, showed more severe symptoms of PTSD and reported worse sleep quality than those that were indirectly affected by the fires. Further to that, one study (Psarros et al., 2017) examined the association of demographic factors and sleep disturbances; it was found that being a female and being older had 3.16 times and 1.04 times greater likelihood for having

insomnia. Other studies in this systematic review either did not explore such association or found no association between demographic factors and sleep disturbances.

2.4.1.6 Timing of Sleep Disturbance Assessment Relative to Fire Occurrence

The studies reviewed assessed sleep disturbances at different time points following the fires, ranging from one month following the fires (Psarros et al., 2017) to ten months post-fires (Krakow et al., 2004). The studies are cross sectionally designed as such they provide limited understanding about how sleep changes overtime post-fires. Future longitudinal studies could provide evidence of how prevalence of sleep disturbances change overtime.

2.5 Discussion

The aim of this systematic review was to explore the prevalence of sleep disturbances in the general public affected by wildfires. Only five studies met the inclusion criteria. The review found that there was a wide variation in the prevalence of sleep disturbances amongst wildfire survivors. The prevalence of sleep disturbances for insomnia diagnosed by a clinician was found to be 43.6% in the general public. This rate was higher (i.e., 72.5%) for insomnia in non-clinical samples using self-report measures (Belleville et al., 2019; Krakow et al., 2004; Psarros et al., 2017). The reported prevalence of 72.5% in this review, in a non-clinical sample, is higher than the rate reported by Jang and colleagues in their sample of firefighters (N = 9810, 50.9%) (Jang et al., 2020), and higher than that reported in the general population of 30% (Ancoli-Israel, 1999; Sateia et al., 2000). The rate of prevalence in this review is also higher than those reported in other natural disasters. For example, in a community sample of 2593, 14 months following the Japan earthquake and tsunami in 2011, Matsumoto and colleagues found that sleep disturbances were reported by 15% of their sample (Matsumoto et al., 2015). The

difference between the prevalence rates reported here and those reported by other researchers may be attributed to differences in methodologies used to measure sleep and the definition of sleep disturbances (Babson & Feldner, 2010; Matsumoto et al., 2015).

Findings from this systematic review provided prevalence of insomnia and recurrent dream symptoms in children. Results from this study showed an increase in symptoms of insomnia and recurrent dreams about the fires at both six-and ten-weeks assessments following the fires for the high loss children compared to the low loss group (Jones et al., 2002). These findings are consistent with those of past research that has reported similar findings in children exposed to natural disasters. Lai et al. (2020) examined sleep in 269 children following Hurricane Ike in 2008, at 8 months and 15 months post-disaster. Sleep problems persisted from time 1 at (8 months) to time 2 at (15 months) measurement; with children reporting difficulties in falling asleep (49% at both measurements), difficulties maintaining sleep (42% to 39%) and sleeping more than usual (45% to 43%) (Lai et al., 2020). This shows that sleep problems in children persist and may also increase over time following the trauma of a natural disaster (Jones et al., 2002; Lai et al., 2020).

The prevalence of nightmares ranged between 33.3% and 46.5%, and were found to be the second most prevalent sleep disturbance in wildfire survivors in this review (Krakow et al., 2004; Psarros et al., 2017). Research exploring other types of traumas also reported high prevalence rates of nightmare in veterans with and without sexual trauma and in adults with PTSD (Jenkins et al., 2015; Milanak et al., 2019; Neylan et al., 1998; Ohayon & Shapiro, 2000; Plumb et al., 2014; Williams et al., 2015). It is difficult to compare prevalence rates emerging from this systematic review with findings from other research studies. Research indicates that the prevalence of nightmares and their severity is governed and is likely dictated by the type of trauma individuals experience. For instance, in a study of 4440 children and youth aged between 7–18 years old, Secrist and

colleagues assessed the prevalence of nightmares and their relationship with the type of experienced trauma (Secrist et al., 2020). Nightmares were deemed to be "clinically significant" if they were experienced twice or more per week. The researchers found that 33.1% of this sample reported "clinically significant" nightmares. Moreover, of those who experienced sexual abuse, 21.1% were more likely to experience "clinically significant" nightmares; and of those who experienced medical trauma, 10.2% were least likely to experience "clinically significant" nightmares. Other types of traumas such as community violence, domestic violence, physical abuse, natural disasters, and death trauma showed different associations with nightmares and their severity. Participants were 1.3 times more likely to report experiencing "clinically significant" nightmares for every additional encountered trauma (Secrist et al., 2020). This suggests that not only the type of trauma that is endured by individuals but also cumulative trauma that someone may experience is likely to increase the prevalence of sleep disturbances.

The study by Silveria and associates reported that cumulative trauma (i.e., childhood trauma) significantly increased the risk of sleep disturbances and predicted poorer sleep quality in wildfire survivors (Silveira et al., 2021). Moreover, in their review of studies published in 2018, Lowe and colleagues examined the impact of disasters on PTSD and other mental health conditions following the occurrence of natural disasters (Lowe et al., 2019). The researchers stated that cumulative trauma can increase the risk of poor outcomes on mental health in a dose–response fashion. Furthermore, the lack of social support and community belonging moderated the relationship between trauma and sleep disorders (Lowe et al., 2019). Notably, a recent study confirmed the importance of social interaction and how this has changed as a result of COVID-19 compromising mental health conditions such as depression and anxiety (Arjmand et al., 2021). This is reflective of the impact of collective trauma, referred to earlier in this review (Hirschberger, 2018).

This calls for the need to cater for such variables when exploring the association between wildfire trauma and sleep disturbances.

Findings from this systematic review also highlighted the high prevalence of sleep disturbances in those with post-traumatic stress symptoms and/or PTSD. More specifically, findings derived from this review indicate a higher prevalence of both insomnia and nightmares, 79.1% and 46.5%, respectively, in those with PTSD or post-traumatic stress symptomatology compared to those without PTSD (Belleville et al., 2019; Krakow et al., 2004; Psarros et al., 2017; Silveira et al., 2021). A wealth of literature supports this significant association and suggests a bi-directionality between the two conditions (Babson & Feldner, 2010; Kartal et al., 2021; Ohayon & Shapiro, 2000). Despite this, leaders in sleep research now affirm that sleep disturbances are stand-alone disorders and they deserve exclusive attention regardless of whether they were initiated by other health conditions (Colvonen et al., 2020; Edinger et al., 2021). The inclusion of sleep disturbances being a hallmark in the diagnosis of PTSD (Germain et al., 2007) may inflate the reported prevalence of sleep disturbances in this population (Babson & Feldner, 2010; Breslau et al., 2004). To illustrate, Breslau and colleagues (2004) carried out a 10-year follow up research on a community subsample (n = 292). At baseline, participants did not meet PTSD diagnosis. Between 1994 and 1999, 25% of participants who were exposed to trauma developed PTSD. In those diagnosed with PTSD, 87% of the sample reported sleep disturbances (indexed using self-report measures). However, when objective measures of sleep such as polysomnography was implemented, no significant differences were detected between those with and without PTSD in either sleep initiation or sleep maintenance (Breslau et al., 2004). This is perhaps indicative of the need to consider both objective and self-report measures when assessing sleep disturbances to gain a complete and an accurate presentation of sleep disturbances.

Another factor for consideration when examining sleep disturbances in wildfire survivors is proximity to, and experience with fires. Two studies in this review provided data on the importance of assessing how proximity, in both children and adults, and the experience with fires can impact sleep disturbances with those directly exposed to fires experiencing higher prevalence of sleep disturbances and poorer sleep quality than those non-directly exposed (Jones et al., 2002; Silveira et al., 2021). Research on other types of disasters confirm such association. Tempesta et al. (2013) assessed sleep quality of 4993 residents, two years following the 2009 L'Aquila earthquake in Italy, utilising subjective sleep quality measures such as the PSQI and PSQI-A. Researchers in this study examined sleep quality of two different subsamples from pre, $n = 754$, to post, $n = 665$, earthquake impact of sleep quality and found a significant decline in sleep quality from pre assessment to post assessment 24 months following the earthquake, $p < 0.001$. They also tested the proximity of other subsamples relative to distance from the epicentre and found that the group, $n = 739$, living within 40 km radius of the disaster showed the highest incidence of disturbed nocturnal behaviour and lowest sleep quality in comparisons to groups living further away $p < 0.001$. Beyond the distance of about 70 km radius, sleep quality scores were found to be within the normal range (Tempesta et al., 2013). Disaster survivors' research suggests that the loss of loved one, injury and property damage, the loss of internal and external resources are the most important factors in predicting mental health and can predict the recovery of individuals (Agyapong et al., 2019; Koopman et al., 1996; Xu et al., 2019).

One study in this systematic review found a significant association between age, gender and sleep disturbances (Psarros et al., 2017). Other studies support this finding, being a female and being older is associated with higher rates of sleep disturbances and

higher likelihood of prolonged sleep difficulties (Matsumoto et al., 2015; Milanak et al., 2019; Ohayon & Shapiro, 2000).

In relation to sleep disturbances and time point of assessments, without longitudinal studies it is difficult to reach a conclusion on how sleep disturbances and their frequency change over time. The selected studies measured sleep disturbances at different intervals ranging from one month to ten months following the fires (Krakow et al., 2004; Psarros et al., 2017). Therefore, the findings from this systematic review are not reflective of how sleep may change overtime following the fires. Other studies carried out on survivors of natural disasters report stability of severity and worsening of symptoms for specific conditions across time in the aftermath of disasters (Geng et al., 2013; Tempesta et al., 2013; Thordardottir et al., 2019). Researchers call for continued need to monitor the symptomology of those affected by disasters and the identification of those who are most vulnerable in the aftermath of a natural disaster; which aids in allocating appropriate resources and treatments to ameliorate the risks associated with sleep disturbances (Bryant et al., 2018; Lowe et al., 2019; Thordardottir et al., 2019).

In interpreting the findings from this systematic review, a number of factors must be considered. Some of the limitations include the small number of studies eligible for inclusion due to the limited research in this area, and the heterogeneity of methodologies and outcome measures which precluded a meta-analysis. Despite these limitations, the findings from this systematic review are novel in the field of wildfires and sleep, and highlight the high prevalence and the severity of sleep disturbances in wildfire survivors.

2.5.1 Conclusions

Wildfires pose a serious risk of injury to humans, both directly by causing physical or psychological injury, and/or indirectly by exposing people to the trauma of losing lives, death of relatives, neighbours, financial hardship and breaking the social ties with

others (Agyapong et al., 2019; Berry et al., 2010; Lowe et al., 2019). This systematic review highlighted the high prevalence of sleep disturbances among wildfire survivors, the significant association of sleep disturbances and post-traumatic symptomology, the importance of the need to cater for the type, the magnitude and proximity to trauma and its impact on sleep disturbances. The area of wildfires and sleep disturbances needs further refinement to establish a more comprehensive system for measuring sleep disturbances in wildfire survivors.

Author Contributions

Conceptualization, F.I., and G.A.K.; methodology, F.I. and G.A.K.; validation, F.I., G.A.K. and S.R.T.; formal analysis, F.I. and G.A.K. data curation, F.I.; writing—original draft preparation, F.I., G.A.K., S.R.T. and M.D.B.; writing—review and editing, F.I., G.A.K., S.R.T. and M.D.B.; visualization, F.I., G.A.K., S.R.T., M.D.B.; supervision, G.A.K., S.R.T. and M.D.B.; project administration, F.I.; funding acquisition, F.I. All authors have read and agreed to the published version of the manuscript.

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This study did not require ethical approval.

Informed Consent Statement

Not applicable

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Conflicts of Interest

The authors declare no conflict of interest.

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Foreword to Chapter 3

The previous chapter provided a systematic review indicating that insomnia and nightmares are prevalent among wildfire survivors. However, only five studies were included in the systematic review, highlighting a significant gap in the literature. To address this, an international survey was conducted to assess the prevalence of insomnia, nightmares, and trauma symptoms among wildfire survivors from Australia, Canada, and the United States of America over the past decade. This chapter aimed to fill the research gap by gathering data on the prevalence of these conditions and examining if trauma-related factors such as fear for life, fear for life of others, fear for loss of property, fear of death, and smoke resulted from the fires predicted sleep difficulties.

Chapter 3: Prevalence and Predictors of Sleep and Trauma Symptoms in Wildfire Survivors

The content of Chapter 3 is identical to my earlier publication "Isaac, F., Toukhsati, S. R., Klein, B., Di Benedetto, D., & Kennedy, G. (2023). Prevalence and predictors of sleep and trauma symptoms in wildfire survivors. *Journal of Sleep Epidemiology*, *3*, 100052. https://doi.org/10.1016/j.sleepe.2022.100052", except for citation style changes to match this thesis's convention. The reproduction of this chapter's content is permitted under the journal's copyright agreement, which allows authors to reuse their work for non-commercial purposes. Permission has been granted (refer to Appendix F).

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3.1 Abstract

Objective: This study aimed to establish the prevalence and to identify predictors of insomnia, nightmares and post-traumatic stress disorder (PTSD) in wildfire survivors.

Method: A total of 126 (23 males, 102 females, and 1 nonbinary individual, *M* age = 52 years, *SD* = 14.4) wildfire survivors from Australia, Canada and the USA took part in an online survey. Participants completed a demographic questionnaire and self-report measures including: The Insomnia Severity Index (ISI), PTSD Checklist for DSM-5 (PCL-5), and Disturbing Dream and Nightmare Severity Index (DDNSI).

Results: Results showed that 49.2% of the sample reported clinical insomnia on the ISI; 28.7% reported nightmares on the DDNSI, and 77.88% reported PTSD symptoms on the PCL-5. Fear for life of others (Pearson's r = .40, .21, .31), and the impact of smoke (Pearson's r, .47, .25, .41) significantly correlated with insomnia, nightmares and PTSD symptoms, respectively. Hierarchical regression showed that smoke was a significant predictor of insomnia (β = .17, p <.05, 95% CI, .15 – 1.49), and insomnia predicted both of PTSD (β = .27, p <.05, 95% CI, .26 – 1.05), and nightmares (β = .19, p = .04, 95% CI, 1.01 – 1.45) scores.

Conclusion: Insomnia, nightmares and PTSD are highly prevalent in wildfire survivors. Smoke, one of the trauma-related factors, was found to be as a significant predictor of insomnia; and insomnia was a significant predictor of both PTSD and nightmares. Future longitudinal studies are needed to establish which disorder emerges first as a result of smoke.

3.2 Introduction

Climate change has set the stage for increased frequency and severity of various natural disasters including floods and fires. Particularly, the rise in global temperature and resulting droughts has contributed to the increase in wildfires, leading to a global crisis (Hess, 2020). Wildfires have been predicted to increase by 57% by the end of this century (Zhong, 2022), as they are now impacting many parts of the world that were previously immune to their destructive nature, including parts of Russia, the Amazon and even the Arctic region (Hess, 2020; UN Environment Programme, 2022). Parts of Australia, Canada and the United States of America (USA), are prone to wildfires and climate change has further increased their vulnerability (Abatzoglou & Williams, 2016; Gillett et al., 2004; Milman, 2013; To et al., 2021).

3.2.1 Repercussions of Wildfires

The repercussions of wildfires extend from financial losses, to human hardship with loss of life and injury, and psychological traumatisation of survivors (To et al., 2021). Many survivors report difficulties initiating sleep, maintaining sleep, waking up too early in the morning with inability to return to sleep, which are typical symptoms of insomnia (American Psychiatric Association (APA), 2013; Belleville et al., 2021). Some survivors report regularly experiencing highly stressful, well remembered dreams that result in awakening from sleep and difficulty returning to sleep which is consistent with nightmare disorder (APA, 2013; Isaac et al., 2021). Survivors may also report constant re-living of the traumatic event, hyperarousal, negative affect symptoms, and avoidance of remembering the traumatic event. This cluster of symptoms is referred to as post-traumatic stress disorder (PTSD, APA, 2013). The co-occurrence of insomnia, nightmares, and PTSD potentially complicate psychological treatment, leading to

increased depression, anxiety, stress, reduced daily functioning, and poor quality of life. Studies show that the presence of sleep disturbances in those who experience trauma, exacerbates and maintains PTSD, and hinders recovery (Babson & Feldner, 2010; Colvonen et al., 2018; Dietch et al., 2021; Nappi et al., 2012).

3.2.2 The Relationship Between Sleep Disturbances and PTSD Symptoms

The literature is inconclusive on whether sleep disturbances lead to the development of PTSD or whether PTSD leads to sleep disturbances. Whilst some researchers suggest a bi-directional relationship between the two (Babson & Feldner, 2010; Weber & Wetter, 2022), experimental animal designs, current theoretical models, and intervention studies suggest that sleep disturbances possibly proceed the development of PTSD (Colvonen et al., 2018; Germain, 2013; Ho et al., 2016; Isaac et al., 2022a; Short et al., 2020; Taranissi et al., 2014; Wright et al., 2011; Youngren et al., 2020). Historically, insomnia and nightmares occurring in the context of PTSD disorder, have always been viewed as symptoms of PTSD disorder rather than independent entities (APA, 2013; Rek et al., 2017). However, with the advances in the field of sleep and trauma, it has been noted that sleep disturbances often precede PTSD and thus should be treated in parallel with trauma symptoms (Colvonen et al., 2018; Germain, 2013).

3.2.3 Prevalence of Sleep Disturbances in Wildfire Survivors

In a systematic review of wildfire studies, Isaac et al. (2021) reported that the prevalence of insomnia ranged between 63.0–72.5%, and nightmares ranged between 33.3–46.5% in wildfire survivors. Even though, Isaac et al.'s study was the first systematic review to assess prevalence of sleep disturbances in wildfire survivors, their review only located five studies, with two studies reporting prevalence of sleep disorders in clinical and paediatric wildfire survivors. There is limited data available on the prevalence of sleep disorders in wildfire survivors and studies have utilised different

methodologies to assess prevalence in this population (Isaac et al., 2021). Examining the prevalence of sleep difficulties in wildfire survivors may provide information to assist government agencies and policy makers to provide appropriate services for wildfire survivors to prevent the development of long-term mental health conditions that complicate treatment and recovery (Isaac et al., 2021).

3.2.4 The Impact of Smoke

The impact of smoke during and after wildfires is one of the variables that has been studied (Bryant et al., 2014; UN Environment Programme, 2022). Most studies of wildfire smoke have focused on examining the impact of smoke on respiratory health, with little attention given to its impact on mental health (Rodney et al., 2021). Smoke from wildfires can travel thousands of kilometres affecting not only those in close proximity but also those who are far away (Buis, 2021). Smoke is also known to negatively affect sleep and is associated with insomnia and nightmares (Rodney et al., 2021). The UN Environment programme (2022) suggests that smoke from wildfires negatively affects the health of hundreds of thousands of people and is responsible for 33,000 deaths annually.

3.2.5 Other Wildfire Trauma-Related Variables

Other wildfire trauma-related outcomes include fear for life, loss of loved ones to fires, loss of property, and imminence of death during the fires (Bryant et al., 2018; Psarros et al., 2017). Bryant and colleagues (2014) found that communities highly affected by the 2009 Black Saturday fires in Australia (in terms of lives lost and property destruction) were significantly more likely to report more major life stressors, fearing for their lives, and having lost someone in the fires in comparison to medium and low impacted communities. Furthermore, significantly higher rates of PTSD were observed in highly affected communities (15.6%) in comparison with communities where affects

were medium (7.2%), or low (1%) (95% CI: 2.61–8.00). Gender, death of loved ones, low education, fear for life, loss of property, and subsequent major life stressors were all significant predictors of PTSD resulting from bushfires (Bryant et al., 2014).

To et al. (2021) reviewed 63 studies and found that witnessing of wildfires, fear for personal and others' life and safety, loss of a loved one, lack of support from family and friends following the fires, and subsequent ongoing trauma increased the risk of developing PTSD following wildfires. Other studies reported that some of the factors that predicted PTSD symptoms in those affected by bushfires were, being female, prior mental health conditions, prior traumatic experiences, lower education, being evacuated, and feeling very distressed during the fire disaster (Bryant et al., 2014; Parslow et al., 2006). One study by Psarros and colleagues (2017) found that scores on imminence of death significantly predicted insomnia scores following wildfires. The studies by Bryant et al. (2014), Parslow et al. (2006), and To et al. (2021) focused mainly on the influence of wildfire trauma-related variables on the development of and/or the severity of PTSD. It is not well understood whether the relationship between wildfire trauma-related factors and the severity of PTSD is simply a direct relationship or whether it is mediated by sleep difficulties such as insomnia and nightmares (Babson & Feldner, 2010).

In summary, there are limited empirical data in relation to the prevalence of sleep disorders in wildfire survivors (Isaac et al., 2021). Gaining such knowledge will provide an understanding of resources and interventions needed to aid wildfire survivors (Krakow et al., 2004). Better understanding of sleep disturbances and trauma symptoms may indicate how early those symptoms emerge following the fires, thus allowing for better and timely interventions to prevent the development of more severe mental health issues. The available studies have mainly explored the influence of wildfire trauma-related factors on PTSD, but have not examined the influence of trauma-related factors on sleep

difficulties including insomnia and nightmares. While, the effect of smoke has been researched in terms of its impact on respiratory health (Rodney et al., 2021), its influence on mental health, including sleep, has been overlooked. Exploring and understanding how different trauma-related and post-trauma related variables affect insomnia, nightmares and PTSD can clarify the contribution of each variable on each health condition following the experience of wildfires (Rodney et al., 2021).

3.2.6 Aims of the Study

The aims of this study were to explore the prevalence of sleep and trauma symptoms in wildfire survivors and to identify wildfire trauma-related variables that predict the development of sleep and trauma symptoms. It was hypothesised that: the prevalence of insomnia, nightmares and trauma symptoms in wildfire survivors would be significantly higher than that reported in a representative sample of college students; wildfire survivors who have experienced more severe trauma-related factors such as greater losses (e.g., personal injury, loss of property, people, and animals), experienced more imminence of death, were more severely impacted by smoke, and experienced more fear for the loss of lives (e.g., fear for loss of own life and life of others) would exhibit more severe insomnia, nightmares, and PTSD symptoms than those experiencing fewer trauma-related factors; and the number of losses, the impact of smoke on health, and fear for loss of lives due to the experience of wildfires, would significantly predict scores for insomnia, nightmares, and PTSD symptoms.

3.3 Method

3.3.1 Participants

One hundred and twenty-six wildfire survivors from Australia, Canada and USA completed an online survey. The sample comprised 23 men (18.3%), 102 women (81%),

and one nonbinary (0.8%). Participants' ages ranged from 20 to 92 years (*M* age = 52 years, *SD* = 14.4). Table 3.1 shows the characteristics of the sample (*N* =126).

Table 3.1

Demographic Characteristics of the Sample

Demographic Variables	(*n*)%
Country of Residence	
Australia	44(34.9%)
Canada	27(21.4%)
USA	55(43.7%)
Education (*n* = 125)	
Primary school	1(0.8%)
High school	23(18.4%)
Certificate/diploma	42(33.6%)
Bachelor degree	37(29.6%)
Postgraduate degree	22(17.6%)
Income (*n* = 123)	
$0 income	1(0.8)
$1 to $20,799 per year	21(17.1%)
$20,800 to $41,599 per year	25(20.3%)
$41,600 to $77,999 per year	31(25.2%)
$78,000 to 155,999 per year	34(27.6%)
$156,000 or more per year	11(8.9%)
Employment (*n* = 125)	
Student	2(1.6%)
Employed	69(55.2%)
Unemployed	11(8.8%)
Looking for work	5(4.0%)
Retired	38(30.4%)
Marital Status (*N* = 126)	
Single	24(19%)
Separated/divorced	13(10.3%)
Widowed	7(5.6%)
Married	82(65.1%)

3.3.2 Measures

Demographic Questionnaire: Participants were asked to provide information about age, sex, employment, education, marital status, country of residence, country of birth, experience with fires, evacuation experience, COVID-19 impact on mental health and sleep, medical history, history of mental health diagnosis prior to the experience of fires, and fear related to fires.

***Additional Trauma Questionnaire (Weathers et al., 2013a)*:** Eight items were obtained and adapted, to our survey, from the PCL-5 with Life Event Check List Criterion A (PCL-5 with LEC-5 and Criterion A) for the purpose of collecting data on additional trauma incurred following the fires including, transport accidents, accidents at work, personal assaults, serious illness, sudden loss of a loved one, disruption to accommodations, disruption to work, and disruption to relationships (Weathers et al., 2013a). Participants were required to respond with a yes or a no to each item.

***The Insomnia Severity Index Scale (ISI, Bastien, 2001)*:** The ISI is a 7-item, self-report, scale measuring severity of insomnia. The scale has a good internal consistency with a Cronbach's alpha ranging from $\alpha = .87$ to $\alpha = .92$ (Morin et al., 2011). In the present study Cronbach's alpha was .92, and a cut off score of 14 was used to discriminate between mild and severe symptoms (Gagnon et al., 2013).

Generalized Anxiety Disorder Questionnaire (GAD-7, Spitzer et al., 2006)*:* The GAD-7 is a 7-item, self-report scale that has a good internal consistency with a Cronbach's alpha ranging from $\alpha = .82$ to $\alpha = .93$ at pre and post-treatment (Johnson et al., 2019). In the present study Cronbach's alpha was .95, and a cut-off score of 10 was used to discriminate between mild and severe symptoms (Spitzer et al., 2006).

***The Patient Health Questionnaire (PHQ-9, Kroenke et al., 2001)*:** The scale consists of nine items assessing depression symptoms. In the present study Cronbach's

alpha for the PHQ-9 was .91, and a cut-off score of 10 was used to discriminate between mild and severe symptoms (Kroenke et al., 2001).

***Pittsburgh Sleep Quality Index (PSQI, Buysse et al., 1989)*:** The PSQI is a 19-item questionnaire with an additional five questions rated by a bed partner. The PSQI has a good test-retest reliability with $r = .87$ (Backhaus et al., 2002). In the present study, Cronbach's alpha was .81, and a cut off score of 5 was used to discriminate between mild and severe symptoms (Backhaus et al., 2002).

***PTSD Checklist for DSM-5 Scale (PCL-5, Weathers et al., 2013b)*:** The PCL-5 Checklist – Civilian Version (PCL-5) consists of 17 self-report items that screen for the presence of PTSD symptoms over the last month. The PCL-5 also provides provisional diagnosis of PTSD. The PCL-5 has good psychometric (Krakow, 2006) properties with an internal consistency of ($\alpha = .94$), convergent validity of ($r = .74$ - .85), and test-retest reliability of ($r = .82$) (Blevins et al., 2015). In the present study Cronbach's alpha was.95, and a cut-off score of 33 was used to discriminate between mild and severe symptoms (Bovin et al., 2016).

***Disturbing Dream and Nightmare Severity Index (DDNSI, Krakow et al., 2002)*:** This scale is a five item self-report instrument which assesses severity and frequency of disturbing nightmares and dreams. The DDNSI has demonstrated a good internal consistency (Cronbach's alpha $\alpha = .93$) (Nadorff et al., 2013). In the present study a cut-off score of 10 was used to discriminate between the presence and absence of nightmares (Krakow, 2006).

3.3.3 Procedure

Following approval from (Federation University Human Research Ethics Committee, approval number: A21-124) advertisements about the study including a URL link were posted from October 2021 to March 2022. Participants were eligible to

complete the survey if they were survivors of wildfires (within the last 10 years), 18+ years old, and fluent in English. Participants were recruited via social media sites such as Facebook, Instagram, Reddit, LinkedIn, online community noticeboards, local newspapers, wildfire and interest group sites.

3.3.4 Data Analysis

Descriptive analyses, frequencies, percentages and means and standard deviations were used to summarise the demographic variables and to assess the prevalence of insomnia, nightmares and PTSD symptoms. Inferential statistics were utilised to examine the relationships and differences between study variables. All dependent variables were normally distributed except the DDNSI which was positively skewed.

Prior to conducting multiple regression analyses to examine which variables predicted insomnia, nightmares and trauma symptoms, statistical analyses of normality, homoscedasticity, and linearity for multiple regression were conducted. Multiple linear hierarchical regression and logistic regression analyses were used to assess predictions of insomnia, trauma and nightmare symptoms.

3.4 Results

3.4.1 Prevalence of Sleep and Trauma Symptoms

Frequencies for the DDNSI, ISI, PCL-5, PSQI, GAD-7, PHQ-9, were calculated to assess the prevalence of anxiety, depression insomnia, sleep quality, nightmare and trauma symptoms. Table 3.2 shows means, standard deviations and percentages for the independent variables (n = 126).

Table 3.2

Means, Standard Deviations, Frequencies and Percentages of Sleep, Trauma Symptoms, Sleep Quality, Anxiety and Depression

Variables	*M(SD)*	*n*(%)
DDNSI (*n* = 87)	8.57(7.25)	62(71.3%) No nightmares 25(28.7%) Nightmare disorder
ISI (*N* =126)	13.78(7.05)	25(19.8%) No clinical insomnia 39(31%) subthreshold insomnia 46(36.5%) clinical moderate insomnia 16(12.7%) clinical severe insomnia
PCL-5 (*n* = 104)	46.42(17.02)	23(22.12%) some symptoms of PTSD 31(29.81%) moderate-moderately high severity 50(48.07%) high severity of PTSD symptoms
PSQI (*n* = 116)	9.54(4.34)	22(19%) good sleep quality 94(81%) poor sleep quality
GAD-7 (*n* = 110)	9.89(6.88)	30(27.3%) minimal anxiety 28(25.5%) mild anxiety 16(14.5%) moderate anxiety 36(22.7%) severe anxiety
PHQ-9 (*n* = 124)	10.79(6.72)	28(22.2%) minimal depression 33(26.2%) mild depression 26(20.6%) moderate depression 24(19%) moderately-severe depression 15(11.9%) severe depression.

Almost half of the sample self-reported clinically moderate (36.5%) and severe (12.7%) insomnia symptoms, over half of the sample reported moderate (29.81%) to high (48.07%) severity of PTSD symptoms (indexed using the PCL-5), and nearly 29% of wildfire survivors self-reported nightmare symptoms (DDNSI).

Of the 81 participants (77.88%) who met a PTSD provisional diagnosis (assessed by the PCL-5), 52 (69.3%) also met criteria for clinical insomnia symptoms (assessed by the ISI), and 21 (28%) also met criteria for nightmare disorders (assessed by the DDNSI).

3.4.2 Comparison Between the Study Sample and College Participants

To examine whether sleep and trauma symptoms were higher in the present study to those reported in a representative college sample (N = 583) (Nadorff et al., 2011), a single sample *t-test* was used and showed that the ISI mean score in the present sample (M = 13.78, SD = 7.05) was significantly higher than that reported in Nadorff et al.'s study (M = 8.84, SD = 4.69), t = 7.87, p < .001 (95% CI, 3.70 - 6.18). A single sample *t-test* also showed that the mean for DDNSI in the present sample was significantly higher (M = 8.57, SD = 7.25) than that reported in Nadorff et al.'s study (2011) (M = 3.78, SD = 4.96), t = 6.17, p < .001 (95% CI, 3.25 - 6.34). Similarly, the mean score for the PCL-5 (M = 46.42, SD = 17.02) was significantly higher to that reported in Nadorff et al.'s study (2011) sample (M = 34.30, SD = 11.81), t = 7.27, p <.001 (95% CI, 8.81-15.43).

3.4.3 Relationship Between Wildfire Trauma-Related Variables and Sleep and Trauma Symptoms

Pearson's correlations were calculated between the ISI, GAD-7, PCL-5, PSQI, and PHQ-9; and Spearman's rho correlations for the DDNSI with other variables to examine if wildfire survivors who have experienced greater losses, greater danger of imminent death, more impact of smoke, and more fear for the loss of lives showed more severe symptoms of insomnia, nightmares and trauma. Table 3.3 shows a correlation matrix of the dependent variables with demographic and trauma variables following fires.

Table 3.3

Correlation Between Demographic Variables and Wildfire Trauma Variables with the Dependent Variables

Variables	DDNSI (n = 87)	GAD7 (n = 110)	ISI (n = 126)	PCL-5 (n = 104)	PHQ9 (n = 124)	PSQI (n = 116)
Age	-.09	.31**	-.131	-.27**	-.23*	-.10
Income	-.10	-.16	-.28**	-.21*	-.24**	-.30**
Additional trauma	.32**	.40**	.37**	.55**	.31**	.40**
COVID-19/sleep	.01	.36**	.31**	.26**	.27**	.126
COVID-19/MH	.11	.48**	.36**	.40**	.37**	.19*
Number of losses	.11	.22*	.17	.22*	.16	.30*
Imminence of death	.07	.44**	.29*	.33*	.26*	.23*
Smoke impact	.25*	.33**	.47**	.41**	.31**	.43**
Fear for personal life	.19	.38**	.40**	.37**	.38**	.30*
Fear for life of others	.21*	.32*	.40**	.31*	.32**	.28*
Fear for loss of property	.11	.29*	.30*	.26*	.17	.23*

Note. *< .05; **< .01; ***< .001.

Table 3.3 shows that additional trauma, smoke impact and fear for life of others were correlated positively with all of insomnia, nightmares and PTSD symptoms. COVID-19 impact on sleep and mental health correlated positively with insomnia and PTSD. The other trauma-related variables including number of losses, imminence of death, fear for personal life and fear for loss of property also correlated positively with PTSD and/or insomnia with a small to large magnitude.

3.4.4 Predictors of Sleep and Trauma Symptoms

To determine which wildfire related variables predicted insomnia, nightmares, and trauma symptoms (ISI, DDNSI, and PCL-5), multiple hierarchal regression and logistic regression analyses were conducted. To examine the unique contribution of imminence of death, fear for own life and the life of others, and smoke caused by wildfires in the explanation of insomnia symptoms, a hierarchical multiple regression analysis was performed. The dependent variable in the model was insomnia score, and

independent variables that explain wildfire trauma were entered in five steps. In Step 1, sex and income were controlled for. This model significantly predicted insomnia symptoms contributing 11.4% to the variance, F (2,100) = 6.42, p = .002. In Step 2, COVID-19 impact on mental health, contributed an extra 11.3% to the model, F (1, 99) = 14.46, p <.001, R^2 = .227. Additional trauma after the fires was entered in Step 3, which contributed 4.8% of variance to the model, F (1,98) = 6.54, p = .012, R^2 = .275. In Step 4, depression scores, anxiety, and trauma symptoms were entered (PHQ-9, GAD-7, PCL-5). The four variables in Step 4 contributed 41% of the variance of insomnia scores, F (3,95) = 41.12, p <.001, R^2 = .685. In the final step, imminence of death, fear for own life and the life of others, and smoke impact were entered which contributed a further 4.1% to the overall model, F (3,92) = 4.63, p = .005, R^2 = .726. Table 3.4 shows the coefficients for the variables entered in the hierarchical regression.

A hierarchical multiple regression analysis was conducted to examine which variables (i.e., number of losses, fear for life, and smoke caused by wildfires) predicted trauma symptoms as measured by the PCL-5 scale. The PCL-5 was entered as a dependent variable in the regression analysis. In Step 1, sex and income were entered. This model significantly predicted trauma symptoms contributing 10.3% of the variance, F (2,100) = 5.77, p = .004. In Step 2, COVID-19 impact on mental health, added an extra 13.4% to the model, F (1, 99) = 17.40, p <.001, R^2 = .237. Additional trauma after the fires was entered in Step 3, which contributed 15.8% of variance to the model, F (1,98) = 25.65, p <.001, R^2 = .396. In Step 4, depression scores, anxiety, and insomnia symptoms (PHQ-9, GAD-7, ISI) were entered. The four variables in Step 4 contributed a further 40.6% of the variance to trauma scores, F (3,95) = 64.90, p <.001, R^2 = .802. In Step 5, number of losses, fear for life, and smoke impact were entered. The model was not

significant, with the trauma of fires adding only .02% to the overall model, F (3,92) = 0.32, p = .811, R^2 = .804 (see Table 3.4).

Table 3.4

Summary of Hierarchical Regression Analyses of Variables Predicting Insomnia, and Trauma Symptoms

Variables	β	t	SE	R^2	95% CI
Insomnia model				.114	
Step 1					
Sex	.19	1.95	1.66		[-0.05 – 6.52]
Income	-.27	-2.44*	.62		[-2.55 – -0.46]
Step 2				.227	
Sex	.13	1.45	1.58		[-0.85 – 5.41]
Income	-.28	-3.13*	.50		[-2.53 – -0.57]
COVID-19/MH	.34	3.80**	.42		[0.61- 2.56]
Step 3				.275	
Sex	.10	1.10	1.55		[-1.36 – 4.78]
Income	-.25	-2.81*	.49		[-2.33 – - 0.40]
COVID-19/MH	.27	3.00*	.43		[0.43 – 2.12]
Additional Trauma	.24	2.56*	.42		[0.24- 1.90]
Step 4				.685	
Sex	.03	.50	1.06		[-1.58 – 2.64]
Income	-.10	-1.69	.34		[-1.23 – 0.10]
COVID-19/MH	.05	.67	.31		[-0.41 – 0.83]
Additional Trauma	-.02	-.30	.33		[-0.74 – 0.55]
PCL-5	.44	3.59*	.05		[0.08 –0.28]
PHQ-9	.39	3.67**	.11		[0.20 – 0.63]
GAD-7	-.00	-.03	.10		[-0.21 –0.20]
Step 5				.726	
Sex	-.03	-.52	1.11		[-2.79 – 1.63]
Income	-.08	-1.31	.33		[-1.10 –0.23]
COVID-19/MH	-.03	-.39	.32		[-0.76 –0.51]
Additional Trauma	-.02	-.22	.32		[-0.69 – 0.55]
PCL-5	.39	3.29*	.05		[0.06 – 0.26]
PHQ9	.38	3.70*	.11		[0.19 – 0.62]
GAD-7	-.00	-.02	.10		[-0.20 – 0.20]
Number of losses	-.04	-.66	.27		[-0.72 – 0.36]
Smoke impact	.17	2.42*	.34		[0.15 – 1.49]
Fear for loss of life	.10	1.42	.21		[-0.12 – 0.70]
PTSD model					
Step 1				.103	
Sex	.25	2.58*	4.02		[2.41 – 18.38]
Income	-.19	-2.01*	1.28		[-5.12 – -0.04]
Step 2				.237	
Sex	.19	2.09*	3.78		[0.38 – 15.37]

Income	-.20	-2.27*	1.19		[-5.05 – -0.34]
COVID-19/MH	.37	4.17**	1.00		[2.19 – 6.17]
Step 3				.396	
Sex	.13	1.58	3.42		[-1.39 – 12.17]
Income	-.14	-1.78	1.07		[-4.03 – 0.23]
COVID-19/MH	.25	3.00*	.94		[0.95 – 4.67]
Additional Trauma	.43	5.06**	.92		[2.84 – 6.50]
Step 4				.802	
Sex	.08	1.81	2.00		[-0.36 – 7.60]
Income	.03	.54	.65		[- 0.94 – 1.64]
COVID-19/MH	-.03	-.49	.60		[-1.48 – 0.90]
Additional Trauma	.24	4.64**	.56		[1.49 – 3.73]
ISI	.27	3.59*	.18		[0.30 – 1.03]
PHQ-9	.32	3.36*	.21		[0.39 – 1.24]
GAD-7	.26	3.36*	.19		[0.26 – 1.00]
Step 5				.804	
Sex	.07	1.38	2.22		[-1.34 – 7.47]
Income	.03	.56	.68		[-0.96 – 1.72]
COVID-19/MH	-.03	-.48	.65		[-1.59 – 0.97]
Additional Trauma	.24	4.62**	.57		[1.50 – 3.78]
ISI	.27	3.29*	.20		[0.26 – 1.05]
PHQ9	.33	3.81**	.22		[0.40 – 1.26]
GAD-7	.26	3.31*	.19		[0.25 – 1.01]
Number of losses	.02	.41	.55		[-0.86 – 1.31]
Smoke impact	.04	.66	.70		[-0.94 – 1.86]
Fear for loss of life	-.05	-.79	.42		[-1.16 – 0.50]

Note. *< .05; **< .01; ***< .001; SE = standard error; CI = confidence intervals.

A logistic regression was conducted to examine which variables predicted nightmare symptoms as measured by the DDNSI (categorised as nightmare *vs*. no nightmare symptoms). Only variables that correlated with the DDNSI were considered. The independent variables were entered in the following order: Step 1/sex, Step 2/additional trauma, Step 3/anxiety, trauma, depression and insomnia symptoms, and Step 4/smoke impact and fear for life. The analysis showed that model 3 significantly predicted nightmare symptoms, $\chi\ 2$ (5, N = 76) = 20.43, p = .001, with insomnia being the only significant predictor in the model (β = .19. p = .017). The addition of smoke impact and fear for life variables to the final model, did not contribute significantly to nightmare symptoms. However, the model remained significant $\chi\ 2$ (7, N = 75) = 20.46, p = .005,

with insomnia being the only significant contributor to the model (β = .16. p = .03) (see Table 3.5 for coefficient values).

Table 3.5

Summary of Logistic Regression Analysis of Variables Predicting Nightmare Symptoms

Variables	β	*SE*	*Wald*	p	95% CI
Nightmare model					
Step 1					
Sex	.43	.72	0.36	.551	[0.37 – 6.30]
Step 2					
Sex	.22	.75	0.09	.77	[0.29 – 5.43]
Additional trauma	.20	.16	1.66	.198	[0.90 – 1.66]
Step 3					
Sex	-.22	.89	0.06	.805	[0.14 – 4.59]
Additional trauma	- .06	.21	0.08	.781	[0.63 – 1.42]
PCL-5	.02	.04	0.41	.522	[0.95 – 1.10]
PHQ-9	.01	.08	0.02	.886	[0.86 – 1.19]
GAD-7	-.03	.08	0.12	.73	[0.84 – 1.14]
ISI	.19	.08	5.70	**.017**	[1.04 – 1.42]
Step 4					
Sex	-.23	.92	0.06	.801	[0.13 – 4.80]
Additional Trauma	-.07	.22	0.09	.760	[0.62 – 1.43]
PCL-5	.02	.04	0.40	.527	[0.95 – 1.10]
PHQ-9	.01	.08	0.01	.892	[0.85 – 1.19]
GAD-7	-.03	.08	0.13	.716	[0.83 – 1.14]
ISI	.19	.09	4.35	**.037**	[1.01 – 1.45]
Smoke impact	.00	.32	0.00	.990	[0.53 – 1.82]
Fear for loss of life	.04	.18	0.04	.845	[0.73 – 1.48]

Note. Wald = Chi-Squared test; SE = standard error; CI = confidence intervals.

3.5 Discussion

The aims of the study were to explore the prevalence of sleep and trauma symptoms and to identify which wildfire trauma-related variables predicted the development of sleep and trauma symptoms in wildfire survivors. In the current study and in support of the first hypothesis, results showed high rates of insomnia, nightmares and trauma symptoms in wildfire survivors; and the reported rates were found to be significantly higher than that reported in a sample of college students (all p <.001) (Nadorff et al., 2011). Although, a college sample is not representative of the general public, the study by Nadorff and colleagues (2011) was the only study that provided

prevalence on insomnia, nightmares and PTSD symptoms using the same scales that were utilised in the present study.

Prevalence of insomnia in the present sample was higher than that reported by Belleville et al. (2021) one year following the 2016 Fort McMurray wildfire, with insomnia prevalence reported to be (n = 1,510, 28.5%). This is perhaps reflective of the fact that the time elapsed since the fires determines prevalence rate of insomnia which may fluctuate over time following trauma. This hypothesis was not tested in the present study; however, it is an important observation and it should be investigated further.

While nightmares were highly prevalent in the present study, the prevalence was lower than that reported by Krakow et al. (2004) as measured by the DDNSI (33%, n = 78) six to ten months following the 2000 Cerro Grande Fire. Notably, Krakow et al.'s (2004) study included wildfire survivors seeking treatment for sleep disturbances, perhaps explaining the discrepancy in rates between the two studies. Nevertheless, there is limited research available on prevalence of nightmares in wildfire survivors and they are always measured in the context of PTSD rather than as an independent entity (Rek et al., 2017).

In relation to PTSD symptoms, the findings were consistent with findings from Belleville et al. (2019) three months following the 2016 Fort McMurray fires, with 60% (N = 379) of their sample reporting symptoms of PTSD, measured by the PCL-5.

Furthermore, in the present study, the prevalence of insomnia and nightmares were high in those presenting with PTSD symptoms (69.3% and 28%, respectively). The higher reported rates are consistent with other studies of wildfire survivors which found insomnia and nightmares to be statistically higher (p <.005) among survivors with PTSD than those without PTSD symptoms (Psarros et al., 2017).

3.5.1 Relationship Between Additional Acquired Trauma Following Wildfires, Insomnia, Nightmares and PTSD

In the present study, those who acquired other types of traumas following the trauma of wildfires, had more insomnia, nightmares, experienced more PTSD symptoms, and reported poorer sleep quality than those without additional trauma. Previous research found that wildfire survivors' PTSD symptoms intensified 6-8 months following the trauma, which may not only be linked to fluctuation in PTSD symptoms across time, but can also be a result of other acquired traumas following the trauma of wildfires (Andrews et al., 2007; Kessler et al., 2008). Other findings from a study comparing high affected with low affected communities by the 2009 Black Saturday bushfires found that the trauma related to difficulties associated with housing and employment following bushfires impacted the mental health of survivors (Bryant et al., 2014). It is worth highlighting that property loss following the fires is likely to cause relocation, difficulties in rebuilding and settling down, difficulties with insurance companies, and perhaps income difficulties which can ultimately contribute to poorer mental health, including sleep disturbances (Bryant et al., 2021; Silveira et al., 2021).

3.5.2 The Impact of COVID-19

The findings in relation to COVID-19 impact on sleep and mental health found that those who scored higher on the impact of COVID-19 on sleep and mental health reported more insomnia, more PTSD symptoms and poorer sleep quality, than those who reported less impact.

The impact of COVID-19 has been undeniably severe on both sleep and mental health. The present findings add to the reported literature by suggesting a possible link between COVID-19 and PTSD. Previous research suggested that 30.2% ($N = 381$) patients who presented to emergency rooms with COVID-19 and recovered in a post-

acute care experienced PTSD symptoms (Janiri et al., 2021). The COVID-19 pandemic adds another layer of trauma to survivors who have endured complex and multiple traumas, which complicates the presentation and treatment of wildfire survivors. For example, Agyapong et al. (2022) assessed the impact of cumulative trauma in Canadians who experienced multiple traumatic events since the 2016 Fort McMurray fires including the 2020 floods, and the COVID-19 pandemic. Those who experienced wildfires, flooding, and the COVID-19, ($N = 47$) were 11 times more likely to report PTSD symptoms compared to respondents who experienced COVID-19 trauma only ($N = 19$). This finding also adds to the aforementioned results about the negative impact of subsequent trauma acquired following the fires, whereby cumulative trauma can compromise resilience leading to the development of psychopathology (To et al., 2021).

3.5.3 Relationship Between Wildfire Trauma-Related Variables, Insomnia, Nightmares and PTSD

In support of hypothesis 2, the present study found that wildfire survivors with higher losses including those who feared for their life and safety, feared for the life of others, those who feared for the loss of property, and those who felt death was imminent scored higher on insomnia, nightmares, PTSD symptoms, and reported poorer sleep quality. Previous findings confirmed that both adults and children who experienced fires directly were more likely to report worse sleep quality than those who were indirectly affected (Isaac et al., 2021; Jones et al., 2002; Silveira et al., 2021). Recent research of the impact of wildfires on mental health, found that trauma-related factors such as witnessing of the fires burning properties, losing loved ones, fearing for the loss of lives, imminence of death, and lack of support from family and friends increased the risk of developing PTSD and insomnia symptoms following the fires (Agyapong et al., 2020; Psarros et al., 2017; To et al., 2021).

3.5.4 Smoke Impact

The present study also revealed that those who were affected more severely by smoke resulted from wildfires scored higher on insomnia, nightmares, PTSD, and had poorer sleep quality. The Sleep Foundation (2022) report indicated that regardless of the location, around 58% of people surveyed stated that smoke resulted from the fires has affected their sleep (Yasinski, 2022). Smoke travels to the nervous system affecting neurotransmitters which affect sleep cycles. Furthermore, inflammation in the brain caused by smoke, affects breathing, causes nasal congestion and sinus inflammation leading to airway obstruction which in turn leads to sleep disturbances (Yu et al., 2019). To the best of our knowledge, only one study examined the impact of smoke on sleep. Rodney et al. (2021) examined the impact of direct exposure to smoke resulted from the 2019-2020 Summer wildfire in Australia in a sample of (N = 2,084), and found that nearly 50% of the sample reported sleep difficulties, with 37.2% reporting disrupted or poor sleep. The impact of smoke seen on sleep can provide evidence on how PTSD symptoms may develop when sleep is affected. Rumination about wildfire trauma due to lack of sleep provides the platform for rehearsal of negative cognition and emotions leading to the contents of the trauma played in a way of nightmares (Youngren et al., 2020). Frequency of nightmares related to the actual trauma leads to further hyperarousal and sleep latency which can eventually lead to the development of psychopathology such as PTSD (Agorastos et al., 2014; Youngren et al., 2020).

3.5.5 Predictors of Insomnia, PTSD, and Nightmares

The third hypothesis which stated that the number of losses, the impact of smoke on health, and fear for loss of lives due to the experience of wildfire, would predict scores on insomnia, nightmares and trauma symptoms was partially supported. For the insomnia model, while depression, anxiety, and PTSD symptoms contributed 41% to the overall

model, smoke predicted insomnia by contributing 4.1% to the model. As highlighted above, the negative impact of smoke on the nervous system, the nasal congestion and sinus inflammation can lead to difficulties in initiation and/or maintenance of sleep leading to insomnia (Rodney et al., 2021; Yu et al., 2019).

In relation to the PTSD model, insomnia significantly predicted PTSD symptoms. Prior research found that insomnia predicts the development of PTSD in both the general public and veterans (Short et al., 2020; Wright et al., 2011). The present findings are contradictory to what previous research has reported in relation to the association between trauma-related variables and PTSD symptoms (Bryant et al., 2014, 2018; Psarros et al., 2017).

The nightmare model showed that only insomnia significantly predicted the development of nightmares. In a longitudinal study, Miller et al. (2018) collected 468 morning reports of 31 veterans revealing that elevated respiratory event index and lower sleep periods respiratory sinus arrhythmia predicted nightmares. Sleep disordered breathing is a factor in nightmares (Miller et al., 2018). It is possible that the negative impact of smoke which predicted insomnia can in turn lead to nightmares.

Taken the three models together, smoke from wildfires predicted insomnia. This is a novel finding and one that should be investigated further. The results from the models also showed that a bidirectional relationship between insomnia and PTSD may exist (Weber & Wetter, 2022). However, time in relation to fire occurrence, which the study did not take into account, can mask the true direction in the relationship between sleep disturbances and PTSD symptoms. The model also found that insomnia predicts nightmares. Rodent models provide support to the present findings. For example, Taranissi et al. (2014) explored the role of sleep disturbance in the development of PTSD in rodents using a “predator odour trauma” model. The mice were exposed to predator

odour (soiled cat litter) for 90 minutes. On day five of the experiment, when the mice were exposed to objective remainders of the odour, they displayed hyperarousal and sleep disruption which resulted in flashbacks in comparison to controls (Taranissi et al., 2014). In consideration of the study's findings, it seems the constant exposure to smoke can act as a reminder of the fire trauma which can disturb sleep leading to insomnia. The presence of insomnia then leads to the development of worry, avoidance of anxiety-related trauma, and increase in suppression of intrusive memories related to trauma (Short et al., 2020). The persistence of insomnia can interfere with processing of traumatic experiences causing further intrusive memories of the trauma and leading to nightmares and ultimately PTSD (Youngren et al., 2020). The impact of smoke (olfactory memory) is perhaps more strongly engraved in the brain more than verbal or visual memories of the trauma (Daniels & Vermetten, 2016; Vermetten & Bremner, 2003).

3.5.6 Conclusion

Insomnia, nightmares and PTSD symptoms were highly prevalent in wildfire survivors. Trauma-related variables such as number of losses, fear for loss of lives, imminence of death and additional acquired trauma following the fires were related to more severe insomnia, nightmares and PTSD symptoms. Finally, smoke from wildfire emerged as the most significant trauma-related predictor of insomnia, which, in turn predicted the development of both PTSD and nightmare symptoms.

3.5.7 Implications

Insomnia and nightmares can emerge in the acute phase of wildfire trauma as the impact of smoke is felt immediately during and after the trauma of wildfires. This theory in consideration, and given how COVID-19 pandemic changed the way health care is received and provided to consumers (Isaac et al., 2022b), early intervention in treating sleep disorders is essential. Furthermore, awareness about the impact of wildfire on sleep

should become part of preparing vulnerable communities for the fire seasons. Furthermore, given the shortage of well-trained counsellors/ psychologists, in the treatment of sleep disorders, particularly in regional and remote locations, digital therapies for sleep difficulties and trauma should be considered and promoted. There is also a need to provide and test the usefulness and effectiveness of digital treatment modalities for sleep difficulties in vulnerable communities that may not get access to face-to-face health care in a timely manner. Digital self-paced interventions are likely to benefit thousands of wildfire survivors. They can also meet the needs of the individual by increasing self-governance, increasing personal responsibility towards therapy, and by providing more privacy (Gieselmann & Pietrowsky, 2019). This will reduce both the burden of sleep disturbances and the subsequent development of serious psychopathology in communities affected by wildfires (Babson & Feldner, 2010; Colvonen et al., 2018).

3.5.8 Limitations

The study would have been more informative if time of wildfire occurrence was measured relative to trauma and sleep disturbances symptoms. This would have provided more information about the timeline of the occurrence of sleep disturbances and trauma symptoms. Furthermore, an assessment of acquired trauma prior to wildfire trauma, would have provided more information to partial out the contribution of trauma caused solely by wildfire.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Foreword to Chapter 4

Our international survey, discussed in Chapter 3, revealed that insomnia, nightmares, and PTSD symptoms are highly prevalent following the trauma of wildfires. The high prevalence of mental health conditions following disasters is not only indicative of a country's disaster response efforts but also highlights potential gaps in policy planning and disaster management strategies. Consequently, the reported mental health conditions impose substantial strain on healthcare systems, exacerbating psychological and physical health issues and increasing healthcare utilisation.

Building on Chapter 1's identification of Australia, Canada, and the USA as countries with severe and frequent wildfires, and in light of the high prevalence rates of insomnia, nightmares, and PTSD symptoms following such disaster, chapter 4 provided a comparative analysis of mental health conditions across these nations. By examining post-wildfire mental health outcomes, this chapter aimed to inform policy decisions, facilitate international knowledge sharing, and highlight effective strategies for mitigating mental health impacts.

Chapter 4: Differences in Anxiety, Insomnia, and Trauma Symptoms in Wildfire Survivors from Australia, Canada, and the United States of America

The content of Chapter 4 is identical to my earlier publication "Isaac, F., Toukhsati, S. R., Klein, B., Di Benedetto, D., & Kennedy, G. (2024). Differences in anxiety, insomnia, and trauma symptoms in wildfire survivors from Australia, Canada and United States of America. *International Journal of Environmental Research and Public Health*, *21*(1), 38. 10.3390/ijerph21010038", except for citation style changes to match this thesis's convention. The reproduction of this chapter's content is permitted under the journal's copyright agreement, with permission granted (refer to Appendix H).

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4.1 Abstract

Many survivors of wildfires report elevated levels of psychological distress following the trauma of wildfires. However, there is only limited research on the effects of wildfires on mental health. This study examined differences in anxiety, depression, insomnia, sleep quality, nightmares, and post-traumatic stress disorder (PTSD) symptoms following wildfires in Australia, Canada, and the United States of America (USA). One hundred and twenty-six participants from Australia, Canada, and the USA completed an online survey. The sample included 102 (81%) women, 23 (18.3%) men, and one non-binary (0.8%) individual. Participants were aged between 20 and 92 years (*M* age = 52 years, *SD* = 14.4). They completed a demographic questionnaire, the Disturbing Dream and Nightmare Severity Index (DDNSI), Generalized Anxiety Disorder Questionnaire (GAD-7), the Insomnia Severity Index (ISI), Patient Health Questionnaire (PHQ-9), the Pittsburgh Sleep Quality Index (PSQI), and PTSD Checklist (PCL-5). Results showed that participants from the USA scored significantly higher on the GAD-7 ($p = 0.009$), ISI ($p = 0.003$), and PCL-5 ($p = 0.021$) than participants from Australia and Canada. The current findings suggest a need for more international collaboration to reduce the severity of mental health conditions in Australia, Canada, and the USA.

Keywords: depression, anxiety, PTSD, nightmares, insomnia, sleep quality, wildfires, survivors, USA, Canada, Australia

4.2 Introduction

Wildfires are vital events for many ecosystems in preserving species that respond to fires, stimulating seed germination and growth of native vegetation, helping to eliminate competition from invasive weeds, and eradicating diseases and insects that cause harm to older plants and vegetation (Department of Environment, 2016; Pausas & Keeley, 2009, 2019). However, when wildfires spread rapidly with great intensity and force, they annihilate forests, wildlife, and entire communities. This decade has witnessed unparalleled numbers of wildfires affecting the globe including; the Arctic, the United States of America (USA), Canada, parts of Europe, and Australia (Climate Reality Project, 2020; Ppoescu et al., 2022; The Canadian Press, 2020).

In Australia, the 2019–2020 Black Summer fires resulted in the burning of more than 24 million hectares of land, destroyed 3000 homes, and killed 33 people (Williams, 2011; World Metrological Organisation, 2020). Similarly, in 2018, British Columbia/Canada was hit by the worst wave of wildfires in the region's recorded history, leading to the destruction of 1.35 million hectares of land, destroying 2211 properties, and USD 615 million was spent to fight the fires (The Canadian Press, 2020). Furthermore, The August Complex Fires in the USA in 2020 were labelled the largest wildfires that the state had ever witnessed. It led to the burning of 1.6 million hectares of land, destroyed 8200 buildings, killed 31 people, and displaced tens of thousands of people for several months following the fires (Boghani, 2019; Smith, 2020; Western Fire Chiefs Association, 2022). The three countries suffered major financial and biodiversity losses. The consequences of wildfires have major negative effects on the mental and physical health of survivors by disrupting social networks and causing financial losses and hardship that may persist for decades (Ppoescu et al., 2022).

Numerous studies suggest that the magnitude of suffering for survivors is associated with geographic proximity to wildfires and the extent and number of losses incurred during the fires (Cianconi et al., 2020; Heffernan et al., 2022; Isaac et al., 2021, 2023). The level of suffering is not only limited to financial losses but also to the negative impact that wildfires impose on the physical and mental wellbeing of survivors. Following the trauma of wildfires, many wildfire survivors report elevated levels of anxiety, depression, stress, sleep difficulties, and post-traumatic stress disorder (PTSD) symptoms (Heffernan et al., 2022; Isaac et al., 2023). In a comprehensive review of 63 studies that examined the impact of wildfires on mental health, To et al. (2021) found that the rates of PTSD ranged between 29% and 60% at 3 months, 12.8% to 26% at 6 months, and 15.6% to 7.6% at 3–10 years following the trauma of wildfires; high rates of depression were also reported following the fires, with percentages ranging between 25.5% and 33% at 3 months, 10.4% and 17.1% at 6 months, and approximately 10% at 10 years following the disaster. Similarly, anxiety was also reported following the fires, with approximately 17.4% to 27.0% of survivors reporting symptoms at 3 months, 19.8% at 6 months, and 4.4% to 7.5% at 10 years post-wildfires (To et al., 2021). Symptoms of insomnia and nightmares were also found to be some of the most prevalent mental health conditions reported by survivors following the trauma of wildfires. For example, the incidence of insomnia was found to range between 28.5% and 77.9%, and the incidence of nightmares ranged between 33.3% and 49.2% following the disaster (Belleville et al., 2021; Cianconi et al., 2020; Hong et al., 2022; Isaac et al., 2021, 2023).

The trauma experienced by survivors in the period following the fires is not the sole contributor to the high rates and the severity of the mental health conditions reported. Studies show that a constellation of other external factors contributed to and/or intensified the impact of the trauma of wildfire by increasing stress levels in affected individuals.

Some of those factors included younger age, being a female, low education levels, loss of a job, job stress and job relocation, limited social support, low socioeconomic status, prior mental health history, and childhood trauma. Experiencing one or more of those factors can lead to higher rates and more severe presentation of conditions such as PTSD, depression, and anxiety (Belleville et al., 2021; Kulig et al., 2011; Lowe et al., 2019; Silveira et al., 2021; To et al., 2021). Recency of wildfires also seemed to be a major contributor in dictating the rates and severity of mental health conditions reported by individuals who experienced wildfires not just within the first 12 months but also in the years following the trauma of wildfires (Belleville et al., 2021; To et al., 2021).

Most findings about the effect of wildfires on mental health are mainly drawn from survivors in countries that are most severely affected by wildfires, including Australia, Canada, and the USA (To et al., 2021). However, comparing the severity of mental health conditions after wildfires between the three countries is poorly researched and understood. One reason for this is that researching mental health in wildfire survivors can be challenging due to ongoing symptoms of trauma that are common, with many survivors wishing to avoid re-visiting traumatizing events. Therefore, it is not surprising that cross-cultural research is limited in exploring how people in different countries with different social structures may be affected by wildfires.

Differences in rates and severity of mental health conditions between different countries may be expected due to not only differences in policies applied in each country but also the level of preparedness implemented in each country in relation to wildfires. The level of preparedness for fires can act as a buffer against the long-term and largely ignored negative consequences on mental health in vulnerable communities (Kulig et al., 2011; Latrobe Valley Express, 2023).

Thus, the main objective of the current study was to compare mental health outcomes following wildfires in Australia, Canada, and the USA. Specifically, the aim was to examine patterns of severity and differences in anxiety, depression, insomnia, sleep quality, nightmares, and PTSD symptoms. Comparing health data across countries can support decision making and policy planning for those at risk of experiencing wildfires (Australian Institute of Health and Welfare, 2022). Furthermore, a comparison of mental health conditions between Australia, Canada, and the USA may provide useful information to inform the international community about the likelihood of mental health outcomes following wildfires and other natural disasters.

4.3 Method

4.3.1 Participants

The participants were 126 wildfire survivors from Australia, Canada, and the USA. Twenty-three males (18.3%), 102 (81%) females, and one nonbinary (0.8%) individual took part in this study. Forty-four (34.9%) participants from Australia, 27 (21.4%) from Canada, and 55 (43.7%) from the USA completed an online survey. Participants ages ranged between 20 and 92 years (*M* age = 52 years, *SD* = 14.4).

4.3.2 Measures

Demographic Questions: Demographic information was collected from participants such as age, gender, country of residence, education level (no schooling, primary, secondary, certificate or diploma, bachelor's degree, or postgraduate degree), employment history (student, employed, unemployed, looking for work, or retired), income (six categories were adapted from the Australian Bureau of Statistics ranging between $AUD 0 and 156,000 or more per year, converted to $USD for each country during the analysis), and recency of wildfires (participants were asked to provide the dates of the wildfires they had experienced in the last 10 years, which were divided into

two categories: wildfires experienced less than 12 months ago and wildfires experienced more than 12 months ago) (Belleville et al., 2021; To et al., 2021).

Disturbing Dream and Nightmare Severity Index (DDNSI): The scale consists of five self-reported items assessing the frequency and severity of disturbing dreams and nightmares (Krakow et al., 2002). The DDNSI assesses the number of nights with nightmares per week (0–7 nights) and number of nightmares per week (0–14 nightmares). The DDNSI also assesses the intensity and severity of nightmares on a Likert-type scale (0 = no problems to 6 = extremely severe) and nightmare awakenings (0 = never or rarely to 4 = always). Scores range 0–37, with scores greater than 10 reflecting the presence of a nightmare disorder (Krakow et al., 2002). A previous study showed that the DDNSI had a Cronbach's alpha of $\alpha = 0.93$ (Nadorff et al., 2013).

Generalized Anxiety Disorder Questionnaire (GAD-7): The GAD-7 consists of seven self-reported items that assess worry and anxiety symptoms. Items are rated on a 4-point Likert scale from 0 = not at all to 3 = nearly every day (Spitzer et al., 2006). Scores range from 0 to 21, with higher scores indicating more severe symptoms of anxiety. The scores fall into one of four ranges, with 0–4 indicating minimal anxiety, 5–9 reflecting mild anxiety, 10–14 representing moderate anxiety, and scores from 15–21 reflecting severe anxiety symptoms. The GAD-7 has been found to be a valid screening tool for anxiety in primary care settings and for assessing severity in clinical practice and research (Spitzer et al., 2006). A cut-off score of 10 has been identified as the optimal point for sensitivity of 89% and specificity of 82% (Spitzer et al., 2006). Cronbach's alpha was found to be $\alpha = 0.95$ for the GAD-7 in the current sample.

The Insomnia Severity Index Scale (ISI): The ISI is a short self-report questionnaire measuring symptoms and severity of insomnia (Bastien, 2001). The ISI is composed of seven items assessing problems with sleep onset, sleep maintenance, early morning

awakening, interference of sleep problems with daily functioning, concern about sleep problems, and satisfaction with sleep patterns over the last month. The severity of each item is rated on a scale from 0 to 4. Total score ranges from 0 to 28, whereby higher scores suggest more severe symptoms. The ISI consists of four categories: 0–7 = no clinical insomnia, 8–14 = subthreshold insomnia, 15–21 = clinical insomnia/moderate severity, and 22–28 = clinical insomnia/severe (Morin et al., 2011). A cut-off score of 14 provides 82.4% sensitivity and 82.1% specificity for detecting clinical insomnia (Gagnon et al., 2013). In the present sample, Cronbach's alpha was $\alpha = 0.92$.

The Patient Health Questionnaire (PHQ-9): Nine self-reported items are used in this scale to measure symptoms of depression (Kroenke et al., 2001). Items are rated on a 4-point Likert scale (0 = not at all to 3 = nearly every day). Total scores range from 0 to 27. Scores higher than10 indicate the presence of depressive disorder (Kroenke et al., 2001). Kroenke and colleagues (2001) suggest the following levels of severity: scores ranging between 1 and 4 = minimal; 5 to 9 = mild; 10 to 14 = moderate; 15 to 19 = moderately severe; and 20 to 27 = severe. Cronbach's alpha for the PHQ-9 in the current study was $\alpha = 0.91$.

Pittsburgh Sleep Quality Index (PSQI): The scale consists of 19 self-reported items with an additional five questions rated by a bed partner (Buysse et al., 1989). The PSQI is scored on a Likert-type scale ranging from 0 to 3. It assesses seven components of sleep quality in the past month, including: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication, and impairment in daytime functioning. A global sleep quality score ranges between 0 and 21, and it is obtained by summing the seven component scores. Higher scores indicate poorer sleep quality. A global PSQI score greater than 5 indicates a diagnostic specificity of 84.4% and a sensitivity of 98.7% in distinguishing between "good" and "poor" sleepers

(Backhaus et al., 2002). In the current sample, Cronbach's alpha for the PSQI was α = 0.81.

PTSD Checklist for DSM-5 Scale (PCL-5, Civilian Version): Providing a provisional diagnosis of PTSD, the PCL-5 consists of 17 self-reported items that screen for the presence of PTSD symptoms over the last month (Blevins et al., 2015). Items are scored on a 5-point Likert scale from "not at all" to "extremely severe". The PCL-5 scores range from 17 to 80, with higher scores indicating more severe symptoms. A cut-off score of 33 is proposed to discriminate between people with or without probable PTSD (Blevins et al., 2015). An alpha of α = 0.95 was observed in the current sample for the PCL-5.

4.3.3 Procedure

Following approval from the Federation University Ethics Committee (Approval Number: A21–124), participants who experienced wildfires in the last decade, were 18+ years old, and could read and write English, were recruited into the study. A URL link was generated using the Qualtrics survey platform and was distributed via Facebook campaigns, Instagram, Reddit, LinkedIn, online community noticeboards, local newspapers, wildfire interest group sites, and using snowball sampling methods. Participation in the survey was voluntary, with no incentives being offered. A digital plain language statement about the study was presented, and participants provided consent by selecting an "I agree" button to take part. The survey took 30 minutes to complete and was launched between October 2021 and March 2022.

4.3.4 Statistical Method

One hundred and eighty-nine participants took part in the survey. Participants who completed only 3–48% of the entire survey (24; 12.7%) and those who were missing 100% data on the main scales (39; 23.6%) were excluded. Missing value analysis

indicated that missing data for the remaining participants were Missing Completely at Random (Little's MCAR test, $\chi^2 = 834.59$; $df = 845$, $p = 0.59$). Therefore, participants with <10% of data missing on the dependent variables were included, and missing values were replaced by computing the series mean for missing items (ISI = 3 participants, PHQ9 = 2 participants, GAD7 = 1 participant, PCL5 = 1 participant, PSQI = 5 participants) (Tabachnick & Fidell, 2019).

An inspection of histograms, Probability Plots (P-P), and scatterplots indicated a normal distribution of all scales except the DDNSI, which was found to be positively skewed (Pallant, 2020).

Descriptive statistics, including frequencies, means, and standard deviations, for each dependent variable were obtained using the IBM SPSS for Windows (Version 26). Analysis of covariance ANCOVA and post-hoc analyses were used to compare the mean differences in scores for participants from the three countries for the GAD-7, ISI, PHQ-9, PSQI, and PCL-5 scales. As indicated above, not all participants completed all scales and/or supplied all demographic variables, and the number of participants in each analysis may vary from the total number for each country (44 participants from Australia, 27 from Canada, and 55 from the USA). For example, only 87 participants from the three countries completed the DDNSI scale.

4.4 Results

4.4.1 Descriptive Statistics for Demographic Variables for Australia, Canada, and the USA

Frequencies on demographic variables for each country were calculated. Table 4.1 shows that more participants from the USA held a bachelor's degree (35.2%) than participants from either Australia (27.3%) or Canada (22.2%). However, a greater percentage of participants from Australia held a postgraduate degree (25%) than

participants from either Canada (7.4%) or the USA (16.7%). In addition, following the conversion of income currency from AUD to USD, a higher percentage of participants from Canada (34.6%) earned USD 26,290 to 49,290 per year than participants from either Australia (27.9%) or the USA (24.1%). Nevertheless, more participants from Australia (16.3%) earned USD 98,580 or more per year than participants from Canada (7.7%) and the USA (3.7%). With respect to employment status, a greater percentage of participants from Australia (63.6%) reported being employed than participants from both Canada (55.6%) and the USA (48.1%). Furthermore, a lower percentage of participants were found to be unemployed in Australia (2.3%) than participants from either Canada (11.1%) or the USA (13%). Recency of fires was coded as wildfires taking place less than 12 months ago or wildfires taking place more than 12 months ago (Belleville et al., 2021; To et al., 2021). Forty-three (97.7%) participants from Australia reported experiencing wildfires more than 12 months ago. Twenty-one (77.8%) participants from Canada reported experiencing wildfires less than 12 months ago, and 5 (18.5%) reported experiencing wildfires more than 12 months ago. Finally, 17 (30.9%) participants from the USA reported experiencing wildfires less than 12 months ago, and 38 (69.1%) reported being affected by wildfires more than 12 months ago.

Table 4.1

Frequencies of Gender, Education, Employment, Income, and Recency of Fires for Australia, Canada, and the United States of America

Variables	Australia *n* (%)	Canada *n* (%)	USA *n* (%)
Gender			
Males	13 (29.5)	5 (18.5)	5 (9.1)
Females	31 (70.5)	22 (81.5)	49 (89.1)
Non-binary	----	----	1 (1.8)
Total (*n*)	44	27	55
Education level			
Primary school	----	----	1 (1.9)
High school	5 (11.4)	6 (22.2)	12 (22.2)

Certificate/diploma	16 (36.4)	13 (48.1)	13 (24.1)
Bachelor's degree	12 (27.3)	6 (22.2)	19 (35.2)
Postgraduate degree	11 (25)	2 (7.4)	9 (16.7)
Total (*n*)	44	27	55
Employment			
Student	1 (2.3)	----	1 (1.9)
Employed	28 (63.6)	15 (55.6)	26 (48.1)
Unemployed	1 (2.3)	3 (11.1)	7 (13)
Looking for work	3 (6.8)	1 (3.7)	1 (1.9)
Retired	11 (25)	8 (29.6)	19 (35.2)
Total (*n*)	44	27	54
Income			
AUD 0 income	1 (2.3)	----	---
AUD 1 to 20,799 per year	4 (9.3)	3 (11.5)	14 (25.9)
AUD 20,800 to 41,599 per year	12 (27.9)	3 (11.5)	10 (18.5)
AUD 41,600 to 77,999 per year	7 (16.3)	9 (34.6)	15 (27.8)
AUD 78,000 to 155,999 per year	12 (27.9)	9 (34.6)	13 (24.1)
AUD 156,000 or more per year	7 (16.3)	2 (7.7)	2 (3.7)
Total (*n*)	44	26	54
Recency of fires			
Less than 12 months	----	21 (77.8)	17 (30.9)
More than 12 months	43 (97.7)	5 (18.5)	38 (69.1)
Total (*n*)	43	26	55

4.4.2 Frequencies of Variables for Australia, Canada, and USA

The severity of symptoms and frequencies on the DDNSI, GAD-7, ISI, PHQ-9, PSQI, and PCL-5 were calculated for each country. Cut-off scores were utilized as specified in each scale under the measures section. No significant differences were found for nightmare symptoms between participants from Australia, Canada, and the USA (Table 4.2). However, a higher percentage of participants from Canada (42.1%) reported more nightmare symptoms than participants from Australia (30.8%) and the USA (21.4%). Table 4.2 also shows that a higher percentage of participants from the USA (47.8%) reported significantly more anxiety symptoms at the severe level than participants from Australia (24.3%) and Canada (18.5%). Similarly, a higher percentage of participants from the USA (21.8%) reported significantly more insomnia symptoms at the severe level than participants from Australia (2.3%) and Canada (11.1%). Furthermore, a significantly higher percentage of participants from the USA (26.4%) had

depressive symptoms at the moderate–severe level than participants from Australia (17.55%) and Canada (11.5%). In addition, even though a higher percentage of participants from the USA (91.7%) reported having "poor sleep" than participants from Australia (80.5%) and participants from Canada (88.9%), these differences were not significant. Finally, a larger percentage of participants from the USA (88.9%) scored significantly higher at the "above the clinical threshold" for PTSD symptoms on the PCL-5 scale than did participants from Australia (48.6%) and Canada (75%) (refer to Table 4.2).

Table 4.2

Frequencies and Percentages of the DDNSI, GAD-7, ISI, PHQ-9, PSQI, and PCL-5 for Australia, Canada, and the United States of America

Variables	Australia *n* (%)	Canada *n* (%)	USA *n* (%)	$\chi^2(df)$, *p*
DDNSI				
No nightmares	18 (69.2%)	11 (57.9%)	33 (78.6%)	12.23 (2), .002
Nightmare disorder	8 (30.8%)	8 (42.1%)	9 (21.4%)	0.08 (2), .961
Total (*n*)	26	19	42	
GAD-7				
Minimal anxiety	16 (43.2%)	6 (22.2%)	8 (17.4%)	5.60 (2), .061
Mild anxiety	8 (21.6%)	11 (40.7%)	9 (19.6%)	0.50 (2), .779
Moderate anxiety	4 (10.8%)	5 (18.5%)	7 (15.2%)	0.87 (2), .646
Severe anxiety	9 (24.3%)	5 (18.5%)	22 (47.8%)	13.17 (2), .001
Total (*n*)	37	27	46	
ISI				
No clinical insomnia	17 (38.6%)	3 (11.1%)	5 (9.1%)	13.76 (2), .001
Subthreshold insomnia	12 (27.3%)	8 (26.6%)	19 (34.5%)	4.77 (2), .092
Clinical moderate insomnia	14 (31.8%)	13 (48.1%)	19 (34.5%)	1.35 (2), .510
Clinical severe insomnia	1 (2.3%)	3 (11.1%)	12 (21.8%)	12.88 (2), .002
Total (*n*)	44	27	55	
PHQ-9				
Minimal depression	13 (32.5%)	3 (11.5%)	5 (9.4%)	8.00 (2), .02
Mild depression	8 (20%)	8 (30.8%)	17 (32.1%)	4.91 (2), .08
Moderate depression	8 (20%)	10 (38.5%)	8 (15.1%)	0.308 (2), .86
Moderately severe depression	7 (17.5%)	3 (11.5%)	14 (26.4%)	7.75 (2), .021
Severe depression	4 (10%)	2 (7.7%)	9 (17%)	5.20 (2), .074
Total (*n*)	43	27	54	
PSQI				
Poor sleepers	33 (80.5%)	24 (88.9%)	44 (91.7%)	5.96 (2), .05

Good sleepers	8 (19.5%)	3 (11.1%)	4 (8.3%)	2.800 (2), .247
Total (*n*)	41	27	48	
PCL-5				
Below clinical threshold	18 (51.4%)	6 (25%)	5 (11.1%)	10.83 (2), .004
Above clinical threshold	17 (48.6%)	18 (75%)	40 (88.9%)	13.52 (2), .001
Total (*n*)	35	24	45	

Note. DDNSI = Disturbing Dream and Nightmare Severity Index; GAD-7 = Generalized Anxiety Disorder Questionnaire; ISI = The Insomnia Severity Index Scale; PHQ-9 = The Patient Health Questionnaire; PSQI = Pittsburgh Sleep Quality Index; PCL-5 = PTSD Checklist for DSM-5 Scale. χ^2 = Chi-square; *df* = degrees of freedom; p = < .05.

4.4.3 Mean Differences in Symptom Presentations Between the Three Countries

Mean differences in symptom scores between participants from the three countries were examined using analyses of covariance (ANCOVA), where GAD-7, ISI, PHQ-9, PSQI, and PCL-5 were entered as dependent variables. The survey country was entered as a fixed factor in the analyses, and gender, education level, employment, income, and recency of fires were entered as covariates. Assumptions of homogeneity of variance (Levene's test) and normality tests were both met. Table 4.3 shows the findings for the analyses of differences between participants from Australia, Canada, and the USA on the dependent variables after controlling for demographic variables.

Table 4.3

Means and Standard Deviations of the Dependent Variables and Results of ANCOVA Comparisons Between Participants from Australia, Canada, and the United States of America

Dependent Variables and Covariates	Countries			*F(df), p*
	Australia *M (SD)*	Canada *M (SD)*	USA *M (SD)*	
GAD-7	7.55 (6.96)	8.88 (5.50)	12.52 (6.87)	
				5.00 (2, 106), .009
Gender				0.26 (1, 106), .609
Education level				0.27 (1, 106), .602
Employment				6.19 (1, 106), .015
Income				2.93 (1, 106), .090

Recency of fires				0.18 (1, 106), .671
ISI total	10.52 (6.79)	15.00 (6.12)	16.25 (6.68)	
				6.00 (2, 120), .003
Gender				1.71 (1, 120), .193
Education level				0.04 (1, 120), .844
Employment				0.99 (1, 120), .321
Income				7.90 (1, 120), .006
Recency of fires				0.17 (1, 120), .681
PHQ-9	9.02 (7.17)	10.56 (5.42)	12.58 (6.60)	
				1.71 (2, 118), .186
Gender				1.25 (1, 118), .267
Education level				0.33 (1, 118), .566
Employment				0.58 (1, 118), .448
Income				3.89 (1, 118), .050
Recency of fires				0.00 (1, 118), .961
PSQI	8.18 (4.22)	9.48 (3.31)	10.90 (4.40)	
				2.47 (2, 112), .890
Gender				5.46 (1, 112), .021
Education Level				0.02 (1, 112), .882
Employment				0.11 (1, 112), .739
Income				6.06 (1, 112), .016
Recency of fires				0.18 (1, 112), .674
PCL-5	39.53 (17.60)	46.08 (16.62)	51.82 (15.32)	
				4.01 (2, 103), .021
Gender				4.61 (1, 103), .034
Education Level				0.36 (1, 103), .551
Employment				3.26 (1, 103), .074
Income				2.81 (1, 103), .097
Recency of fires				1.17 (1, 103), .283

Note. GAD-7 = Generalized Anxiety Disorder Questionnaire; ISI = The Insomnia Severity Index Scale; PHQ-9 = The Patient Health Questionnaire; PSQI = Pittsburgh Sleep Quality Index; PCL-5 = PTSD Checklist for DSM-5 Scale; *M* = mean; *SD* = standard deviation; *F* = *F-test*; *df* = degrees of freedom*; p* = < .05.

The ANCOVA analysis showed that GAD-7 scores were significantly different between the three countries ($F(2, 106) = 4.46$, $p = .014$), and remained significant even after entering the covariates into the model (refer to Table 4.3). Pair-wise post-hoc comparisons conducted at $p < .05$ revealed no significant differences in scores on the GAD-7 between participants from Australia and Canada ($p = .85$) and between participants from Canada and the USA ($p = .64$). However, participants from the USA scored significantly higher than participants from Australia ($p = .008$) on the GAD-7. Only employment was found to be a significant covariate in this model ($p = .015$).

Employment reduced the likelihood of higher scores on the GAD-7, but the country of survey better accounted for overall differences between scores.

Similarly, ANCOVA revealed a significant difference between the three countries for ISI scores ($F(2, 120) = 6.24$, $p = .003$), and after entering all the demographic variables as covariates, the ISI scores remained significantly different for Australia, Canada, and the USA (see Table 4. 3). Pair-wise post-hoc comparisons showed that scores on the ISI for participants from the USA were significantly higher than scores for participants from Australia ($p = .003$). Participants from Canada showed no significant difference in the ISI scores from participants from Australia ($p = .06$) or the USA ($p = 1.00$). Income was found to be a significant covariate in this model ($p = .006$). Higher income reduced the likelihood of higher scores on the ISI, but main differences were better accounted for by country of survey.

ANCOVA showed that the PSQI scores differed significantly between Australia, Canada, and the USA, ($F(2, 114) = 3.81$, $p = .025$). However, this difference was no longer significant when the demographic variables were entered as covariates (refer to Table 4.3). Both gender ($p = .021$) and income ($p = .016$) were significant in the ANCOVA model, indicating that female gender and lower income accounted for more of the differences in scores than the country of survey.

In addition, scores on the PCL-5 were found to be significantly different between the three countries, ($F(1, 102) = 4.81$, $p = .01$), and this difference continued to be significant even with the addition of the covariates to this model (Table 4.3). Pair-wise post-hoc comparisons showed that scores on the PCL-5 for participants from the USA were significantly higher than scores for participants from Australia ($p = .02$). However, no significant differences were observed for scores on the PCL-5 between participants from Australia and Canada ($p = .26$) and between participants from the USA and Canada

(p = 1.00). Gender was the only significant covariate in this model (p = .034), indicating that female gender accounted for some of the differences between countries in PCL-5 scores.

The PHQ-9 was the only dependent variable that was not significant in the ANCOVA analysis, and none of the covariates were found to be significant (Table 4.3).

A Kruskal–Wallis analysis was used to assess the differences between participants' scores on the DDNSI scale across the three countries. The analysis showed that there were no significant differences between the three countries ($\chi^2(2, n = 87) = 1.06, p = .589$) on the DDNSI. To assess the likelihood of affecting the outcome in the former analysis, Kruskal–Wallis analyses were used to examine associations between the DDNSI scores and all demographic variables. No significant associations were found between any of the demographic variables and the scores on the DDNSI, and therefore, the non-significant results for the comparisons between countries are unlikely to have been due to any effects of the demographic factors.

4.5 Discussion

The aim of this study was to compare the frequency and severity of anxiety, depression, insomnia, sleep quality, nightmares, and PTSD symptoms among participants affected by wildfires in Australia, Canada, and the USA. The descriptive data confirmed differences in frequencies on demographic variables between the three countries with an unequal number of participants completing the survey; more participants from the USA (n = 55) took part in the online survey than participants from Australia and Canada (n = 44, n = 27, respectively). Furthermore, the overall sample consisted of more females (81%) than males (18.3%).

Studies conducted in the field of wildfires and the impact they have on peoples' mental health have been consistent in demonstrating elevated rates of multiple mental

health conditions, such as depression, anxiety, sleep difficulties, and PTSD, in the aftermath of wildfires (Belleville et al., 2021; Hong et al., 2022; Isaac et al., 2021, 2023; Silveira et al., 2021; To et al., 2021). In comparing the three countries' anxiety symptoms, significant differences among Australia, Canada, and the USA were found. Approximately 50% of participants from the USA reported significantly more "severe" anxiety symptoms than participants from Australia and Canada ($p = .001$). Similarly, a higher percentage of participants from the USA reported significantly more severe symptoms of insomnia (clinically moderate–severe level, $p = .002$), depression (moderately severe, $p = .021$), and trauma symptoms (above clinical threshold, $p = .001$) than their counterparts in Australia and Canada. Although the current findings are in line with previously reported studies in the field of wildfires and mental health, the reported percentages are somewhat different from those observed in the literature. This is not surprising given the various methods used in each study and the unique characteristics of each sample.

Notably, Owusu et al. (2022) found that 42.5% of their sample ($n = 186$) reported symptoms of anxiety after the fires. Insomnia is one of the most prevalent mental health conditions after the fires (Rifkin et al., 2018), with studies reporting different percentages: 49.2% (Isaac et al., 2023), 63.0% (Psarros et al., 2017), and 43.6% (Belleville et al., 2019). Another mental health condition that is also repeatedly seen following the fires is depression. For example, using the PHQ-9, depression has been reported at various rates, 25.5% (Belleville et al., 2019), 45.0% (Mao et al., 2023), and 32.5% (Hong et al., 2022), by several studies. Moreover, the current findings are also in line with other studies in relation to PTSD symptoms. For instance, a study by Belleville et al. (2019) found that three months after the Fort McMurray fires, nearly 60% of survivors ($n = 379$) suffered from PTSD, and 29.1% ($n = 55$) met the clinical diagnostic criteria for PTSD (Belleville

et al., 2019). Furthermore, different percentages of PTSD symptoms, 46.7% (Psarros et al., 2017), 39.6% (Mao, 2023), 12.8% (Agyapong et al., 2019), and 77.88% (Isaac et al., 2023), have been reported at different times after the fires took place.

When exploring the mean differences between Australia, Canada, and the USA, anxiety symptoms remained significantly different between the three countries, with employment being a significant contributor to this difference. In inspecting the data, the unemployment rate was higher in the USA sample. It is well documented in the literature that being unemployed leads to lower income, which plays a major role in heightening anxiety levels. For example, five years following the Fort McMurray fires, Owusu et al. (2022) (n = 186) found that unemployed survivors were seventeen times more likely to develop anxiety symptoms (Odd's Ratio = 16.62; 95% CI 1.23–223.67) in comparison to those who were employed. When communities are impacted by wildfires, they are subjected to displacement, job relocation, and/or job loss, leading to lower income (Rosenthal et al., 2021). This can, in turn, lead to higher levels of anxiety, not only due to the trauma of wildfires but also due to the losses associated with them (Rosenthal et al., 2021). Research indicates that some of the most reportedly encountered challenges by survivors after the fires include access to housing and gaining employment (Collie et al, 2020; Rosenthal et al., 2021; World Health Organization, 2010). In the current sample, insomnia was also found to be significantly different, with income as a significant contributor to the elevated levels of both insomnia and sleep quality between the three countries. A review of studies (Rifkin et al., 2018) found that those who reported high levels of insomnia were also more economically disadvantaged. Long-term displacement from one's home while their property is being rebuilt, uncertainty about employment, and loss of assets can cause major disruption to one's sleep routine, sleep hygiene, and eventually sleep quality (Isaac et al., 2023; Palinkas, 2020). The mean scores on sleep did

not differ between the three countries in the current sample. Research shows that pre-levels of sleep quality determine the level of traumatic symptoms in the aftermath of traumatic experiences (Salfi et al., 2023). The current study did not account for pre-fire levels of sleep quality; therefore, this may have contributed to the non-significant differences between Australia, Canada, and the USA.

Post-traumatic stress disorder symptoms were also found to be significantly different between the three countries in the current study. Gender was the only significant variable in this model. The association between gender and PTSD symptoms is well established, with females reporting higher rates of PTSD than males in wildfire survivors (Psarros et al., 2017; To et al., 2021). More specifically, one study found that the prevalence of PTSD symptoms was 12.8%, and females reported higher rates of PTSD than males (14.9%, 8.7%, respectively) (Agyapong et al., 2019). Similarly, another study (n = 2085) also reported similar findings (Parslow et al., 2006). Evidence suggests that women are more likely to experience sexual assault, incidents of violence, and childhood trauma than men; this, in turn, can lead to the build up of cumulative trauma, possibly exacerbating reported differences between males and females in PTSD symptoms following the trauma of wildfires (Breslau, 2001; Silveira et al., 2021; Tolin & Foa, 2008).

Even though the current study found a significant difference in percentages in depression scores, exploring the mean scores of depression between the three countries did not show significant differences. This is perhaps a function of the small sample size in the current study compared to other studies.

Similarly, no significant differences were found for the three countries on nightmare symptoms. This contrasts with what is reported in the literature (Isaac et al., 2021, 2023). It is possible that nightmares change gradually from the content of events to

symptoms that overlap with other mental health conditions in the weeks and months following the trauma (Hartmann, 1998; Porcheret et al., 2020).

Recency of fires was not found to be a significant contributor to differences between the three countries in the current study. This is contrary to what has been reported by other studies (Agyapong et al., 2019; Belleville et al., 2019, 2021; Lowe et al., 2019; Mao, 2023; Owusu et al., 2022; Psarros et al., 2017; Rosenthal et al., 2021; Silveira et al., 2021; To et al., 2021). One line of research suggests that people "bounce back," and mental health conditions such as PTSD wane rapidly in the first few months after disaster (Pietrzak et al., 2012). No complementary measures, such as coping/resilience scales, were used in the current study, which may have better explained the current findings in relation to the recency of fires (Silveira et al., 2021).

Overall, participants from the USA reported significantly more severe symptoms of anxiety, insomnia, depression, and PTSD than participants from both Canada and Australia. In explaining the findings of the current study, two hypotheses may be considered. First, the number and magnitude of disastrous events that have occurred in the USA in the last two decades in comparison to Canada and Australia, and second, the disparities between the three countries in terms of the availability of resources for survivors, preferences for self-help, differences in land management and cultural practices, and preparedness levels for wildfires.

In the last twenty years, the USA—unlike Canada and Australia—experienced economic recessions and natural disasters on a national level, more so than the other two countries (Jorm et al., 2017). Findings from the 2016 World Mental Health Survey from 24 countries across the globe found that the USA (82.7%) was second only to Ukraine (84.6%) in its citizens being affected by any type of trauma (Benjet et al., 2016).

Availability and accessibility to mental health resources are not paralleled nor linear in the three countries. For example, Australia provides Medicare to all its citizens, which is affordable, while the USA government provides Medicare only to people with low income and to retirees (Fraser Institute, 2016). Some of the most reported challenges by survivors of California's wildfires in 2017 and 2018 were: lack of accessibility to safe and secure rental properties, shelters, and hostels following the fires; loss of jobs; difficulties in accessing basic health needs; and delay in response from insurance companies. This led to an exacerbation of psychological symptoms and stress levels (Rosenthal et al., 2021). Furthermore, survivors of wildfires show a preference for self-help. For example, a Canadian study of 1510 evacuees from the 2016 Fort McMurray wildfires found that 26.8% of the sample preferred self-help to seeking help from a health professional, while 47.2% of the sample preferred self-help to receiving medications (Binet et al., 2021). Other studies showed similar findings in that survivors of different types of traumas who experienced symptoms of depression, substance dependence, insomnia, anxiety, and PTSD reported a preference for self-help to seeking help from health professionals (Koenen et al., 2003; Morin et al., 2006; Slaunwhite, 2015; van Beljouw et al., 2010).

The higher rates of mental illness in the USA sample may also be related to policies associated with forest and land management. Prior to the European settlement, cultural burning was long known in the indigenous communities in the USA and Australia as part of "caring for the land" (Burr, 2013). These cultural practices have been overlooked and ignored with the rise of the Industrial Revolution. In the state of California/USA, more than 129 million trees have died since 2010, as forest management has been neglected and overlooked (Little Hoover Commission, 2018). The USA commission reported that 27 million trees have died nationally since 2016. There is a call

for adopting historical and cultural practices such as planned burnings to preserve the land and reduce the magnitude of wildfires (Little Hoover Commission, 2018). Another major discrepancy between the three countries is the different approaches they adopt in managing disasters. Experts of wildfires report on how Canada's forests have been logged and abandoned, leaving the land more vulnerable to accumulating tons of flammable fuel for wildfires (Woodcentral, 2023). Underwood, a wildfire expert, states that academics and environmentalists adopt the emergency response or what is referred to as the "American approach"—wait for the disaster to take place, then try to contain it—while wildfire experts support the "Australian approach", which recognizes that wildfires cannot be prevented; however, they can be mitigated through sound land management (Woodcentral, 2023). If the fire grounds are better prepared, then the consequences of wildfires will be easier to manage, safer, and cheaper to control (Woodcentral, 2023).

In Australia, unlike Canada, there is an awareness about land care among vulnerable communities (Pannell, 2007). Preparedness for the fire season is encouraged in Australia to become not only a seasonal but also a regular practice and a way of living among farmers (Westcott et al., 2019). There is also an awareness in the Australian community about the implications of maximizing crop productivity, density of crop per hectare, planned burnings, and the impacts these practices could have on communities (Westcott et al., 2019). Australians are now working in partnership with indigenous groups to implement traditional knowledge and wisdom to care for the land (Burr, 2013; Australia's National Science Agency, 2020). There is a recognition that cultural burning/savannah burning has been a successful tool in land management (Australia's National Science Agency, 2020). The practice of savannah burning, whereby smaller fires are lit to suppress the occurrence of larger and out-of-control fires, is now being adopted and applied in Canada (The Guardian, 2017). Better land management is not only about

minimizing the impact of wildfires but also leads to creating job opportunities and building stronger communities (The Guardian, 2017).

Researchers are now calling for a new model called the "developmentalist model", whereby land management is not only the responsibility of the government but also the responsibility of communities at large. It is about changing values and raising awareness about the relationship between practices and consequences pertaining to sustainable forest management (Lane & McDonald, 2002). The benefit–cost analysis should be applied and reflected upon when discussing the market value of forests, and a recognition of the social, cultural, and economic values of forests should all be considered before the implementation of policies (Lane & McDonald, 2002).

4.5.1 Implications

Clinicians treating survivors of wildfires should have sufficient training in recognizing symptoms of anxiety, depression, insomnia, sleep quality, nightmares, and PTSD. Knowledge about barriers to seeking professional help is imperative, as delays in seeking treatment may lead to the progression of symptoms and the development of chronic psychopathology (Agyapong et al., 2019; Belleville et al., 2019; Mao et al., 2023). Countries that showed a more severe presentation of mental health conditions, for example, the USA, may benefit from reviewing policies associated with the availability of resources and forest and land management practices.

4.5.2 Limitations

The current cross-cultural survey is based on retrospective data, which may have masked any pre- or post-traumatic events following the fires that could have contributed to the reported findings. Longitudinal studies are needed to understand the factors at the pre-, peri-, and post-stages following the fires, which can impact the outcomes of mental health for wildfire survivors. Another limitation of the study was the absence of measures

of coping/resilience, which could have shed some light on the differences between the three countries. Finally, the differences in the timeline of fire occurrences for the three countries may have contributed to the current findings. While the USA and Canada faced wildfires in 2022–2023, Australia's latest wildfires were in 2020.

4.5.3 Conclusions

Overall, the current cross-cultural sample showed differences in anxiety, insomnia, and PTSD symptoms. Variables such as gender, income, and employment contributed partially to the observed differences. The current findings also indicated that participants from the USA reported more severe levels of mental health conditions than their counterparts in Australia and Canada. The differences between Australia, Canada, and the USA may be attributable to differences in the availability of resources to survivors of wildfires and differences in policies pertaining to forest management and land practices. International collaborative research will offer one way of communication in responding to and recovering from wildfire disasters, as there are valuable lessons to be learned from Australia, Canada, and the USA.

Author Contributions

Conceptualization, F.I. and G.A.K.; methodology, F.I. and G.A.K.; validation, F.I., G.A.K. and S.R.T.; formal analysis, F.I. and G.A.K. data curation, F.I.; writing—original draft preparation, F.I. and G.A.K.; writing—review and editing, F.I., G.A.K., B.K., S.R.T. and M.D.B.; visualization, F.I., G.A.K., B.K., S.R.T. and M.D.B.; supervision, G.A.K., B.K., S.R.T. and M.D.B.; project administration, F.I.; funding acquisition, F.I. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

This study obtained ethical approval from the Federation University Human Ethics Committee, Australia (Ethics code # A21-124).

Informed Consent Statement

Informed consent was obtained from all participants.

Data Availability Statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical restriction.

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Conflicts of Interest

The authors declare no conflict of interest.

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Foreword to Chapter 5

One conclusion drawn from Chapter 4 was that symptoms of post-traumatic stress disorder (PTSD) varied significantly across Australia, Canada, and the United States of America. While disparities among these countries can partly be attributed to differences in resource availability and policies related to mitigation of and emergency response following disasters, other pre-trauma variables also influence this disparity. Factors such as age, sex, psychosocial elements, and prior diagnoses of mental health conditions like insomnia, nightmares, PTSD, anxiety, and depression can significantly increase survivors' vulnerability to developing PTSD symptoms following wildfires. Compounded trauma, for that matter, has been extensively researched in different populations including veterans and sexual assault victims with limited to non-existing research concerning wildfire survivors.

Therefore, the primary aim of Chapter 5 was to investigate whether pre-existing mental health conditions such as insomnia, nightmares, anxiety, depression, and PTSD symptoms act as risk factors for the development of trauma symptoms following wildfires. Understanding cumulative trauma in individuals exposed to natural disasters is crucial for researchers and clinicians. This knowledge helps in developing and preparing tailored treatment packages that address a broad range of health conditions which might otherwise be overlooked when individuals seek treatment. This comprehensive approach can lead to more successful treatment outcomes and improved recovery rates for survivors.

Chapter 5: Pre-Existing Depression, Anxiety and Trauma as Risk Factors for the Development of Post-Traumatic Stress Disorder Symptoms Following Wildfires

The content of Chapter 5 is identical to my earlier publication "Isaac, F., Toukhsati, S. R., Klein, B., Di Benedetto, D., & Kennedy, G. (2023). Pre-existing depression, anxiety and trauma as risk factors for the development of post-traumatic stress disorder symptoms following the trauma of wildfires. *Psychiatry Research Communications*, *4*(2), 100161. https://doi.org/10.1016/j.psycom.2024.100161." The reproduction of this chapter's content is permitted under the journal's copyright agreement, which allows authors to reuse their work for non-commercial purposes (refer to Appendix I).

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5.1 Abstract

The trauma of wildfires leads to one of the most challenging and treatment resistant mental health conditions-namely-post-traumatic stress disorder (PTSD). Research addressing the contribution of pre-existing mental health conditions to the development of PTSD symptoms following traumatization by wildfires is limited. This study examined whether people with pre-existing diagnoses of anxiety, depression, PTSD, insomnia and nightmares, by a mental health professional, are more likely to develop symptoms of PTSD than those with no previous diagnosis following the trauma of wildfires. A total of 126 wildfire survivors from Australia, Canada and the United States of America completed an online survey. An independent sample *t-tests* revealed that pre-existing diagnosed conditions of depression, an anxiety disorder and PTSD significantly increased the likelihood of developing PTSD symptoms following traumatization by wildfires (t = -2.51, p = 0.014, 95% CI [-18.91 to -2.20], t = -2.61, p = 0.01, 95% CI [-18.91 to -2.57], t = -2.57, p = 0.012, 95% CI [-22.36 to -2.87] respectively). Practitioners working in communities subjected to wildfires need to run a thorough screening of their patients' pre-existing mental health conditions to provide the right treatment and referral pathways to those affected by the trauma of wildfires.

Keywords: PTSD, anxiety, depression, trauma, wildfires, insomnia

5.2 Introduction

There has been a tenfold increase in natural disasters since 1960, with a further predicted and inevitable increase over the next two decades (The Royal Commission, 2020; Vision of Humanity, 2020). Wildfires severely and negatively impact infrastructure, agriculture, forestry and wildlife, and have deleterious effects on people's lives (The Royal Commission, 2020). More specifically, the impact of fires on mental health is palpable, with many survivors reporting multiple mental health conditions following wildfires such as depression, anxiety, alcohol and substance use, sleep difficulties, and post-traumatic stress disorder (PTSD) (Bryant et al., 2014, Isaac et al., 2023, To et al., 2021).

The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) defines PTSD as any event that involves exposure to and/or witnessing a life-threatening event where a person's life and/or their physical integrity is severely threatened leading to physical and/or psychological injuries (APA, 2013). Reactions during traumatic events include but are not limited to extreme fear, horror and feeling of helplessness. A diagnosis of PTSD is warranted if the following symptoms are present: (1) re-experiencing or reliving the traumatic event; (2) deliberate avoidance of cues or stimuli associated with the traumatic event and emotional numbness; and (3) prominent arousal state. The symptoms must be present for at least one month and must lead to significant disruptions in daily functioning (APA, 2013).

Post-traumatic stress disorder is highly prevalent in wildfire survivors, ranging between 39.6% and 77.88%, leading to major challenges in managing and treating the disorder (Belleville et al., 2019; Isaac et al., 2023; Mao et al., 2022). The negative impact of PTSD is far-reaching with studies indicating negative effects to both physical and

psychological health. For example, those with PTSD diagnosis are significantly more likely to experience stroke, heart attacks, coronary disease, bodily pain, renal disease, asthma, arthritis, interpersonal difficulties, income reduction, increased stress levels and increased risk of suicide (Asnaani et al., 2014; Glaesmer et al., 2011; Maia et al., 2011; Sareen, 2014; Sareen et al., 2011; Spitzer et al., 2009).

There is consensus among researchers that pre-trauma experiences such as childhood abuse, family history of psychopathology, prior diagnosis of depression, anxiety, and sleep conditions such as insomnia and nightmares are significant risk factors in the development of PTSD following traumatic events (Agyapong et al., 2021; Brewin et al., 2000; Mao et al., 2022; Ozer et al., 2003; Weber & Wetter, 2022). Additionally, other factors taking place during and immediately after the traumatic event such as lack of social support, negative appraisal of the trauma and its sequalae, and additional stressors equally contribute to the development of PTSD (Ehlers, & Clark, 2000; Heron-Delaney et al., 2013; Sareen, 2014). The combination of both pre-and-post-trauma experiences clearly play a role in the development of psychopathology in survivors of wildfires. However, there is particularly limited research on the type of risk factors preceding the trauma of wildfires on the development of PTSD in fire survivors. Since, the development of PTSD can be unique to the actual characteristics of the trauma of wildfires (To et al., 2021), there is a need for acquiring more knowledge about the risk factors that may contribute to the development of PTSD in this cohort. Gaining an insight on which risk factors play a role in the development of PTSD, may lead to better and more tailored treatment plans addressing the needs of wildfire survivors. This in turn, may lead to better treatment outcomes, and more rapid recovery for survivors. In addition, advances in wildfire research can help shape current and future policies and

procedures related to prevention, mitigation, and recovery from mental health conditions/PTSD in affected communities (Montesanti et al., 2022).

This study investigated some key risk factors such as pre-existing depression, anxiety, PTSD, insomnia and nightmares in the emergence of PTSD symptoms following the trauma of wildfires.

5.2.1 Aims of the Study

The first aim of this study was to explore whether wildfire survivors with pre-existing diagnoses of anxiety, depression, PTSD, insomnia and nightmares, are significantly more likely to develop symptoms of PTSD than those with no previous diagnoses following the trauma of wildfires. The second aim was to compare the mean score for PTSD in the current study with the mean score reported in other studies of wildfire survivors.

5.3 Method

5.3.1 Participants

The sample was 126 survivors of wildfires from Australia, Canada and United States of America. Twenty-three males (18.3%), 102 females (81%), and one nonbinary (0.8%) participant took part in an online survey. Ages in the sample ranged from 20 to 92 years (M = 52 years, SD = 14.4). Demographic information collected in the survey included sex, education, employment, marital status, country of residence, and diagnosis of mental health condition/s by a health professional prior to the experience of wildfires.

5.3.2 Measures

The Insomnia Severity Index Scale (ISI): the ISI is a seven-item scale that is used to measure the severity of insomnia symptoms (Bastien et al., 2001). In the current study Cronbach's alpha for the ISI was .92. A cut-off score of 14 provides 82.4% sensitivity, and 82.1% specificity for detecting clinical insomnia (Gagnon et al., 2013).

Generalized Anxiety Disorder Questionnaire (GAD-7): is a seven-item self-report scale that is used to measure the presence and severity of anxiety symptoms (Spitzer et al., 2006). In this study, Cronbach's alpha was .95. A cut-off score of 10 is identified as the optimal point for sensitivity of (89%) and specificity of (82%) for detecting clinical anxiety (Spitzer et al., 2006).

The Patient Health Questionnaire (PHQ-9): the scale consists of nine items. It is used to measure the presence of depression, with scores higher than10 indicating the presence of depressive disorder (Kroenke et al., 2001). In this study Cronbach's alpha for the PHQ-9 was .91.

***PTSD Checklist for DSM-5 Scale (PCL-5 – Civilian Version)*:** seventeen self-report items make up the PCL-5. The scale provides provisional diagnosis of PTSD (Weathers et al., 2013). A cut-off score of 31 to 33 discriminates between people with or without provisional diagnosis of PTSD (Weathers et al., 2013). In this study, Cronbach's alpha was.95.

Disturbing Dream and Nightmare Severity Index DDNSI: the DDNSI is a five-item-scale that measures the frequency and severity of disturbing nightmares and dreams. Scores greater than 10 reflects the presence of nightmare disorder (Krakow et al., 2002).

5.3.3 Procedure

A URL link about the online study was advertised following ethics approval from (Federation University Ethics Committee, approval number: A21–124) via social media and Facebook campaigns between October of 2021 and March of 2022. Adult participants who were fluent in English and experienced wildfires within the previous 10 years, were eligible to participate. A plain language statement was presented and participants who wished to take part in the study selected an "I agree" button after reading the plain language statement.

5.3.4 Data Analysis

Means and standard deviations were calculated for all dependent variables. Independent groups *t-tests* were used to compare participants who reported having or not having diagnoses of mental health conditions prior to the occurrence of wildfire trauma on each of the dependent variables.

5.4 Results

5.4.1 Descriptive Statistics for the Groups

Using the cut-off scores reported in section 5.3.2, Table 5.1 shows the number and percentage of participants diagnosed with or without, depression, anxiety, PTSD, insomnia and nightmare disorder prior to the trauma of wildfires. Approximately, around 15% to 20% of participants reported pre-existing anxiety, depression and insomnia, while 11.9% and 9.5% reported pre-existing PTSD and nightmares, respectively.

Table 5.1

Frequencies and Percentages of Diagnosis of Depression, Anxiety, PTSD, Insomnia and Nightmare Disorders Prior to Wildfires

Variables	Yes *n* (%)	No *n (%)*
Anxiety disorder before fires	22(17.5%)	104(82.5%)
Depression before fires	25(19.8%)	101(80.2%)
Insomnia before fires	19(15.1%)	107(84.9%)
Nightmares before fires	12(9.5%)	114(90.5%)
PTSD before fires	15(11.9%)	111(88.1%)

Note. $N = 126$ for all variables

5.4.2 Mean Differences Among Groups

Table 5.2 shows means and standard deviations for those who reported being diagnosed by a mental health professional, prior to the trauma of fires with depression, anxiety disorder, PTSD, insomnia and nightmare disorders. Independent groups *t-tests* showed that the PCL-5 scores were significantly higher in those with previous diagnoses of depression, anxiety and PTSD than participants with no previous diagnoses. There were no significant differences between participants with or without previous diagnoses of insomnia and nightmares on the PCL-5 scores prior to the trauma of wildfires.

Table 5.2

Comparison of the PCL-5 Mean Scores for Groups Based on Previous Diagnosis of Depression, Anxiety, PTSD, Insomnia and Nightmare Disorders

Variable	No *M(SD)*	Yes *M(SD)*	*t(df)*	*p*	95% CI
Pre-Anxiety	44.36(17.00)	55.10(14.45)	-2.61(102)	0.01	[-18.91 – -2.57]
Pre-Depression	44.49(16.64)	55.05(16.41)	-2.51(102)	0.01	[-18.91 – -2.20]
Pre-ISI	45.70(17.49)	50.37(13.99)	-1.01(102)	0.32	[-13.84 – 4.50]
Pre-NTM	45.59(16.42)	54.30(21.29)	-1.55(102)	0.12	[-19.87 – 2.44]
Pre-PTSD	44.85(16.94)	57.46(13.48)	-2.57(102)	0.01	[-22.36 – -2.87]

Note. Pre-Anxiety = previous diagnosis of anxiety prior to wildfires; Pre-Depression = previous diagnosis of depression prior to wildfires; Pre-ISI= previous diagnosis of insomnia prior to wildfires; Pre-NTM= previous diagnosis of nightmares prior to wildfires; Pre-PTSD = previous diagnosis of PTSD prior to wildfires; CI = confidence intervals.

5.4.3 Prevalence of PTSD and Means Comparison Between the Current Sample and a Representative Sample of Wildfire Survivors

A total of 104 participants provided data on the PCL-5; using a cut-off score of 33, 29 (27.9%) participants reported no PTSD symptoms, and 75 (72.1%) participants reported symptoms of PTSD. To examine whether PTSD symptoms were higher in the present study than those reported in a representative sample of wildfire survivors, a single sample *t-test* was used and showed that the mean score for the PCL-5 ($M = 46.42$, $SD = 17.02$) in the present study was significantly higher than the mean score reported in Silveira et al.'s (2021) sample ($N = 725$) ($M = 26.68$, $SD = 19.50$), $t = 11.83$, $p < 0.001$ (95% CI, 16.43-23.05).

5.5 Discussion

The first aim of this study was to establish whether pre-existing diagnosis of anxiety disorders, depression, PTSD, insomnia and nightmares posed risks to the development of PTSD symptoms following the trauma of wildfires.

5.5.1 Anxiety Disorders and the Emergence of PTSD Symptoms

The current results showed that those with a previous anxiety diagnosis were significantly more likely to report PTSD symptoms following the trauma of wildfires as measured by the PCL-5 (Weathers et al., 2013). This finding is consistent with previous cross-sectional research. For example, in a sample of 486 wildfire survivors, Agyapong et al. (2021) found that prior diagnosis of anxiety increased the risk ($p = 0.01$) for developing PTSD six months following wildfires. A more recent study by Mao et al. (2022) found that survivors with a history of anxiety (59.45%, $N = 186$) disorders prior to the trauma of wildfires were significantly more likely to develop PTSD than those with no previous diagnosis of anxiety (25.3%, $p < 0.001$).

5.5.2 Depression and the Emergence of PTSD Symptoms

The current results also revealed that survivors with a history of depression were significantly more likely to develop PTSD symptoms following the trauma of fires. The current results lend support to previous research in this field. A study of 186 survivors of the Fort McMurray fires found that those who received a diagnosis of depression from a mental health professional (67.3%) were five times more likely to develop PTSD than those without a history of depression (26.8%) (Mao et al., 2022). Researchers suggest that people with depression are more susceptible to experience traumatic experiences than those without depression leading to the development of other disorders such as PTSD (Mao et al., 2022). This link between depression and PTSD is based on cross sectional designs. Therefore, it is not well known whether those who receive diagnosis of depression in adulthood are individuals that have been subjected to trauma in early childhood, and as such, are more likely to report more trauma and higher rates of PTSD, or whether individuals with depression are more likely to report the severity of events as more traumatic than their counterparts without depression (Withers et al., 2013). It is evident that the two disorders have a bidirectional relationship (Withers et al., 2013).

Another line of research of 2085 individuals found that diagnosis of anxiety disorders and depression prior to the trauma of fires significantly predicted diagnosis of PTSD following the trauma (Parslow et al., 2006). Research shows that depression, anxiety, and PTSD share a biological underpinning. Perhaps this overlap provides the basis for the likelihood of participants with previous history of depression and anxiety to develop PTSD following the trauma of wildfires (Smoller, 2016; Withers et al., 2013).

5.5.3 Insomnia, Nightmares and the Emergence of PTSD Symptoms

The current results showed that previous diagnosis of insomnia and nightmares did not increase survivors' chances of developing PTSD symptoms following the experience of wildfires. The current results contradict previous research findings whereby previous sleep disorders predicted PTSD (Belleville et al., 2019)

In a study of 30 individuals diagnosed with clinical PTSD, Short et al. (2018) found that PTSD related fear of sleep, PTSD, depression, anxiety severity and daytime nightmares significantly predicted poor sleep, and reduced efficiency of sleep; and daily PTSD symptoms and fear of sleep significantly predicted the occurrence of nightmares. Fear of sleep has also been confirmed as a significant predictor of poor sleep quality in individuals with trauma (Pruiksma et al., 2014). It is possible that fear of sleep, daytime nightmares, and PTSD related symptoms, can lead to insomnia, which in turn may lead to PTSD (Pruiksma et al., 2014; Short et al., 2018). However, the current study did not take into account fear of sleep or daytime nightmares and therefore, future research can investigate the association between such factors and the development of PTSD. It is also possible that PTSD may proceed sleep disorders.

5.5.4 Previous PTSD Diagnosis and the Emergence of PTSD Symptoms Following the Fires

Similarly, the current results showed that survivors with a history of PTSD, diagnosed by a mental health professional prior to the fires, were significantly more likely to develop symptoms of PTSD following the trauma of wildfires. Stress sensitization theory suggests that severity level of trauma plays a significant role in determining how survivors respond to stress following a traumatic event (Schoedl et al., 2014). Research affirms that trauma is linearly associated with an increase in PTSD symptoms (F (4,912)

= 7.60, p = 0.001, N = 922) (Suliman, et al., 2009). People who experience greater loss following a trauma such as losing loved ones and belongings are more likely to feel vulnerable especially in the first year following a disaster (Isaac et al., 2023; Smid et al., 2012). It is possible that cumulative trauma may make survivors more vulnerable and reactive, intensifying their reactions to subsequent trauma rather than enhancing their resilience to stressful factors (Schoedl et al., 2014; Smith et al., 2008).

The second aim examined whether the mean score of PTSD symptoms as measured by the PCL-5 (Weathers et al., 2013) in the present study was higher than the mean score reported in a representative sample of wildfire survivors.

5.5.5 Comparing the Means on the PCL-5

The mean score in the current study was significantly higher than that reported by Silveira et al (2021). It is noteworthy to highlight that prior to the commencement of data collection for this survey, multiple states in the USA and Canada were affected by wildfires of a severe nature including California, Oregon, Nevada, Alberta, and British Columbia. Given the wildfire experience recency, this may explain why the mean score of PTSD symptoms in the current study was significantly higher than that reported by Silveira et al (2021). In addition, the first few years after a disaster, stress sensitization may occur in survivors who experienced extreme disaster exposure. In turn, increased response to stress is expected in survivors, providing a rationale for the current high prevalence of PTSD in our study sample (Smid et al., 2012).

5.5.6 Implications

Clinicians working in communities subjected to wildfires may need to make screening for PTSD, depression and anxiety disorders a standard practice. Having a thorough understanding of a survivor's mental health can guide the provision of a more tailored treatment plans for those affected by wildfires. This, as a result, may lead to a

more successful treatment outcomes and better recovery rate for survivors. Preparing and training aid workers to also pay attention to early signs of stress and provide pathways for early intervention is also warranted.

5.5.7 Limitations

This study is not without its limitations. It is a retrospective study, and previous diagnosis of depression, anxiety and PTSD are based on survivors' accounts. Therefore, longitudinal studies are needed whereby regular assessments of mental health conditions in the pre, peri and post periods of wildfires may provide a better understanding about the nature of the relationship between different risk factors and the development of PTSD. Furthermore, a proportion of the current sample may have had pre-existing mental health conditions such as depression, anxiety disorders, PTSD and sleep disorders that were not formally diagnosed prior to the trauma of wildfires leading to an under-representation of the current findings. Another major limitation of the study is the over-representation of females in the current sample in comparison to males. Not only females are twice as likely as males to develop PTSD (Perrin et al., 2014), they are also more likely to report depression and anxiety symptoms (Borooah, 2010). The unequal proportion of males to females in the current sample maybe due to our recruitment method. While online data collection methods are becoming increasingly more popular in research, they introduce an unconstrained selection bias in relation to age and gender (Haddad et al., 2022). Finally, the absence of a measure for substance abuse was another major limitation in the current study. Both depression and anxiety can be co-morbid conditions with substance abuse (Garey et al., 2020), which in turn, can lead to the development of PTSD.

5.5.8 Conclusion

The current findings suggest that pre-existing diagnosis of depression, anxiety disorders, and PTSD prior to the trauma of wildfires may increase the risk of developing PTSD symptoms following the trauma of wildfires.

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CRediT authorship contribution statement

Fadia Isaac: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Samia R. Toukhsati:** Conceptualization, Supervision, Visualization. **Britt Klein:** Conceptualization, Supervision, Visualization, Writing – review & editing. **Mirella Di Benedetto:** Supervision, Writing – review & editing. **Gerard A. Kennedy**: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors have no conflicts of interest to declare.

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Foreword to Chapter 6

The first part of this thesis, Chapters 2-5, established that insomnia, nightmares, and PTSD symptoms are highly prevalent among wildfire survivors. These chapters provided prevalence rates for the three disorders through an international survey conducted in Australia, Canada, and the United States of America. The survey also revealed variations in mental health condition prevalence, including sleep and trauma symptoms, among individuals from the three countries. Additionally, prior diagnosis of depression, anxiety, or PTSD significantly increased the likelihood of developing PTSD symptoms following wildfires.

Treating individuals who present with both sleep and trauma symptoms poses unique challenges, with some researchers advocating for either focusing on sleep or trauma symptoms independently, or treating both concurrently. Consequently, we aimed to review the literature systematically to identify the most effective treatment modalities for individuals presenting with both sleep and trauma symptoms. The overarching objective was to inform the design of clinical trials using the therapies identified in this systematic review. By identifying suitable and effective treatments, we can potentially assist in developing treatment protocols tailored for wildfire survivors, presenting with both sleep and trauma symptoms.

Chapter 6: Cognitive Behavioral Therapy-Based Treatments for Insomnia and Nightmares in Adults with Trauma Symptoms: A Systematic Review

The content of Chapter 6 is identical to my earlier publication "Isaac, F., Toukhsati, S. R., DiBenedetto, M., & Kennedy, G. A. (2022). Cognitive behavioral therapy-based treatments for insomnia and nightmares in adults with trauma symptoms: a systematic review. *Current Psychology*, *42*(27), 23495-23505. https://doi.org/10.1007/s12144-022-03512-1." The content of this chapter has been reproduced with permission from Springer Nature (refer to Appendix E).

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6.1 Abstract

Cognitive behavioral therapy (CBT)-based treatments for insomnia and nightmares in people with post-traumatic stress disorder (PTSD) have been shown to reduce sleep and other trauma-related psychological symptoms. In this review, we assessed the effectiveness of CBT-based treatments for diagnosed insomnia and/or nightmare disorders in adults exposed to trauma in studies that used both self-report and objective measures of sleep. We performed a search using EBSCO, MEDLINE, PsychINFO, CINAHL, Scopus, EMBASE, PubMed, Cochrane Library and Taylor & Francis databases between January 2021 and January 2022. Five studies met the inclusion criteria. The findings indicated that CBT for insomnia (CBT-I); a brief exposure, relaxation, and rescripting therapy (ERRT); and imagery rehearsal therapy (IRT) were all effective treatments in reducing the frequency and severity of nightmares in trauma-exposed participants as measured by the Pittsburgh Sleep Quality Index and its Addendum (PSQI-A), and improved sleep efficiency (SE) at post-treatment and 6-month follow up. Objective measures of sleep such as polysomnography (PSG) and other physiological methods are promising tools for assessing the effectiveness of sleep-specific psychological and behavioral treatments for insomnia and nightmares in trauma-exposed individuals. The findings emerging from this review showed that a successful treatment of insomnia and/or nightmares with CBT-based treatments resulted in a reduction of post-traumatic stress symptomology.

Keywords: CBT, insomnia, nightmares, PTSD, actigraphy, polysomnography

6.2 Introduction

Post-Traumatic Stress Disorder (PTSD) is one of the most frequently reported psychopathological conditions following trauma. PTSD occurs in people who experience and/or witness, either directly or vicariously traumatic events such as accidents, natural disasters and personal assaults (APA, 2013). Depending on the country of residence and social background, the lifetime prevalence of PTSD ranges from 1.3 to 12.2%, (Karam et al., 2014). PTSD leads to several negative physical, psychological and social sequelae. These include but are not limited to physical pain, gastrointestinal and cardio-respiratory issues, anxiety, depression, premature death, onset of Type 2 diabetes, drug and alcohol use, reduced occupational capacity and loss of important personal relationships (Pacella et al., 2013; Pietrzak et al., 2011; Shalev et al., 2017; Schlenger, et al., 2015; Vogt et al., 2016).

Insomnia and nightmares are the most prevalent sleep disturbances reported by people with PTSD (Buysse et al., 2006; Pruiksma et al., 2016). Studies show that 70% to 91% of people with PTSD have difficulty initiating sleep, staying asleep, and may experience chronic nightmares (Neylan et al., 1998; Ohayon & Shapiro, 2000). Notably, insomnia and nightmares are the most frequently reported residual health problems following a successful resolution of PTSD treatment with psychological interventions (Pruiksma et al., 2016).

In a sample of 108 US military veterans receiving psychological treatment for PTSD, insomnia and nightmares were highly prevalent at baseline (92% and 69%, respectively), and remained high following psychological treatment (77% and 52%, respectively) (Pruiksma et al., 2016). A recent clinical trial by Taylor and colleagues (2020) showed that both insomnia and nightmares remained in the clinically significant

range following a prolonged exposure therapy treatment for PTSD even among those who achieved remission of PTSD.

6.2.1 Theoretical Framework

Youngren and colleagues (2020) proposed a Nightmare Cognitive Arousal Processing (Night-CAP) model that explains how the presence of sleep difficulties predict the development of PTSD. More specifically, pre-sleep cognitive arousal, worry and rumination, and sleep latency predict the occurrence of post-traumatic nightmares. When levels of sleep latency and pre-sleep cognitive arousal are high, an individual is at an increased risk of developing/experiencing post-traumatic nightmares (Youngren et al., 2020). The Night-CAP model suggests that rumination provides the right opportunity for longer period of rehearsing of negative cognitions about the actual trauma priming the content of nightmares that replay during sleep.

Similarly, the longer an individual spends in waking-state wanting to fall asleep the more pressure to fall asleep leading to rapid eye movement (REM-sleep stage) rebound and more prompt entry into REM sleep. Dreams are more likely to take place during REM; providing a rationale as to why sleep latency leads to more post-trauma nightmares (Youngren et al., 2020). The presence of trauma related nightmares, pre-sleep cognitive hyperarousal and sleep latency will increase vulnerability to the development of PTSD (Agorastos, et al 2014; Youngren et al., 2020).

Even though the Night-CAP model provides a framework of how an individual is at increased risk of developing trauma related nightmares following trauma, the model can be utilized to describe how insomnia can also emerge as a result of both sleep latency and pre-sleep cognitive arousal. Insomnia is known as a hyperarousal disorder; external as well as internal factors such as alterations in neurobiological brain process can, in turn, lead to neurophysiological hyperarousal, variations in behavioral and psychological

processes and behavioral conditioning learning which, in turn, increases vulnerability to the development of insomnia and associated health risks (Levenson et al., 2015). The Night-CAP model lends support to the premise that treating sleep disturbances in those exposed to trauma will lead to better outcomes for both sleep and post trauma symptoms (Agorastos, et al 2014; Levenson et al., 2015).

Studies suggest that treating sleep disturbances in those with PTSD leads to better outcomes in terms of both improved sleep and also reduced trauma symptoms (Colvonen et al., 2018). Some of the sleep-focused psychological treatments include: (1) cognitive behavioral therapy for insomnia (CBT-I) which encompasses sleep restriction, stimulus control, cognitive component, and sleep hygiene (Morin & Espie, 2007); (2) exposure, relaxation, and rescripting therapy for nightmares (ERRT) which consists of psychoeducation about nightmares, sleep hygiene, muscle relaxation, exposure and rescripting of chronic nightmares (Davis & Wright, 2007); (3) imagery rehearsal therapy (IRT) consists of education about sleep, nightmares, homework of personalized pleasant imagery scenes, rescripting of the nightmare, problem solving and relapse prevention (Krakow & Zadra, 2010).

Multiple systematic reviews and meta-analyses have explored the effectiveness of sleep focused therapy on sleep disorders as well as PTSD symptoms. For example, a meta-analysis of 11 randomized controlled trials (RCTs) assessed the effectiveness of CBT-I, IRT and ERRT on sleep and found that these treatments significantly improved sleep quality and also reduced PTSD symptoms, with a moderate effect size of $ES = 0.6$, for the treatment group. In addition, the overall effect size as measured by sleep-diaries for sleep efficiency (SE), sleep onset latency, wake after sleep onset, Insomnia Severity Index (ISI), and the Pittsburgh Sleep Quality Index (PSQI) were large ($ES = 0.83$-1.15) in comparison to waitlist groups (Ho et al., 2016).

Similarly, Casement and Swanson (2012) identified 13 studies in their review and found that sleep-specific psychological treatments (IRT or IRT+ CBT-I, or ERRT, or EERT+CBT-I) significantly reduced nightmare frequency (*ES*= 0.59), significantly improved sleep quality (*ES* = 0.69) and significantly reduced PTSD symptoms with a large effect size (*ES* = 0.67) for the treatment groups in comparison to the control groups. Other reviews reported comparable results (Taylor & Pruiksma, 2014; Wu et al., 2015).

6.2.2 Gaps in the Literature

The presentation of sleep disorders in people with PTSD symptoms is different to those who suffer from insomnia unrelated to traumatic events. Whilst those who suffer from insomnia without trauma may look forward to sleep, individuals suffering from insomnia related to trauma view sleep as "a necessary evil" (Ulmer et al., 2011, p. 58). Individuals presenting with sleep and PTSD symptoms tend to overestimate their sleep latency, how long it takes them to sleep, are more likely to experience hypervigilance at night, and worry more relative to those that present with sleep difficulties only (Perlis et al., 2001; Semler & Harvey, 2007).

Literature reporting on the effectiveness of psychological treatments for insomnia and nightmares in individuals exposed to trauma use self-report measures such as sleep diaries. There are issues with self-report measures being prone to bias and issues with validity checks/ whether they were completed at the time indicated (Buysse et al., 2006; Dietch et al., 2019).

Objective measures such as polysomnography (PSG) and actigraphy are recommended for utilization in assessing sleep-specific interventions in conjunction with self-report measures to gain more confidence in treatment outcomes (Buysse et al., 2006; Dietch et al., 2019). PSG, the gold standard in the diagnosis of sleep disorder, provides heart rate, activity of brain waves, oxygen levels in the blood, breathing, and eye and leg

movements during sleep; it is also used to objectively measure sleep and the various sleep stages (Buysse et al., 2006).

Actigraphy is an objective measure of sleep that provides data about sleepiness and wakefulness states, it also generates estimates of sleep parameters that are usually collected from sleep diaries and PSG (Smith et al., 2018). To date, no reviews have exclusively assessed the effectiveness of objective measures of sleep and how they align with self-report measures in providing a general overview of sleep-specific treatment outcomes in those with trauma symptoms. Therefore, a better understanding of available psychological interventions through selecting high quality RCTs that assess sleep disorders both objectively and subjectively is likely to underscore a better understanding of available effective treatments.

Better understanding of the alignment between self-report and objective measures will further strengthen sleep diagnosis, not only for researchers but also for clinician and primary care of their patients. This in turn will inform treatment and referral processes (Gieselmann et al., 2018). A major limitation in the aforementioned systematic reviews was the exclusion of objective measures in assessing the effectiveness of sleep-specific psychological treatment outcomes. More specifically, some reviews used trials without control groups (Casement & Swanson, 2012), and others included non-peer reviewed studies (Ho et al., 2016). As such, this review tries to address the above gaps.

6.2.3 Aims of this Review

In this review, we aimed to extend the work that has been carried out by other reviews. Firstly, we aimed to synthesize the available literature from RCTs that used both self-report and objective measures of sleep. Secondly, we examined the effectiveness of sleep-specific psychological treatment in those diagnosed with insomnia and/or nightmares comorbid with post-traumatic stress symptoms. Finally, we explored the

effectiveness of sleep-specific psychological treatment on post-traumatic stress symptoms.

6.3 Method

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PRISMA) (Moher et al., 2009), searchers were conducted between January of 2021, and January of 2022. We performed a literature search using EBSCO, MEDLINE, PsychINFO, CINAHL, EMBASE, PubMed, Cochrane Library and Taylor & Francis databases by entering the following terminologies: (insomnia OR parasomnia OR hypersomnia OR insomniac OR night terror* OR nightmare*) AND (post-traumatic stress disorder* OR PTSD OR depression OR major depressive disorder* OR trauma OR complex trauma) AND (Psychological intervention* OR Psychotherapy* OR Psychological treatment* OR Cognitive behavioural therapy* OR cognitive behavioral Therapy* OR CBT OR multi-model CBT OR EMDR OR multicomponent psychotherapy* OR Imagery Rehearsal Therapy* OR IRT, Exposure, Relaxation, and Re-scripting Therapy* OR ERRT OR CBT-I) NOT (Pharmacotherapy*) AND (actigraph* OR actimetry OR polysomnograph OR PSG OR objective measures OR objective sleep OR sleep parameters). The following terminologies were entered into Scopus as the pre-determined terminologies yielded no results: (insomnia OR nightmares AND posttraumatic AND stress AND trauma AND objective AND measures AND psychological AND intervention AND randomized AND trials). An additional search checking reference lists and Google Scholar was carried out. Figure 6.1 provides a map of our literature search. Table 6.1 provides details of the selected studies, and Table 6.2 provides assessment of risk of bias (Higgins et al., 2019).

6.3.1 Study Inclusion Criteria

Inclusion criteria for this review considered peer reviewed RCTs; studies published in English between January 1990 and January 2022; adult population 18+; RCTs taking a diagnostic approach /being assessed by a health professional using structured clinical interview for insomnia and/or nightmares comorbid with post traumatic symptoms; RCTs primarily using and assessing the effectiveness of sleep-specific psychological interventions for insomnia and/or nightmares using both self-report and objective measures in assessing sleep.

6.3.2 Exclusion Criteria

The following studies were excluded from this review: animal studies, study protocols, symposiums, oral presentations and posters, studies with minors, qualitative studies, studies published prior to 1990, non-RCTs, studies excluding objective measures, overlapping RCTs, correlational studies, studies excluding diagnosis of sleep disorders and/or trauma related symptoms, theses, and RCTs treating PTSD rather than sleep disorders (refer to Figure 6.1).

6.3.3 Selection of Studies

The eligibility, suitability and risk of bias of selected RCTs were verified by two researchers (FI and GK). There were some concerns about data overlap for four studies. Email correspondence with one author confirmed data overlap in two papers (Davis et al., 2011) and another paper was deleted because data overlap could not be ascertained (Kanady et al., 2018).

6.3.4 Study Sample Characteristics

A total of 290 participants were included in the selected studies. There were 92 females and 198 males, with a mean age ranging between 33-41 years.

6.3.5 Outcome Parameters

Sleep efficiency (SE), derived from sleep diaries, was chosen as the primary measure of insomnia for this review. SE encompasses a number of sleep variables collected through sleep diaries. SE = total sleep time/time in bed multiplied by 100; and total sleep time (TST) = time in bed - sleep onset latency - waking time after sleep onset - morning waking time (Taylor & Pruiksma, 2014).

ISI scores (Bastien et al., 2001), were also reported where appropriate. The Pittsburgh Sleep Quality Index-Addendum (PSQI-A) was the selected measure for nightmares. PSQI-A is a self-report measure used to examine the frequency of disruptive sleep behavior and nightmares that are present in adults with PTSD (Germain et al., 2005). PSG, actigraphy and other physiological parameters were the selected objective measures of sleep in this review.

6.3.6 Statistical Data Reporting

The data presented in the results section, where available, reports on the interaction effect of time (pre-intervention against post-intervention) by group (intervention against control group). Where interaction effect is not provided, main effects alone were reported.

Figure 6.1

PRISMA Flow Diagram of Database Searches and Final Studies Selection

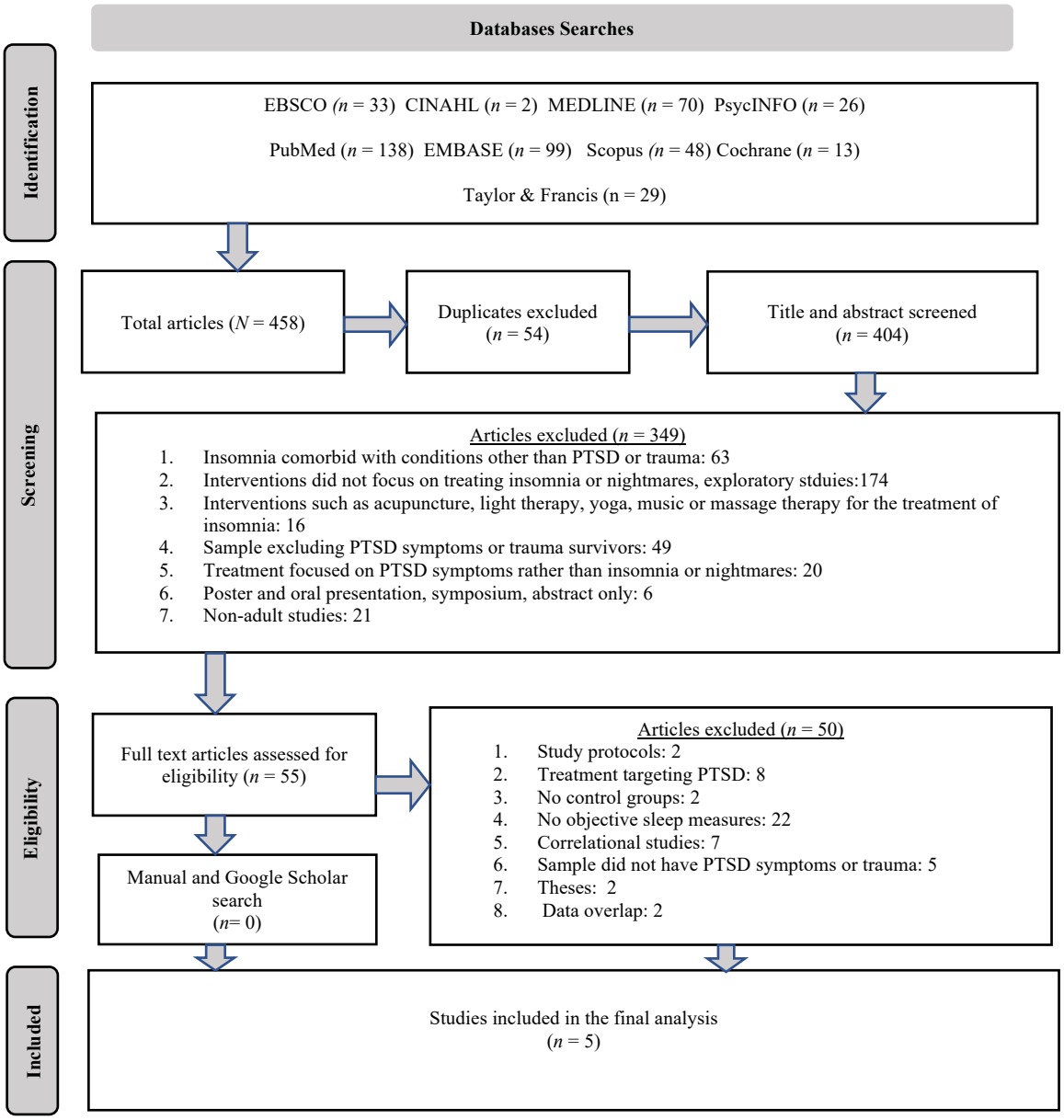

Table 6.1

Summary of Randomized Control Trials Examining the Effectiveness of Psychological Intervention on Insomnia and/or Nightmares Comorbid With PTSD

Author/Country	Sample size *N*	Group-Allocations	Therapies Implemented	Objective/Subjective Measures	Treatment Focus & Post-Trauma Symptoms	Results
Germain et al., 2012 USA	50 MV	BSI (*n* = 17) Prazosin (*n*= 18) control placebo (*n* = 15)	8 weeks of BSI 8 weeks of Prazosin or placebo	Sleep diary, ISI, PSQI, PSQI-A, PSG	Insomnia & Nightmares PTSD diagnosis using clinical structured interview	BSI significantly reduced nightmare frequency
Rhudy et al., 2010 USA	40 adults	ERRT (*n* = 19) control (*n* = 21)	3 weeks of ERRT two-hour duration waitlist control	PSQI, global sleep quality score, PSQI-A, SAM, electrodes to measure corrugator electromyogram EMG, heart rate HR, and skin conductance SC	Nightmares PTSD diagnosis using clinical structured interview	ERRT led to significantly lower physiological reactivity to nightmare imagery through the reduction of subjective emotions such as displeasure, sadness, fear and arousal at post treatment, three and six months follow up

Talbot et al., 2014 USA	45 adults	CBT-I (*n* = 29) waitlist group (*n* = 16)	8 weekly individualized CBT-I sessions	Sleep diary, ISI, PSQI, ESS, PSQI-A, Actigraphy & PSG	Insomnia PTSD diagnosis using clinical structured interview	CBT-I significantly reduced nightmares and significantly improved all measures on sleep diary and insomnia scores
Taylor et al., 2017 USA	100 MV	FTF CBT-I (n = 34) Online CBT-I (n = 33) Control group (n = 33)	6 weeks, 60-minutes sessions of either FTF CBT-I or Online CBT-I Control group received a check in call every second week for 6 weeks	Sleep diary, ISI, ESS, DBAS Actigraphy	Insomnia PTSD using PTSD Checklist-Military Version	Both FTF and online CBT-I significantly improved SE and reduced insomnia scores compared to control group FTF CBT-I outperformed online CBT-I and control group on quality of sleep
Walters et al., 2020 USA	55 MV	All participants received 12 sessions of PE then randomized to CBT-I +IRT (*n* = 12) or SCT (*n* = 11)	5 weekly, 60-minutes session of IRT + 7 weekly, 60 minutes sessions of CBT-I control group received 12, weekly 60-minute sessions of SCT	Sleep diary, ISI, PSQI, PSQI-A Actigraphy	Insomnia Nightmares PTSD diagnosis using clinical structured interview	Participants who received CBT-I were no longer in the clinical range for sleep efficiency in comparison to SCT group The addition of CBT-I to IRT led to significantly improved sleep efficiency in comparison to control groups

Note. PTSD = post-traumatic stress disorder; DBAS = The Dysfunctional Beliefs and Attitudes about Sleep; BSI = behavioral sleep intervention; CBT-I = cognitive behavioral therapy for insomnia; MV = military veterans; ERRT = exposure, relaxation, and rescripting therapy for nightmares; IRT = imagery rehearsal therapy; SCT = supportive care therapy; PE = prolonged exposure; ISI = Insomnia Severity Index; ESS = The Epworth Sleepiness Scale; PSQI-I = The Pittsburgh Sleep Quality Index; PSG = polysomnography; PSQI-A = The Pittsburgh Sleep Quality Index Addendum; SAM = A computer version of the Self-Assessment Manikin.

Table 6.2

Assessment of Risk of Bias Utilizing the Revised Cochrane Risk-of-Bias Tool for Randomized Trials (RoB 2) of the Selected Studies

Scale	Studies				
RoB 2 Bias Domains	Germain et al., 2012	Rhudy et al., 2010	Talbot et al., 2014	Taylor et al., 2017	Walters et al., 2020
Bias due to randomization	Low risk	Low risk	Low risk	Low risk	Some concerns
Bias due to departure from intended interventions (assignment to intervention)	Low risk	Low risk	Low risk	Low risk	Low risk
Bias due to departure from intended interventions (adhering to intervention)	Low risk	Low risk	Low risk	Low risk	Some concerns
Bias due to missing outcome data	Low risk	Low risk	Low risk	Low risk	High risk
Bias in measurement of outcomes	Low risk	Low risk	Low risk	Low risk	Low risk
Bias in selection of reported results	Low risk	Low risk	Low risk	Low risk	Low risk
Overall RoB 2 judgement	Low risk	Low risk	Low risk	Low risk	High risk

6.4 Results

Our search yielded four hundred and fifty-eight studies. Fifty-four duplicate studies were excluded. A total of 404 articles were screened by abstract. Of these, 349 were excluded because they did not meet the inclusion criteria (see Figure 6.1). The remaining 55 studies were assessed by full text. Of these, 50 studies were excluded for reasons provided in Figure 6.1. Five RCTs met the inclusion criteria and were selected for the final analysis of this review.

6.4.1 Findings from Selected Studies

6.4.1.1 The Effect of CBT-I and ERRT Therapy on Nightmares

Four RCTs assessed the effectiveness of psychological treatment on nightmares in those presenting with post-traumatic stress symptoms in this review. Germain et al. (2012) examined the efficacy of eight sessions of Behavioral Sleep Intervention (BSI) for sleep disturbances in veterans. BSI consisted of IRT, psychoeducation about insomnia and nightmares, stimulus control, sleep restrictions, and adherence to treatment. BSI resulted in main effects of time on the PSQI-A ($p < 0.01$) for both the treatment and the placebo group. No significant treatment by time interaction was detected. Researchers of this study attributed their findings to the small sample which included veterans with low nightmare frequency and low severity of post-traumatic stress symptoms (42% of the sample) (Germain et al., 2012).

Likewise, Rhudy et al. (2010) applied three sessions of ERRT and found that ERRT led to a significant interaction of treatment by time effect ($p < 0.04$) with lower scores on subjective measures of emotions such as displeasure (d =1.24), sadness (d = 0.90), fear (d =1.20), and arousal (d = 0.68) (all $p < 0.001$) from baseline to posttreatment for the treatment group compared to the waitlist control group (Rhudy et al., 2010).

Furthermore, Talbot et al. (2014) assessed the effectiveness of eight sessions of CBT-I for the treatment of insomnia. CBT-I resulted in a significant group by time effect ($p < 0.001$), with participants receiving CBT-I experiencing a significant reduction on PSQI-A scores from pre-treatment to six months follow-up ($p < 0.001$, $d = 1.07$) compared to the waitlist group (Talbot et al., 2014). Similarly, 12 sessions of CBT-I and IRT, led to a non-significant yet large decrease main time effect on nightmare frequency ($p = 0.11$, $d = 0.90$) compared to a control supportive care therapy from pre-to post-treatment (Walters et al., 2020) (see Table 6.1 for group comparisons).

Taken together, the findings of studies outlined above suggest that both CBT-I treatment alone or combined with IRT or ERRT (average of 3-12 sessions) led to a reduction in nightmares frequency with medium to large effect sizes for individuals presenting with post-traumatic stress symptoms (Germain et al., 2012; Rhudy et al., 2010; Talbot et al., 2014; Walters et al., 2020).

6.4.1.2 CBT-I Effectiveness on Diary Measures

SE as indexed by sleep diaries was further explored by examining the effectiveness of CBT-I for insomnia in three studies in this review. Germain et al. (2012) found that eight sessions of BSI, resulted in no significant group by time interaction effect for BSI and prazosin/sleep medication for insomnia as measured by the ISI (Bastien et al., 2001) compared to the placebo group. However, at four months follow up, results showed a group by time interaction (post-treatment $p < 0.04$, and follow-up $p < 0.009$) on ISI with noticeable improvement for the BSI group compared to the prazosin group.

Similarly, Talbot and colleagues (2014) found a significant group by time interaction for SE with participants receiving eight sessions of CBT-I experiencing significantly more improvements from pre-to-post-intervention ($p < 0.001$, $d = 1.06$) and at six months follow up ($p < 0.001$, $d = -1.48$) compared to the waitlist group. Six

sessions of both face to face (FTF), and online CBT-I both led to significant group by time interaction on SE ($p = 0.002$) in comparison to the control group; with the FTF treatment showing larger effect size than online CBT-I ($d = 0.89$, and $d = 0.53$ respectively) (Taylor et al., 2017). The improvements were maintained at six month follow up (Taylor et al., 2017).

Walters et al. (2020) found that seven sessions of CBT-I significantly increased SE for the treatment group compared to supportive care therapy ($p = 0.04$, $d = 1.25$). At the completion of all treatments, participants who received CBT-I no longer fell in the clinical range of insomnia (SE > 85%), whereas those receiving supportive care therapy remained in the clinical range (SE = 75%) (Walters et al., 2020).

The four RCTs suggest that CBT-I, average of six-eight sessions, is effective in improving SE and reducing insomnia severity, at both post treatment, and six-month follow up (effect sizes ranging between small to large with trends towards large effect sizes) (Germain et al., 2012; Talbot et al., 2014; Taylor et al., 2017; Walters et al., 2020).

6.4.1.3 Objective/Actigraphy Assessment of Insomnia

Three studies in this review used actigraphy as an objective measure of sleep. Talbot and colleagues (2014) found no significant group by time interaction nor main effects of condition or time. Walters et al.'s (2020) sample size did not allow for a meaningful statistical analysis on the actigraphy measure. Total sleep time TST was significantly reduced from pre-to-post-treatment for both FTF CBT-I ($p = 0.004$) and online CBT- ($p = 0.011$) in comparison to the control group (Taylor et al., 2017). Findings from the three RCTs suggest that actigraphy maybe robust in providing data for TST parameter only (Talbot et al., 2014; Walters et al., 2020).

6.4.1.4 Objective/Physiological Assessment of Nightmares Following ERRT

One study provided objective/physiological assessment of CBT treatment and its effectiveness on nightmares. A significant group by time interaction was found following three sessions of ERRT with the intervention group experiencing significantly reduced physiological reaction to nightmares imagery from baseline to post-treatment ($p < 0.013$) compared to the waitlist group ($p > 0.40$). Large effect sizes for corrugator electromyogram ($d = 1.13$), lateralis frontalis electromyogram ($d = 0.89$), heart rate ($d = 0.93$), and skin conductance ($d = 0.99$) were found for the treatment group (Rhudy et al., 2010). This reduction remained significant at six months follow up ($p < 0.03$) for the treatment group (Rhudy et al., 2010).

Whilst results from this research is promising, it is important to highlight that this is one RCT, and more research in needed to confirm these findings. Furthermore, the study by Rhudy and colleagues (2010) measured physiological assessments of reactions to nightmare content during wakefulness rather than sleep.

6.4.1.5 Objective/Polysomnography PSG Assessment of Insomnia

Two studies reported PSG data. Germain and colleagues (2012) found no significant treatment by time interaction for PSG on any of the sleep parameters including SE. The researchers attributed the absence of effect on the PSG from this study to the inclusion of a military veterans with mild psychiatric symptoms which may have indicated the lack of response or improvement following psychological treatment for insomnia.

Talbot and colleagues (2014) found that an analysis of covariance revealed a significant increase of TST for the CBT-I group (i.e., 30 minutes more) at posttreatment ($p = 0.008$) compared to the control group, measured by PSG. The two studies provide

inconsistent findings, however findings reported by Talbot and colleagues (2014) are promising in relation to the effectiveness of PSG for assessing sleep outcome parameters following a psychological treatment for sleep difficulties.

6.4.1.6 CBT for Insomnia and Nightmares and its Impact on PTSD

The effect of the impact of psychological sleep treatments on post-traumatic stress symptomology was considered in four RCTs. Germain et al. (2012) assessed participants symptoms using a self-report measure of PTSD Checklist (PCL, Blanchard et al., 1996) and found no significant treatment by time interaction for PTSD ($p = 0.18$). Germain and colleagues suggested that despite the absence of significant reduction in PTSD symptoms, mild improvements for PTSD symptoms were obtained because of adherence to sleep diaries, medication consumption, and telephone or personal checking with participants throughout the study.

Similarly, Talbot et al. (2014) found no significant group by time interception, however the main effect of treatment for participants receiving CBT-I showed a reduction in scores on the Clinician Administered PTSD Scale (CAPS, Blake et al., 1995) from baseline to six months follow up ($p < 0.001$, $d = 1.23$), and a significant reduction on the self-report PCL scores from baseline to six month follow up ($p = 0.001$, $d = 0.83$). Utilizing CAPS, Walters et al. (2020) found no significant group by time interaction. However, following 12 sessions of IRT and CBT-I, the CAPS scores were reduced ($p = 0.54$. $d = 0.31$) for the treatment group compared to supportive care therapy. The findings from the three RCTs lend support to the notion that post-traumatic stress symptoms improve with small to large effect sizes following psychological treatments for insomnia and nightmares (Germain et al., 2012; Talbot et al., 2014; Walters et al., 2020).

6.5 Discussion

The aim of this preliminary review was to summarize RCTs that assessed the effectiveness of psychological interventions, using both subjective and objective measures, for treating diagnosed insomnia and/or nightmares in patients presenting with post-traumatic stress symptoms.

Our findings from the four selected RCTs showed that CBT-I treatment alone or combined with either IRT and ERRT, led to a reduction in nightmare frequency in individuals presenting with nightmares and post-traumatic stress symptoms with medium to large effect sizes (Germain et al., 2012; Rhudy et al., 2010; Talbot et al., 2014; Walters et al., 2020). The findings of this review are in line with previous research that has shown that CBT-I and ERRT alone or combined are effective in reducing nightmares in people with post-traumatic stress symptoms (Casement & Swanson, 2012; Taylor & Pruiksma, 2014).

Furthermore, our preliminary review showed that an average of six to eight sessions of CBT-I is effective in reducing insomnia severity and improving SE at posttreatment and follow up with small to large effect sizes (Germain et al., 2012; Talbot et al., 2014; Taylor et al., 2017; Walters et al., 2020). The findings of our review are consistent with those of Taylor and Pruiksma (2014) who reviewed studies targeting insomnia comorbid with psychiatric conditions and found that CBT-I improves SE.

Actigraphy data derived from this review did not detect changes on any sleep parameter except TST due to sleep restriction therapy component of CBT-I (Talbot et al., 2014; Taylor et al., 2017; Walters et al., 2020). Actigraphy may not be a sensitive or specific enough measure to capture sleep-wake patterns in people with insomnia, as it cannot distinguish between quiet wakefulness and the sleep state (Buysse et al., 2006).

The lack of alignment between self-report and objective measures has been reported by other studies (Arditte Hall et al., 2020; Stout et al., 2017).

Possibly the inconsistency between objective and subjective measures is related to subtle sleep and/or post-traumatic stress variables such as sleep quality, anger, anxiety and hypervigilance rather than a function of instruments per se. Stout and colleagues (2017) found that military personnel with PTSD showed higher levels of emotional arousal, reported significantly more nightmares, flashbacks, significantly higher levels of anxiety and anger in comparison to those without PTSD. Otherwise stated, someone who is completing a sleep diary is likely to engage his emotions when answering questions/filling out questionnaires, a phenomenon that is missed by objective measures such as PSG and actigraphy, explaining the discrepancy between subjective and objective measures of sleep.

Despite the findings in relation to actigraphy, physiological assessments and findings related to PSG in measuring the effectiveness of psychological treatment for insomnia and nightmares are promising. Our findings from this review showed that reaction to nightmares imagery from baseline to post-treatment was reduced, with large effect sizes, when measured using electromyogram, heart rate and skin conductance. Furthermore, a significant increase in TST (more than 30 minutes for the treatment group) was found for participants receiving CBT-I for insomnia at post-treatment as assessed by PSG (Rhudy et al., 2010; Talbot et al., 2014). The inclusion of physiological and PSG data in sleep research is essential to increase the validity of the findings and further research in needed to confirm the above findings. More research is needed to close the gap between subjective and objective measures.

Interestingly, sleep-specific psychological treatments from this review supports the premise that post-traumatic stress symptoms are reduced, with small to large effect

sizes, following a successful treatment of insomnia and/or nightmares in those with trauma symptoms (Germain et al., 2012; Talbot et al., 2014; Walters et al., 2020). Our findings lend further support to previous research which indicated that an application of psychological treatments for insomnia and nightmares leads to improvements in post-traumatic symptoms (Ho et al., 2016; Taylor & Pruiksma, 2014).

6.5.1 Limitations

In light of the above findings, the small number of the selected studies limited our ability to reach a strong conclusion in relation to the effectiveness of objective measures and their robustness in assessing the efficacy of sleep-specific psychological treatments in those with post-traumatic stress symptoms. All studies were conducted in the USA and thus, the generalizability of the findings across-cultures remain to be demonstrated.

Furthermore, whilst the PSQI-A was used as a primary outcome for nightmares, the PSQI-A does not differentiate between memories or nightmares of a traumatic experience which may not be specific to nightmares during sleep. Nevertheless, this review is the first in the field of sleep and trauma to assess the effectiveness of psychological treatments using both self-report and objective measures. Further research in needed to understand and close the gap between self-report and objective measures of sleep in those with post-traumatic symptoms.

6.5.2 Implications

All the studies examined in our review did not take into account variables other than insomnia, nightmares and post-traumatic stress. Observational and empirical studies should screen for the presence of other variables when measuring sleep in those with post-traumatic stress symptoms to better understand the discrepancy between the objective and subjective measures of sleep. One method in achieving this would be using qualitative designs to explore how insomnia develops and under what conditions it is

maintained and exacerbated. Understanding sleep disruption following trauma, heterogeneity of symptoms and risk of co-morbid conditions, will guide prevention and treatment of sleep disorders (Agorastos et al., 2014; Levenson et al., 2015).

Researchers are utilizing methods such as Online Photovoice (OPV, Tanhan & Strack, 2020), a reliable and effective method that uses life experiences and narratives to guide understanding of experiences such as trauma and sleep difficulties. This will provide insight into sleep disorders, trauma symptoms, and potential feasible effective interventions on what would help an individual in overcoming and coping with their mental health conditions.

All the clinical trials selected in our systematic reviews utilized interventions that have not undergone feasibility check for targeted population. To advance in this area, more research is needed using usability qualitative methods as a starting point using OPV, focus groups and structured interviews. Following the implementation of usability studies, clinical trials can be conducted to gain more confidence in sleep interventions used in adults presenting with sleep difficulties and trauma symptoms.

Furthermore, given the challenges posed by COVID-19, online interventions need to come to the forefront of research and clinical practice as more demand for psychological help is needed (Isaac et al., 2022). Possibly this active approach with understanding sleep disorders and trauma symptoms will provide the opportunity for diligent and effective interventions which can potentially close the gap between objective and subjective measures of sleep.

Author contribution

Conceptualization, F.I. and G.A.K.; methodology, F.I. and G.A.K.; validation, F.I., G.A.K. and S.R.T.; formal analysis, F.I. and G.A.K. data curation, F.I.; writing—original draft preparation, F.I., G.A.K., S.R.T. and M.D.B.; writing—review and editing, F.I., G.A.K., S.R.T. and M.D.B.; visualization, F.I., G.A.K., S.R.T., M.D.B.; supervision, G.A.K., S.R.T. and M.D.B.; project administration, F.I.

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Data availability

All data generated or analysed during this research are included in this published article.

Declarations Informed consent

Informed consent was not relevant to the content of this manuscript.

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Foreword to Chapter 7

Chapter 6 demonstrated that cognitive behavioural therapy for insomnia (CBT-I), either alone or combined with imagery rehearsal therapy (IRT) and/or exposure relaxation and rescripting therapy (ERRT), significantly reduced nightmares and/or insomnia in individuals presenting with post-traumatic stress symptoms. The systematic review also highlighted that sleep-specific psychological treatments not only alleviated insomnia and nightmares but also led to reductions in post-traumatic stress symptoms, with small to large effect sizes. However, access to such treatments is often limited due to multiple factors. These include limited availability of therapists, inadequate specialisation and training of therapists in certain treatments, and the stigma and costs associated with therapy.

In the last few years, there has been a notable shift in therapy delivery methods, with a growing emphasis on digital therapies. These approaches provide immediate access to treatment, eliminate wait times, offer help to those in urgent need, promote personal responsibility towards therapy, provide more privacy, and reduce the stigma associated with seeking mental health support. Therefore, building on Chapter 6's work, Chapter 7 evaluated the effectiveness of online CBT for treating insomnia compared to traditional face-to-face CBT, using self-report and objective sleep measures.

Chapter 7: Assessment of the Effectiveness of Online and Face-to-Face Cognitive Behavioural Therapy for Insomnia/ Nightmares in Adults Exposed to Trauma Using Self-Report and Objective Measures: Preliminary Findings

The content of Chapter 7 is identical to my earlier publication "Isaac, F., Toukhsati, S. R., Di Benedetto, M., & Kennedy, G. A. (2022). Assessment of the effectiveness of online and face-to-face cognitive behavioural therapy for insomnia/ nightmares in adults exposed to trauma using self-report and objective measures: Preliminary findings. *Trends in Telemedicine & E-Health*, *3*(2), 1-7. doi:10.31031/TTEH.2022.03.000559", except for citation style changes to match this thesis's convention. The reproduction of this chapter's content is permitted under the journal's copyright agreement, with permission granted (refer to Appendix G).

Publication Details

Title: Assessment of the effectiveness of online and face-to-face cognitive behavioural therapy for insomnia/ nightmares in adults exposed to trauma using self-report and objective measures: Preliminary findings

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7.1 Abstract

Online therapies are gaining rapid attention since the COVID-19 pandemic. The ever-evolving way of living during the pandemic changed our health system and the way therapies are delivered and received. Online cognitive behavioural therapy (CBT) has been shown to be as effective as face-to-face therapies in treating insomnia and/or nightmares in adults presenting with trauma symptoms. This review assessed the efficacy of online CBT for the treatment of insomnia in comparison to face-to-face CBT using self-report and objective measures of sleep such as actigraphy. A literature search on the following databases was carried out: PubMed, MEDLINE, PsychINFO, Scopus, CINAHL, EMBASE, Cochrane Library, EBSCO and Taylor & Francis between January 1990 and January of 2022. Two studies met the inclusion criteria. Findings from this review showed that both online and face-to-face CBT were effective treatments of insomnia, with face-to-face outperforming online CBT in adults with trauma symptoms using sleep diaries. However, findings from actigraphy were not consistent with self-report measures. Further studies that assess and compare online and face-to-face psychological treatments for the treatment of insomnia/nightmares in those presenting with trauma symptoms are needed.

Keywords: Insomnia, nightmares, trauma, CBT, objective, self-report, measures

7.2 Introduction

Sleep disorders including insomnia and nightmares are the most predominant sleep complaints reported by people exposed to trauma (Isaac et al., 2021). Research shows that both insomnia and nightmares continue to be prevalent even after successful treatment of trauma (77% and 52%, respectively) (Pruiksma et al., 2016; Taylor et al., 2020). Notably, the presence of sleep difficulties acts as antecedents to the development of certain psychiatric conditions including post-traumatic stress disorder (Babson & Feldner, 2010; Belleville et al., 2009; Germain, 2013). Moreover, treating sleep disturbances in those presenting with trauma, leads to reduction of symptoms for both sleep disorders and related trauma symptoms (Colvonen et al., 2018; Germain, 2013; Taylor & Pruiksma, 2014; Ulmer et al., 2011; Wu et al., 2015). Therefore, it follows that the focus of future research should be on treating sleep disturbances in those presenting with co-morbid conditions.

Cognitive behavioural therapy emerged as the treatment of choice for sleep disturbances, including cognitive behavioural therapy for insomnia (CBT-I). The American Academy of Sleep Medicine recommends the use of CBT-I as the first line treatment for insomnia (Edinger et al., 2021). CBT-I incorporates sleep restriction, stimulus control, cognitive restructuring of negative thoughts, relaxation techniques, and sleep hygiene (Morin & Espie, 2007). More specifically, online CBT-I has gained rapid attention since the COVID-19 pandemic. Online CBT-I is found to promote well-being and resilience and to be a suitable and feasible treatment for individuals subject to home confinement during the pandemic, those doing home schooling, mothers looking after children, and those who cannot access face-to-face health care in a timely manner (Altena et al., 2020; Cheng et al., 2021). Online treatment can reach a large number of

individuals, is cost effective, it is easy to administer, and guarantees a timely-access to treatments in comparison to face-to-face (Sawdon et al., 2021). A number of studies found online CBT-I to be as effective as face-to-face treatments for sleep difficulties including insomnia and nightmares, and at times online CBT-I outperformed face-to-face treatments (de Bruin et al., 2015; Gieselmann & Pietrowsky, 2019).

In assessing the effectiveness of sleep-specific psychological interventions, researchers mainly rely on self-report measures such as sleep diaries and self-administered scales (Stout et al., 2017). There are issues with self-report measures because people presenting with insomnia related to trauma tend to overestimate sleep latency (sleep state misperception), underestimate total sleep time and report sleep problems to be more severe than they are (Caldwell & Redeker, 2005; Perlis et al., 1997; Slightam et al., 2018). Actigraphy is an objective measure of sleep that measures sleepiness and wakefulness states through the use of a watch that is worn during sleep; it further provides appraisals of sleep parameters that are extracted from sleep diaries and polysomnography (PSG), the gold standard for measuring sleep (Smith et al., 2018). While polysomnography (PSG) studies have been robust in assessing sleep quality in individuals with and without trauma symptoms (Baglioni et al., 2016; Kobayashi et al., 2007; Zhang et al., 2019), PSG and actigraphy effectiveness in assessing treatment outcomes of online vs face-to-face psychological sleep interventions in adults presenting with trauma symptoms is less clear. Leaders in sleep research call for the need to incorporate objective outcome measures such as PSG and actigraphy as well as self-report measures in assessing the effectiveness of sleep specific treatments to gain more confidence in treatment outcomes; and minimise the gap between objective and subjective measures of sleep (Buysse et al., 2006). This is vital hence the majority of

clinicians working with adults with insomnia and/or nightmares do not have access to objective measures of sleep and rely exclusively on self-report measures.

We aimed to address the above limitations by reviewing the literature systematically and summarising the findings of randomised controlled trials (RCT) examining the effectiveness of online and face-to-face psychological treatments for insomnia/ nightmares in individuals presenting with trauma symptoms using both self-report as well as objective measures of sleep (PSG and Actigraphy).

7.3 Method

The methodology for this review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PRISMA) (Moher et al., 2010). The protocol for this systematic review was registered on PROSPERO on the 24th of February 2021 (CRD42021232975) (International Prospective Register of Systematic Reviews [PROSPERO], 2021).

The Population, Intervention, Comparison, Outcome (PICO) method (Methley et al., 2014) was used to address the following research question: How effective are online and face-to-face psychological interventions for treating diagnosed insomnia/nightmares in adults exposed to trauma using both self-report and objective measures of sleep.

7.3.1 Search Method

A literature search was performed using databases specified in Table 7.1 between January 2021 and January 2022. Moreover, Google Scholar and reference lists manual examination were also implemented. Table 7.1 shows the combination of search terms that were used to search databases.

7.3.2 Study Inclusion Criteria

Studies written in English and published between January of 1990 and January of 2022 were selected; only peer reviewed RCTs, on adults 18+ years, were considered for

this review; studies treating diagnosed insomnia and/or nightmares, as diagnosed by a health professional, in those presenting with trauma symptoms were elected; RCTs assessing the effectiveness of sleep-specific psychological interventions on insomnia and/or nightmares using both objective and self-report scales were selected to be in the inclusion criteria (see Figure 7.1).

7.3.3 Exclusion Criteria

By examining the title, abstract and full text articles, the following studies were excluded: animal studies, posters and oral presentations, symposiums, study protocols, non-adult studies, qualitative studies, RCTs without control or waitlist groups, studies without objective measures, studies with overlapping data, correlational studies, studies that did not include diagnosis of sleep disorders and/or trauma related symptoms, theses, studies treating PTSD rather than sleep disorders, and studies published prior to 1990 (see Figure 7.1).

7.3.4 Examination of Studies

The initial search of databases and screening of studies by title and abstracts was performed by one reviewer (FI). Full text examination of RCTs that deemed suitable were screened and underwent further assessment. Once the final articles were selected, their eligibility was reviewed by a senior researcher for verification and appropriateness (GK). A 100% inter-rater agreement between the two reviewers was achieved for the selected studies (FI and GK). There were some concerns about data overlap for four studies. Email correspondence with one author confirmed data overlap in two papers and another paper was deleted because data overlap could not be established.

7.3.5 Risk of Bias Assessment

The effect of, and adherence to, interventions in RCTs was assessed utilising the Revised Cochrane Risk-of-Bias tool for randomised trials (RoB 2) (Higgins et al., 2019).

RoB 2 assesses biases in relation to deviations from per-protocol interventions, bias arising from the randomisation process and measurement issues, missing data, and bias in reporting results. See Table 7.2 for the results of a risk of bias assessment for the selected studies.

7.4 Results

A total of 458 studies were detected and screened by both title and the specified inclusion criteria. Fifty-four duplicates were removed from the analysis. This led to examination of 404 articles by abstract. A total of 349 articles were excluded after careful consideration of the inclusion criteria (See Figure 7.1 for a detailed description of the excluded studies). Fifty-five randomised trials were then assessed by examination of full articles. This led to the exclusion of 53 studies for reasons delineated in Figure 7.1. An additional manual checking of reference lists and Google Scholar produced no further articles. Two RCTs met the inclusion criteria and were assigned for the final analysis of this systematic review. Table 7.3 provides details of the two RCTs.

7.4.1 Sample Characteristics

Three hundred and forty-two participants were included from the two selected studies. There were 259 females and 83 males. Their mean age ranged between 33 and 54 years.

7.4.2 Outcome Measures

The main measure of insomnia was selected to be sleep efficiency extracted from insomnia or nightmare diaries. Sleep efficiency was deemed to be the most appropriate parameter hence it encompasses total sleep time, sleep onset latency, wake time after sleep onset and morning wakeup time (Taylor & Pruiksma, 2014). Actigraphy was used in both studies as an objective measure of sleep.

7.4.3 Statistical Reporting of Data

The interaction effect of time (pre-versus post-intervention), by group (intervention versus control group) was reported where available. Main effects alone were reported if interactions of time by group were not reported.

Table 7.1

Search Terms and Databases Searches

Database	Search Terms
EBSCO PsychINFO MEDLINE CINAHL EMBASE PubMed Cochrane Library Taylor & Francis	(insomnia OR parasomnia OR hypersomnia OR insomniac OR night terror* OR nightmare*) AND (post-traumatic stress disorder* OR PTSD OR depression OR major depressive disorder* OR trauma OR complex trauma) AND (Psychological intervention* OR Psychotherapy* OR Psychological treatment* OR Cognitive behavioural therapy* OR cognitive behavioral Therapy* OR CBT OR multi-model CBT OR EMDR OR multicomponent psychotherapy* OR Imagery Rehearsal Therapy* OR IRT, Exposure, Relaxation, and Re-scripting Therapy* OR ERRT OR CBT-I) NOT (Pharmacotherapy*) AND (actigraph* OR actimetry OR polysomnograph OR PSG OR objective measures OR objective sleep OR sleep parameters)
Scopus	*insomnia* OR *nightmare* AND *posttraumatic* AND *stress* AND *trauma* AND *objective* AND *measures* AND *psychological* AND *intervention* AND *randomised* AND *trials*

Table 7.2

Risk of Bias Assessment Using the Revised Cochrane Risk-of-Bias Tool for Randomised Trials (RoB 2)

Scale	Studies	
RoB 2 Bias Domains	Savard et al. (2014)	Taylor et al. (2017)
Bias due to randomisation	Low risk	Low risk
Bias due to departure from intended interventions (assignment to intervention)	Low risk	Low risk
Bias due to departure from intended interventions (adhering to intervention)	Low risk	Low risk
Bias due to missing outcome data	Low risk	Low risk
Bias in measurement of outcomes	Low risk	Low risk
Bias in selection of reported results	Low risk	Low risk
Overall RoB 2 judgement	Low risk	Low risk

Table 7.3

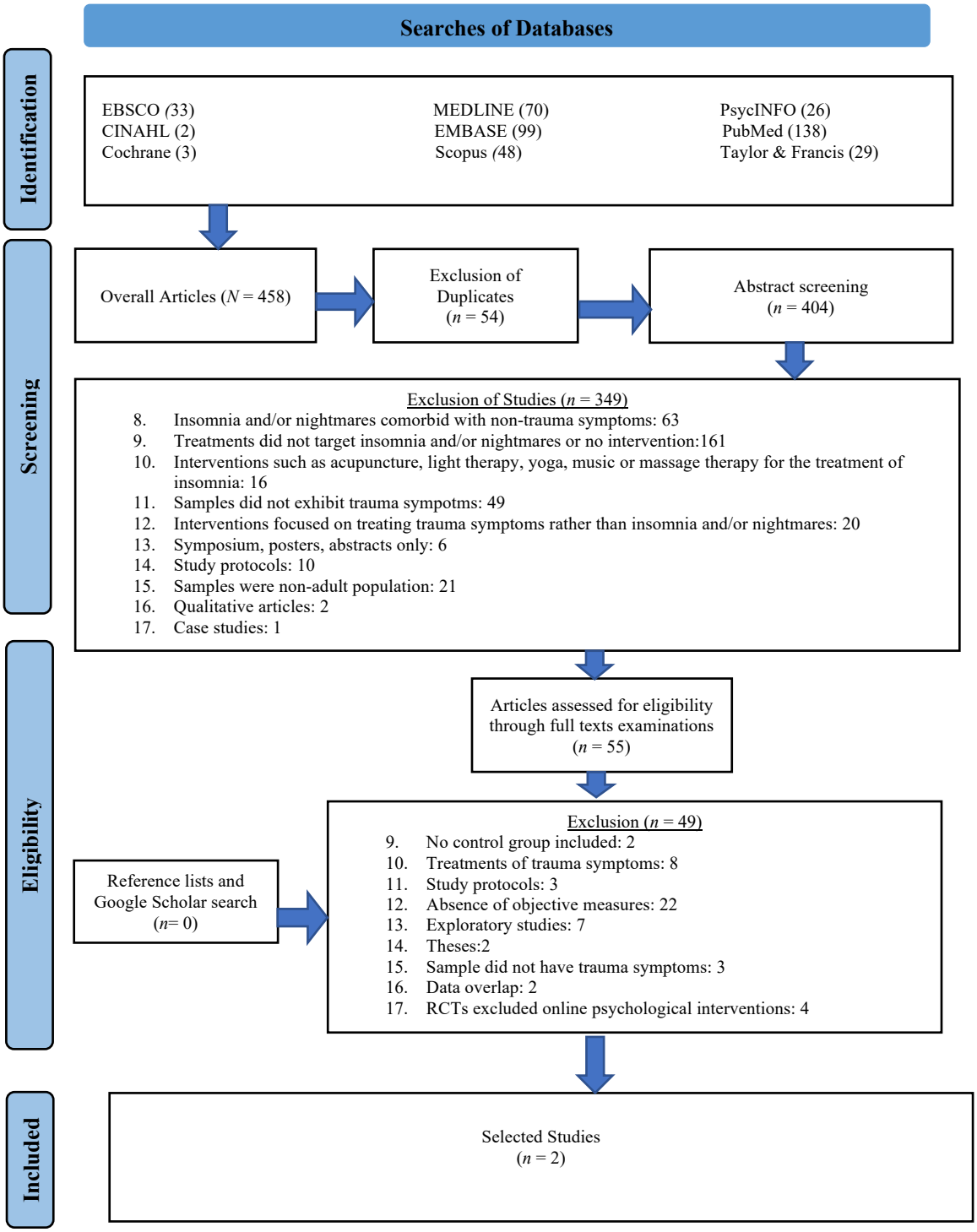
The Efficacy of Psychological Treatments for Insomnia and/or Nightmares

Author/country	Sample size *N*	Group-allocations	Therapies Implemented	Objective and subjective Outcome measures	Outcomes
Savard et al. (2014) Canada	242 women with breast cancer	PCBT-I (*n* = 81) VCBT-I (*n* = 80) Control (*n* = 81)	PCBT-I received 6-weekly 50 min sessions of one-on-one treatment VCBT-I received a self - help package composed of 60 minutes video and six booklets	ISI, sleep diary, DBAS, Actigraphy	Both PCBT-I and VCBT-I showed significant improvement on all sleep diary measures in comparison to the control group PCBT-I showed larger effects sizes than VCBT-I on reported measures of sleep
Taylor et al. (2017) USA	100 active -duty soldiers	CBT-I (*n* = 33) Internet CBT-I (*n* = 34) Control (*n* = 33)	6 weekly 60-minute sessions of face-to-face CBT-I 6 weekly 60-minute sessions of internet CBT-I (lessons were self-paced modules with visual animations) Control group received a brief (5 minutes) check-in call every second week for 6 weeks	Sleep diary, ISI, DBAS, ESS Actigraphy	Both face to face and internet CBT-I showed significant improvements on sleep efficiency and insomnia scores in comparison to the control group Face to face CBT-I was superior to both internet CBT-T and control group for sleep quality

Note. CBT-I = cognitive behavioural therapy for insomnia; PCBT-I = professional cognitive behavioural therapy for insomnia; VCBT-I = video cognitive behavioural therapy for insomnia; ISI = Insomnia Severity Index; ESS = The Epworth Sleepiness Scale; DBAS = The Dysfunctional Beliefs and Attitudes about Sleep.

Figure 7.1

PRISMA Flow Diagram of Database Searches and Final Studies Selection



7.4.4 Findings from Selected Studies

7.4.4.1 Face-to-Face Versus Internet/Video CBT-I on Diary Measures

Only two RCTs met the inclusion criteria and were selected for this review. The two RCTs compared the effectiveness of face-to-face and online CBT-I for the treatment of insomnia in those exposed to trauma. Savard and colleagues (2014) applied six sessions of CBT-I (stimulus control, sleep restriction, cognitive restructuring, and sleep hygiene) for the treatment of insomnia in women with cancer. CBT-I revealed a significant group by time effect for sleep efficiency SE as measured by sleep diaries for both face-to-face and online CBT-I ($p = .001$) in comparison to no treatment/control group from baseline to post-intervention. However, effect sizes were greater for face-to-face CBT-I (from pre- to post-treatment, $d = 0.66$ to $d = 1.84$) than online CBT-I ($d = 0.50$ to $d = 1.40$) and control group ($d = 0.23$ to $d = 0.69$) (Savard et al., 2014). Furthermore, more participants in the face-to-face CBT-I (71.3%) experienced remission than online CBT-I (44.3%) and control group (25.7%) ($p < .04$) (Savard et al., 2014). Similarly, six sessions of either face-to-face or online CBT-I treatment consisting of stimulus control, sleep restriction, cognitive restructuring, sleep hygiene and relaxation were implemented for the treatment of insomnia in military personnel (Taylor et al., 2017). A significant group by time interaction for both face-to-face and online CBT-I treatment was found in comparison to the control group receiving a 5-minute check calls throughout the trial on sleep efficiency ($p = .002$). Although, no significant difference was detected between face-to-face and online CBT-I treatment on sleep efficiency, larger effect size was found for face-to-face ($d = 0.89$) than online CBT-I ($d = 0.53$) when both treatments were compared to the control group. At six months follow up, results remained significant for sleep efficiency ($p < .05$) between post-treatment and six months follow up

for both face-to-face and online CBT-I groups suggesting a durability of treatment (Taylor et al., 2017).

The above findings from the two studies suggest that both face-to-face and online CBT-I are effective in significantly improving sleep efficiency parameters in those presenting with diagnosed insomnia presenting with trauma symptoms with face-to-face CBT-I outperforming online CBT-I with large effects sizes. Both studies were assessed as high-quality RCTs according to the RoB 2 scale (Higgins et al., 2019; Savard et al., 2014; Taylor et al., 2017).

7.4.4.2 Objective/Actigraphy Assessment of Insomnia

Both studies found no significant group by time interaction effect on the actigraphy measure for any sleep parameters except for a reduction of total sleep time TST from pre- to post-treatment for those who received face-to-face CBT-I in comparison to online CBT-I ($p = .004$, $p = .05$, respectively) (Savard et al., 2014; Taylor et al., 2017).

7.5 Discussion

We searched the literature for RCTs that compared online and face-to-face CBT for diagnosed insomnia/nightmares in those exposed to trauma using self-report and objective measures of sleep. Two RCTs were located that compared online and face-to-face CBT for the treatment of insomnia in those with trauma symptoms using self-report and objective measures of sleep (Savard et al., 2014; Taylor et al., 2017). No studies for the treatment of nightmares were identified in this review.

Preliminary findings from this review showed that both face-to-face and online CBT-I are effective in improving sleep efficiency with face-to face CBT-I showing larger effect size than online CBT-I (Savard et al., 2014; Taylor et al., 2017). Online CBT-I can be challenging due to the absence of therapist's support and other issues relating to access

and motivation of client (Taylor et al., 2017). Face-to-face CBT-I outperformed online CBT-I in this review, which is in line with other research findings, perhaps due to participants having the support of a therapist who provides encouragement and reassurance in relation to treatment (Lancee et al., 2016; Palmqvist et al., 2007; Savard et al., 2014). Both support and helpful feedback provided by a therapist can affect treatment outcomes positively (Lancee et al., 2016). This is contradictory to what has been reported recently by Gieselmann and Pietrowsky (2019) who found that digital treatment for insomnia outperformed face-to-face treatment. Researchers of this study suggested that online therapy can potentially be made more personalised to meet the needs of the individual by increasing self-governance and personal responsibility towards therapy, and by providing more privacy to those receiving therapy (Gieselmann & Pietrowsky, 2019).

This review also showed that results obtained from actigraphy were not in line with subjective measures. Research suggests that the reduction of TST on actigraphy could be a function of the rigorous application of sleep restriction therapy which restricts the amount of time in bed, as a result affecting the recorded TST (de Bruin et al., 2015; Miller et al., 2014). Objective measures are not widely researched due to costs involved and difficulties with implementation that potentially affects sleep quality for participants during sleep (Hood et al., 2004; Moore et al., 2017).

The COVID-19 pandemic changed the way we live. It has also changed the way we receive and provide health care. In order for us to continue to provide health care in a sensible and effective way, digital therapies and online methods need to come to the forefront of research and clinical practice. The progression in digital therapies and treatment methods have been slow despite considerable demands for them (Wind et al., 2020). This review highlighted the scarcity of online CBT-I for the treatment of insomnia and the absence of studies that addressed nightmares in those presenting with symptoms

of trauma using both self-report and objective measures of sleep. As such, there is an urgent need for RCTs that address the above limitations. We propose the need for immediate RCTs that assess the effectiveness of online CBT treatments for both insomnia and nightmares in adults presenting with trauma symptoms. We also propose the need for clinical assessments of sleep and trauma symptoms in this cohort. The effectiveness of treatments' outcomes should be assessed using both objective and subjective measures at pre, post and follow up treatments. Perhaps more research and more rigours implementation of measures of sleep will assist in upscaling online treatments to be as effective as face-to-face interventions during a time where COVID-19 continues to impact our lives in an unprecedented way.

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Foreword to Chapter 8

Wildfire survivors face numerous challenges, including rebuilding their lives, finding employment, and accessing mental health services in a timely manner. Chapter 6 established that cognitive-behavioural therapy (CBT)-based treatments are effective in reducing symptoms of insomnia, nightmares, and post-traumatic stress disorder (PTSD). Specifically, the preliminary findings from Chapter 7 demonstrated that digital (CBT)-based treatments are as effective as face-to-face approaches. Therefore, we have compiled a treatment manual that includes CBT-based interventions (refer to Appendix M). Building on this manual, we developed a digital program called Sleep Best-i. This chapter reports on a clinical pilot trial assessing the feasibility and preliminary effectiveness of Sleep Best-i, a digital CBT-based treatment and PTSD psychoeducation, in reducing insomnia, nightmares, and PTSD symptoms over a four-week period. Brief digital therapies are essential for communities affected by wildfires, particularly when access to mental health services is scarce and costly.

Chapter 8: Digital Cognitive-Behavioural Therapy-Based Treatment for Insomnia, Nightmares and Post-Traumatic Stress Disorder Symptoms in Wildfire Survivors: A Randomised Feasibility Pilot Trial

The content of Chapter 8 shares similarities with a manuscript that has been published in JMIR Human Factors, "Isaac, F., Klein, B., Nguyen, H., Watson, S., & Kennedy, G. (2025). Digital cognitive-behavioural therapy-based treatment for insomnia, nightmares and post-traumatic stress disorder symptoms in wildfire survivors: A randomised feasibility pilot trial. *JMIR Human Factors*, *12*, e65228." However, this chapter provides a more detailed introduction offering additional context and background, and an expanded discussion section that explores further insights and implications. Furthermore, it incorporates supplementary data in the methods section, including sleep diary and Fitbit data, and qualitative analysis, which collectively provide a more comprehensive understanding of the research findings. To maintain consistency with thesis formatting guidelines, the reference style in this chapter has been modified from the original submission to adhere to the American Psychological Association (APA) style.

8.1 Abstract

Background: Symptoms of insomnia, nightmares and trauma are highly prevalent in wildfire survivors. However, there are significant barriers to accessing evidence-based treatments for these conditions, leading to poor mental health outcomes for many wildfire survivors.

Objective: This pilot trial evaluated the feasibility of a four-week, digital, self-paced intervention combining cognitive behavioural therapy for insomnia (CBT-I), and exposure, relaxation, and rescripting therapy for nightmares (ERRT) in wildfire survivors from Australia, Canada, and the United States of America.

Methods: Study participants were recruited between May and December 2023 through social media platforms, workshops, conferences, and radio interviews. To be eligible, participants had to meet at least one of the following criteria: a score of ≥ 8 on the Insomnia Severity Index (ISI), and/or a score of ≥ 3 on the Nightmare Disorder Index (NDI), and/or a score of ≥ 31 on the PTSD Checklist – Civilian Version (PCL-5). Thirty wildfire survivors were allocated to either the treatment group (n = 16) or the waitlist control group (n = 14). This method of allocation is referred to as a sequential or consecutive randomisation, whereby participants are randomly assigned to groups in a sequential manner, without regard to participant characteristics or preferences. Participants' ages ranged from 18 to 79 years, with a mean age of 52.5 years (SD = 16.26). The cohort consisted of 19 females (63.3%) and 11 males (36.7%). Participants also completed self-report secondary outcome measures, including the Generalized Anxiety Disorder Questionnaire (GAD-7), the Patient Health Questionnaire (PHQ-9), and the Pittsburgh Sleep Quality Index (PSQI), via the HealthZone digital platform. They were informed about the purpose, allocation, and the structure of the study. Assessments were conducted at baseline, post-treatment, and 3-months follow-up, with the waitlist group providing an additional assessment at pre-treatment, after 4 weeks of

waiting, and prior to crossing over to treatment. The study employed two analyses including Intention-To-Treat analysis (ITT) as a principal analysis, and Per Protocol (PP) analysis as a secondary analysis.

Results: Mixed-effects linear regression models and difference-in-difference analyses were utilised to assess the intervention's effects. The ITT revealed significant improvements over time (main effect of time) with a 1.64 point reduction (p = .001) on the NDI and 10.64 point reduction (p = .009) on the PCL-5 at post-intervention. No significant changes were observed in insomnia symptoms. On the secondary measures, there was an interaction effect of condition x time with a 2.22 point reduction (p <.001) on the PSQI and a main effect of time with a 6.48 point reduction (p <.001) on the PHQ-9. No significant changes were detected on the GAD-7. The PP analysis yielded comparable results for both the primary and the secondary measures.

Conclusion: The findings of this pilot trial demonstrated a reduction in nightmares and trauma symptoms. Future research studies should aim at evaluating the intervention in a more definitive trial with a larger sample size.

Keywords: Insomnia, nightmares, PTSD, wildfires, CBT-I, ERRT, Sleep Best-I, mobile, eHealth, computer, digital intervention

Clinical trial name: Sleep Best-i: An online cognitive-behavioral intervention for the treatment of insomnia and nightmares in wildfire survivors

Trial ID: ACTRN12623000415606

URL: https://anzctr.org.au/Trial/Registration/TrialReview.aspx?id=385054

Registry: Australian New Zealand Clinical Trial Registry

8.2 Introduction

Over the past decade there has been a growing interest in examining the influence of wildfire trauma on mental health (Brown et al., 2019; Hong et al., 2022; Malhi & Marwaha, 2023; Psarros et al., 2015; To et al., 2021). Post-traumatic stress disorder (PTSD) emerges either immediately or in the months following exposure to traumatic events (To et al., 2021). It is recognised as one of the most complex and highly challenging mental health conditions to treat and recover from. A diagnosis of PTSD is warranted when symptoms persist for more than four weeks following a traumatic event; characterised by an actual threat to life or wellbeing, and/or enduring a serious injury through direct or indirect exposure to trauma, replay of the traumatic incident through nightmares or flashbacks, experiencing unwanted and upsetting memories of the event, avoidance of internal feelings or thoughts, avoidance of external trauma related cues, and alterations in arousal state and mood or cognition (American Psychiatric Association, 2013).

Sleep disturbances are frequently reported by those who experience trauma (Schoenfeld et al., 2012; Swift et al., 2022), and they can predict the development of PTSD (Koren et al., 2002). In the context of wildfire survivors, insomnia is the most prevalent sleep difficulty, characterised by the inability to initiate asleep, maintain sleep and/or resume sleep after early morning awakening (American Psychiatric Association, 2013). Survivors may also frequently experience nightmares, which are repeated distressing and unforgettable narrative dreams that lead to the individual waking up in a fight-flight state of alertness (American Psychiatric Association, 2013). Studies conducted in the field of sleep disorders and PTSD in wildfire survivors revealed that approximately 49.2% (n = 126) of individuals experienced symptoms of insomnia, 28.7% experienced nightmares, and 77.9% reported PTSD symptoms following the trauma of wildfires (Isaac, et al., 2023a). Notably, the rate of both insomnia (79.1%,) and nightmares (46.5%) were observed to be significantly higher (p = .002) in those

with possible PTSD diagnosis in comparison to those without PTSD symptoms (Isaac et al., 2021; Psarros et al., 2017). The presence of insomnia, nightmares, and PTSD contributes to a range of health conditions including alcohol use, depression, anger, social isolation, self-injury, respiratory diseases, gastrointestinal problems, headaches, aches and pains, heart palpitation, chest pain, dizziness, compromised quality of life, fatigue, impaired social functioning, impaired emotional well-being, cardiovascular disease, cancer, short- and long-term disability, suicidal ideation and suicidal attempts (Pagotto et al., 2015; Pruiksma et al., 2021; Sareen, 2014; Sareen et al., 2007; Wagner et al., 2000). Therefore, there is a clinical consensus that treating sleep disturbances and associated PTSD symptoms is essential for the overall wellbeing of sufferers.

The treatment of PTSD, with less focus on sleep disturbances, has received a considerable amount of attention (Watkins et al., 2018). Studies show that unaddressed sleep disturbances can persevere for years leading to an exacerbation of PTSD symptoms and related comorbid psychiatric issues (Belleville & Dubé-Frenette, 2015; Germain et al., 2008). While psychotherapies such as cognitive-behavioural therapy (CBT) is successful in treating symptoms of PTSD (Nanduri et al., 2023; Schoenfeld et al., 2012), CBT for PTSD lacks strategies that address sleep disturbances related to PTSD (Belleville & Dubé-Frenette, 2015). Therefore, in the field of PTSD and sleep disturbances, CBT, and imagery rehearsal therapy (IRT) are considered the treatment of choice for PTSD, nightmares, and insomnia (Belleville & Dubé-Frenette, 2015).

The primary principle of IRT is that nightmares following trauma may initially help with emotional processing. However, when experienced for an extended period, they become a maladaptive, learned persisting habit through classical conditioning (Germain, 2013). IRT counters this by altering the connection between sleep and nightmares through mental rehearsing of a re-written version of a nightmare during waking hours. Altering the nightmare

can be done through scripting a less stressful or neutral dream that can be rehearsed daily using mental imagery. The process of rehearing the new dream is likely to replace the nightmare and make it is less frequent and less disturbing by giving the sufferer a sense of control over the nightmare and over the traumatic event (Germain, 2013). In addition, exposure, relaxation, and rescripting therapy (ERRT) is yet another variant of IRT. In a similar manner, ERRT empowers sufferers by providing a sense of control through a written script that can be rehearsed verbally or mentally (Davis, 2009). Specifically, ERRT targets nightmares by addressing the underlying themes through rescripting, imagery or verbal rehearsal, relaxation, and sleep hygiene (Pruiksma et al., 2018a).

Studies demonstrate that CBT for insomnia (CBT-I), CBT for PTSD, and IRT or ERRT for nightmares have been effective in treating the three conditions, respectively (Germain et al., 2012; Harb et al., 2019; Isaac, et al., 2023b; Taylor et al., 2017; Walters et al., 2020). For example, in a clinical trial conducted on 22 veterans meeting PTSD diagnosis, CBT-I and IRT were evaluated against those receiving care from a physician. The intervention group received 6-weekly sessions, consisting of three sessions of CBT-I and three IRT sessions for nightmares (Ulmer et al., 2011). The CBT-I component consisted of sleep hygiene, stimulus control, cognitive restructuring, sleep restriction, and relaxation training; and the IRT included psychoeducation about nightmares, and methods to rescript nightmares (Krakow & Zadra, 2010; Morin & Espie, 2007). From baseline to post-treatment, the intervention group experienced improvement in total sleep time (TST, $p = .02$), wake after sleep onset (WASO, $p = .02$), sleep onset latency (SOL, $p = .004$), sleep efficiency (SE, $p = .001$), and nightmare frequency ($p = .04$) in comparison to receiving care from a physician. The intervention group also reported significant improvements in insomnia severity ($p = .003$), and PTSD symptoms ($p = .0001$) (Ulmer et al., 2011).

Building on this evidence, 40 combat veterans were randomly assigned to either CBT-I or waitlist control condition. Veterans in the intervention group received four-60-minute sessions (IRT for nightmares and CBT-I). The CBT-I group reported significant improvements in WASO ($p = .01$), SE ($p < .001$), and SOL ($p < .001$) from pre-to-post-treatment compared to the waitlist control group. Furthermore, veterans receiving CBT-I experienced a significant reduction in insomnia severity, decrease in sleep difficulties and improved sleep quality from baseline to post-treatment (all $p < .001$). In relation to PTSD symptoms, veterans in the treatment condition reported a significant decrease in PTSD symptoms ($p <.001$) and significantly fewer night-time related PTSD symptoms ($p = .02$) than the waitlist group (Margolies et al., 2013).

Comparably, ERRT shows similar results in reducing nightmares as IRT. A randomised trial involving 70 participants demonstrated significant reductions in nightmare severity for ERRT with and without nightmare exposure and full rescripting (Pruiksma et al., 2018b). Studies indicate that ERRT is superior to IRT by specifically addressing post-trauma related nightmares (Casement & Swanson, 2012; Ho et al., 2016), with a meta-analysis yielding larger overall effect sizes for ERRT compared with IRT and pharmacological treatments (Augedal et al., 2013).

The majority of research on trauma and sleep disorders primarily involves clinical trials with veterans (Margolies et al., 2013; Taylor et al., 2018; Ulmer et al., 2011). However, there is a pressing need to develop treatments for individuals affected by wildfires. Wildfire trauma represents a unique form of distress that can have a significant impact. The consequences of wildfires extend beyond those directly affected by the trauma to include individuals who are geographically distant from the fires. Such impact is evident in enduring losses for both individuals and communities with effects persisting for years (Kulig et al., 2013; Malhi & Marwaha, 2023). Only two trials addressed the treatment of PTSD and sleep

disturbances in wildfire survivors. Belleville and colleagues (2023) tested the effectiveness of 12 digital CBT-based sessions for the treatment of insomnia, and PTSD symptoms in 136 survivors of the Fort McMurray wildfire. The intervention significantly decreased PTSD symptoms from pre-to-post treatment (p <.001) for the intervention group in comparison to the waitlist group. Similar findings were reported for insomnia severity with the treatment group reporting significantly lower insomnia scores than the waitlist group (p = .002), and this significance was observed from pre-to-post treatment (p = .003) (Belleville et al., 2023). Another study examined the effectiveness of 6-weekly sessions, 90 minutes in duration, of Sleep Dynamic Therapy consisting of stimulus control, sleep restriction, sleep hygiene, emotional processing, sleep quality assessment, IRT for nightmares, and psychoeducation about intrusion, avoidance, and arousal symptoms. Sixty-six survivors of the Cerro Grande Fire received the treatment and experienced significant decrease of insomnia and PTSD symptoms from pre-to-post treatment (p = .0001). There was also a significant decrease in intrusion, avoidance, and arousal symptoms of PTSD (p <.001) (Krakow et al., 2002).

Despite the efficacy of CBT-based treatments for insomnia, nightmares and PTSD, communities affected by natural disasters often face significant barriers to accessing psychologists with expertise in treating PTSD and sleep disturbances. This challenge is evident in the aftermath of devastating events like wildfires, where survivors tend to prioritise basic needs over mental health. Specifically, following wildfires, survivors often focus on rebuilding their lives by prioritising securing housing and employment (Rosenthal et al., 2021). Concurrently, damage to infrastructure, such as pharmacies and local roads, further complicates timely access to healthcare (Rosenthal et al., 2021). To address these challenges, digital therapies are needed for communities affected by the trauma of wildfires when access to mental health is limited, challenging, costly and stigmatisation is a concern in small communities. Reviews of studies suggest that online CBT therapies are as effective as face-

to-face approaches as they increase access to treatment without compromising the quality of care (Gehrman et al., 2020; Isaac et al., 2022; Palmqvist et al., 2007; Seyffert et al., 2016). In addition, studies show that brief therapies (i.e., four sessions over four weeks) are as effective as 6-8 sessions in treating insomnia and PTSD symptoms (Edinger et al., 2007; Isaac et al., 2023b).

Nonetheless, prior to implementing digital, self-paced and integrated therapeutic modalities, the efficacy and usability of such treatments should be examined in clinical trials (Belleville et al., 2023; Miller et al., 2020). Thus, we designed a brief digital, entirely self-paced, multicomponent therapeutic approach, where all components - including CBT-I, CBT for PTSD and ERRT for nightmares - were integrated into a single program called Sleep Best-i, allowing participants to progress through each component at their own pace. The main objective of this clinical trial was to examine the feasibility of Sleep Best-i in reducing symptoms of PTSD, insomnia and nightmares in wildfire survivors. A second objective was to compare Sleep Best-i to a waitlist group in reducing symptoms of insomnia, nightmares, and PTSD from baseline to post-treatment and to determine the feasibility of undertaking a subsequent, fully powered randomised controlled trial.

The following hypotheses were proposed: (1) Sleep Best-i will lead to a reduction of insomnia, nightmare, and PTSD symptoms, from baseline to post-treatment for the intervention group in comparison to the waitlist group; (2) Sleep Best-i will further lead to a reduction of scores on the secondary measures including anxiety, depression and sleep quality scores, from baseline to post treatment for the intervention group in comparison to the waitlist group; (3) each group (within group effects) will experience improvements in insomnia, nightmares, PTSD, anxiety, depression and sleep quality sleep from baseline to post-treatment to 3-months follow-up following receiving Sleep Best-i; (4) participants in the treatment group will sleep more hours and have better sleep efficiency from baseline to post-

treatment in comparison to the waitlist group as measured by both the Fitbit Inspire 2 and sleep diary; (5) each group (within group effects) will sleep more hours and have better sleep efficiency from baseline to post-treatment to 3-months follow-up following receiving Sleep Best-i.

8.3 Methods

8.3.1 Study Design

This study used a parallel arm, sequential alternation method of assigning participants to either intervention or waitlist groups in a 50:50 ratio, with a crossover of the latter group. The alternation method ensures the ability to answer questions about the effectiveness of treatments to inform decision making in clinical practice (Mathe et al., 2015). The treatment group completed self-report assessments at baseline, post-treatment following the application of Sleep Best-i and at 3-months follow-up. The waitlist group completed the same assessments at baseline, at pre-treatment (following 4 weeks of waiting and prior to crossing over to treatment), at post-treatment following the application of Sleep Best-i and at 3-months follow-up. The Consolidated Standards of Reporting Trials (CONSORT) was followed (Schulz et al., 2010).

8.3.2 Ethical Considerations

Following the ethics approval from Federation University Australia Human Research Ethics Committee (Approval #: 2022-153), an advertisement about the study was distributed. Wildfire survivors interested in the study read a Plain Language Information Statement (PLIS) about the study and provided baseline data. Participants who met the selection criteria provided informed consent by checking a box on a digital consent form hosted on Federation University's HealthZone platform, thereby indicating their agreement to participate in the study. Participants were notified that their involvement in the study was entirely voluntary.

To ensure the secure storage and handling of collected information, data was stored on a password-protected digital health platform (HealthZone) during the trial, accessible only to the researchers involved in the study. To protect participants' confidentiality, names were replaced with unique identifiers, and only country of residence was collected, with no addresses recorded. The data will be retained for fifteen years before being destroyed. To manage any potential risks, participants were provided with emergency contact numbers relevant to their country of residence. As a gesture of appreciation, participants who completed the study were offered an Aus $100 e-voucher (approximately USD $66.70).

8.3.3 Participants

Participants were recruited between May 2023 and December 2023 via social media platforms including international Facebook campaigns, radio broadcasts, LinkedIn, Reddit, and online community noticeboards. The study was also advertised on the Natural Hazards Research Australia and the Australian Institute for Disaster Resilience online sites.

Adult wildfire survivors from Australia, Canada, and the USA, aged 18 years and over, were invited to take part in the clinical pilot trial if they experienced wildfires at any point in the past and had sleep and/or trauma symptoms.

An a priori power analysis indicated a sample size of $n = 50$ was required to detect meaningful differences between the intervention and waitlist groups, considering $\alpha = .05$, $d = 1.0$, attrition rate of 20%, and 80% power (Cohen, 1988).

Thirty-three participants responded to the advertisement, registered an account with Federation University's digital HealthZone platform, and provided baseline data. Three were excluded because they did not meet the selection criteria, and 30 were randomised to either the intervention or the waitlist groups. Sixteen (53.33%) were randomised into the intervention group and fourteen (46.67%) were in the waitlist group (for the participants' CONSORT chart refer to Figure 8.1). Age ranged between 18 and 79 years ($M = 52.5$, $SD =$

16.26, *n* = 30), with the majority being females 19 (63.3%), vs 11(36.7%) males. Twenty participants completed the trial, and their data were analysed as per protocol. Their ages ranged from 18 to 79 years (*M* = 53.7, *SD* = 16.54) with most being females (*n* = 14, 70%; males *n* = 6, 30%). Demographic variables for the treatment and waitlist groups are shown in Table 8.1.

Figure 8.1

CONSORT Chart Showing Participant Flow Through Allocation to Treatment and Waitlist Conditions

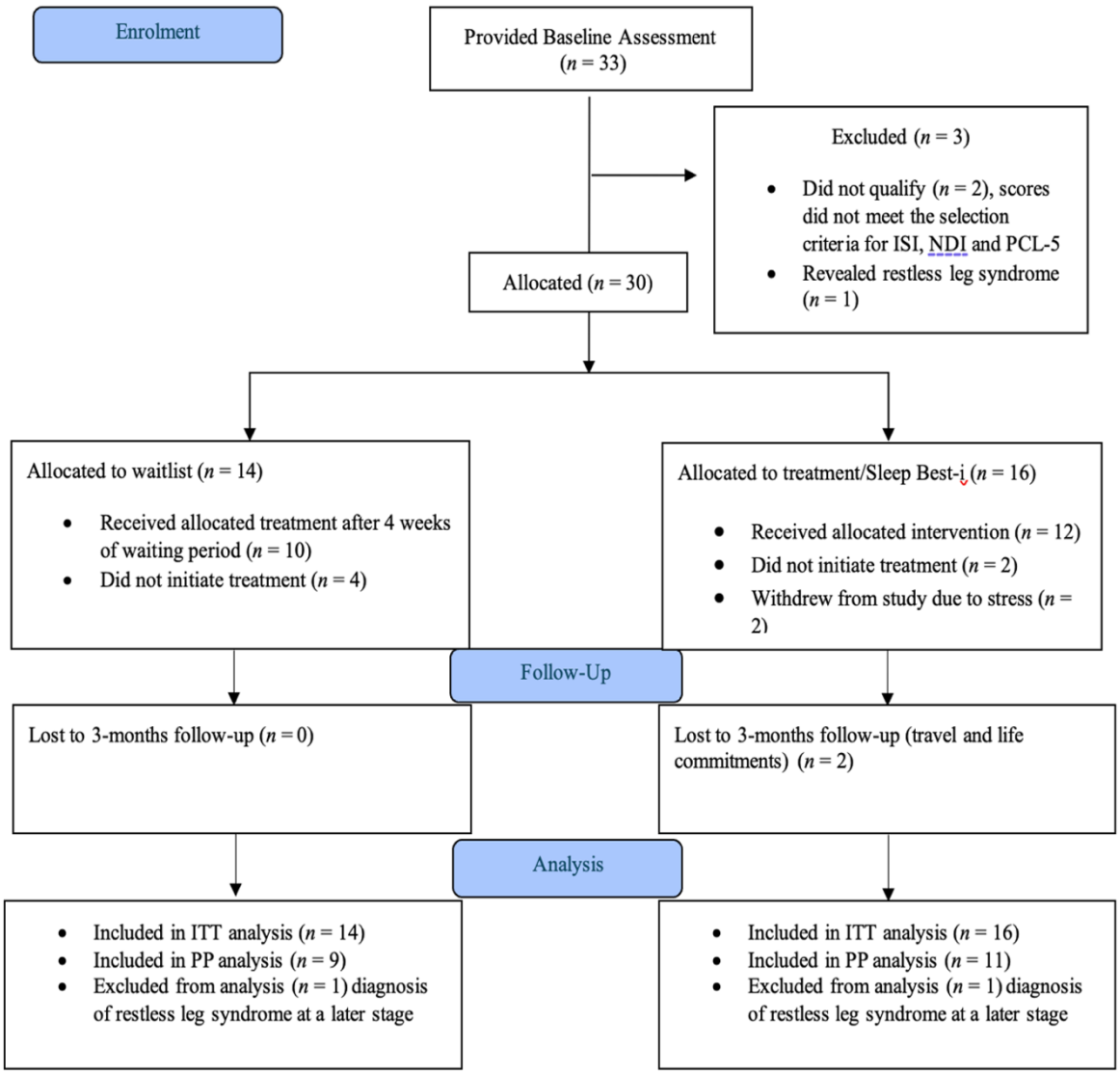


Table 8.1

Demographic Variables for the Treatment and the Waitlist Groups and Differences Between the Two at Baseline Assessment

Demographics	Treatment (n = 16) n (%)	Waitlist (n = 14) n (%)	Statistic	p
Age	M = 55.5 SD = 15.14	M = 49.00 SD = 17.34	$t(28) = 1.11$	.28
Biological Sex				
Female	11(68)	8(57.1)	$\chi^2(2, n = 30) = 1.35$	.51
Male	5(31.3)	6(42.9)		
Country				
Australia	12(75)	14(100)		
Canada	3(18.8)			
USA	1(6.3)			
Education				
Bachelor's degree	8(50)	6(42.9)	$\chi^2(3, n = 30) = 1.22$	.75
Certificate/Diploma	4(25)	6(42.9)		
High school	2(12.5)	1(7.1)		
Postgraduate	2(12.5)	1(7.1)		
Employment				
Employed	7(43.8)	5(35.7)	$\chi^2(4, n = 30) = 2.55$	.64
Looking for work	1(6.3)	---------		
Retired	5(31.3)	5(35.7)		
Student	2(12.5)	1(7.1)		
Unemployed	1(6.3)	3(21.4)		
Relationship status				
Married	8(50)	5(35.7)		
Divorced/separated	-----	5(35.7)	$\chi^2(3, n = 30) = 7.99$	.05
Single	6(37.5)	4(28.6)		
Widowed	2(12.2)	--------		
Wildfires				
2019-2020 wildfires/Aus	8(50)	11(78.6)		
2016 Waroona/Aus	1(6.3)			
2020 Oregon/USA	1(6.3)			
2023 Canadian wildfires	1(6.3)			
2021 BC /CAD Fires	2(12.5)			
2009 Black Saturday/Aus	2(12.5)	1(7.1)		
2021 Currowan/Aus	1(6.3)			
2014 Sacramento/USA		1(7.1)		
2013 Blue Mountains/Aus		1(7.1)		

Note. t=t-test statistic; χ^2= Chi-square; p = significance level <.05.

8.3.4 Inclusion Criteria

To be eligible to take part in the trial, participants had to: (1) provide a digital consent; (2) score ≥ 8 on the Insomnia Severity Index (ISI): (3) and/or score ≥ 3 on the Nightmare Disorder Index (NDI): (4) and/or score ≥ 31 on the PTSD CheckList – Civilian Version (PCL-5); (5) be fluent in the English language; (6) and have access to the internet. Exclusion criteria included the following; not a wildfire survivor, diagnosis of psychotic disorder, diagnosis of sleep apnoea and/or restless leg syndrome, current use of steroids for any health condition, diagnosis of alcohol or drug dependence, and attending psychotherapy for either sleep and/or PTSD conditions.

8.3.5 Procedure

This trial was prospectively registered in the Australian New Zealand Clinical Trial Registry (Trial ID: ACTRN12623000415606). Since commencement, no major changes were made to the trial protocol except for an update to the statistical analysis method, which now utilises linear mixed methods with ITT analysis. The desired sample size was not achieved due to the project's timeline, resulting in a smaller sample size than anticipated.

An advertisement about the pilot study with a URL link was distributed on social media platforms displaying Federation University and the Natural Hazards Research Australia affiliations. The study was also promoted in national conferences, sleep workshops delivered to communities affected by wildfires, the Red Cross, and group meetings for people with sleep disorders in Australia. Radio interviews were also undertaken to promote the study. Wildfire survivors who were interested were asked to read a PLIS, signed a digital consent to register an account on Federation University's digital HealthZone platform and provided baseline data by completing demographics as well as self-report measures on insomnia, nightmares, and trauma symptoms. Participants had the option of providing a pseudo name if

they wished. However, they needed to provide a valid email address to allow communication about the study. Their email addresses were also directly connected to their personal dashboard on HealthZone. The baseline data was viewed by two researchers to decide eligibility. Those who were eligible (assessed by FI and GK, both clinical psychologists) were contacted via email to notify them of their eligibility and their randomisation and giving them instruction on how to access their personal dashboard on HealthZone. Participants were sequentially allocated via simple randomisation in the order of their enrolment (using a computer-generated simple randomisation sequence), and they were informed about the purpose, allocation, and the structure of the study as explained in the PLIS (Kim & Shin, 2014). However, they were not informed about the study's hypotheses. Once participants gained access to their personal dashboard in HealthZone, they were able to access information about the trial, complete the secondary study measures and access the treatment modules consecutively. Participants were able to access the treatment modules at no cost via either a mobile phone, a computer or a tablet. The modules were released sequentially to participants over four weeks. All data was collected through self-report measures at prespecified intervals. Participants were instructed to complete a module or a set of two modules each week along with the required interval assessments. Automated email reminders alerted participants about the release of each module and the specified assessments. Participants were encouraged to complete the entire Sleep Best-i program, but completion of each module was not mandatory, allowing individuals to engage with relevant content tailored to their specific needs, whether they experienced nightmares, PTSD, insomnia, or a combination of these conditions. To support engagement, automated email reminders were sent at regular intervals, including reminders at three and seven days after module release, as well as reminders for self-report assessments, to help participants stay on track with the program. The personal dashboard was accessible to participants at any time. A "Contact Us"

tab was available on the personal dashboard that allowed participants to contact the research team and ask questions about the study or express any concerns. Two participants had an inquiry about how to access the modules and one participant inquired about the content of one of the modules.

The research team sent two follow-up emails, spaced two weeks apart, to participants who registered, been randomised, but had not commenced treatment, serving as a reminder about the study and to gauge their ongoing interest in participating.

The modules were available to participants from the start of the trial to the end the follow-up period. Participants were able to access their dashboard up to four weeks following the 3-months follow-up data collection. HealthZone recorded data about the number of logins, number of pages visited, date of commencement and duration of participation, for each participant. Login attempts and adherence were monitored by tracking the number of logins and time spent on the site. The system recorded each participant's logins and time spent on the site, allowing for calculations of average logins and engagement. We expected participants to spend at least three hours over the four weeks to indicate adherence to treatment. This time is optimal for viewing all modules and completing all assessments. No statistical analyses were performed in the interim of the study. HealthZone was monitored daily during the trial to track any potential concerns or issues associate with the site or the participants.

8.3.6 Treatment Protocol

8.3.6.1 Sleep Best-i/Intervention

Sleep Best-i was specifically designed for this clinical trial by some researchers of this study (FI, BK & GK). The collated treatment manual draws from evidence-based treatment manuals authored by other sleep researchers (Davis, 2009; Davis & Wright, 2007; Edinger, 2018; Edinger & Carney, 2014; Germain & Buysse, 2011; Lynch et al., 2015; Morin

& Espie, 2007) (refer to Appendix M for the treatment manual). The main therapeutic methods used in the manual were CBT-I and ERRT. The recorded digital modules featured a human recorded voice and animated videos utilising VideoScribe that explained concepts related to sleep and trauma symptoms (Sparkol, 2022). The intervention also offered two role plays of therapeutic sessions to demonstrate the application of cognitive restructuring, dream rescripting, and sleep scheduling. Sleep Best-i consisted of six modules administered over a four-week period. Module 1 and Module 2-Part 1 were administered in the first week of treatment, Module 2-Part 2 was administered in the second week, Module 3 was administered in the third week, and Modules 4 and 5 were administered in the fourth week of treatment. Module 1/Psychoeducation offered psychoeducation about sleep and insomnia, stages of sleep and neurobiology of sleep (Morin & Espie, 2007). Module 2-Part 1/Cognitive Restructuring and Sleep Hygiene focused on the cognitive component of CBT-I, types of unhelpful thoughts, how to challenge unhelpful thoughts, and sleep hygiene (Edinger, 2018). Module 2-Part 2/Sleep Scheduling and Stimulus Control educated participants about specifying a regular sleeping and waking up time with as little variation as possible between the two, while stimulus control restricted the bedroom to sleep only (Germain & Buysse, 2011). Module 3/Trauma, PTSD and Flashbacks provided psychoeducation about trauma, PTSD, flashbacks and how trauma leads to sleep difficulties. It also provided behavioural intervention for trauma symptoms. Module 4/Nightmares explored nightmare disorder, how nightmares develop, and how to rescript the nightmare into a more benign dream (Davis, 2009). Module 5/Relapse Prevention focused on identifying early warning signs and steps to take to prevent a relapse of symptoms (Lynch et al., 2015). Each module was 17 minutes in duration (refer to Appendix P for Sleep Best-i's Modules). Sleep Best-i included two recorded videos of therapeutic sessions. Participants were also offered a recorded progressive muscle relaxation mindfulness module that was available throughout the study (refer to

Appendix L for the transcript of the recorded progressive muscle relaxation). Once released, the modules remained unchanged throughout the trial, and the intervention was successfully implemented without encountering technical difficulties. There were periodical checks to ensure modules were compliant with the treatment manual. All links have been archived in Wayback Machine (Internet Archive, n.d.).

8.3.6.2 Waitlist Control Group

Following a waiting period of 4 weeks, the waitlist group received sleep Best-i in the same sequence that it was released to the treatment group. The waitlist group provided an extra assessment of all measures in comparison to the treatment group at the end of their wait-period. Participants in both the intervention and waitlist groups used a digital sleep diary and a Fitbit Inspire 2 to track their sleep patterns throughout the treatment period.

8.3.7 Measures

All scales were digital, self-report measures that were administered through HealthZone. The self-report scales as well as the modules were evaluated by two research team members (FI & BK) before being released to participants. The order of the modules and the questions were the same for all participants in the two groups.

***Demographic data*:** potential participants provided the following personal information: name, email address, age, employment, sex, marital status, education, experience with wildfires, country of residence, history of taking steroids, diagnosis of sleep apnoea or restless leg syndrome, diagnosis of psychotic disorder, use of alcohol or drug dependence, type of medications used to assist with sleeping, history of antidepressants, and whether participants were attending psychotherapy for sleep or PTSD.

8.3.7.1 Primary Sleep Measures

***The Insomnia Severity Index Scale (ISI, Bastien, 2001)*:** the ISI includes seven items measuring insomnia severity through subjective experience of sleep. The seven-item scale

employs a 4-point Likert-type response format, ranging from 0 (not satisfied) to 4 (very much satisfied). The scale yields scores ranging from 0 to 28, with higher values indicating greater severity of insomnia symptoms. Guidelines for scoring are as follows: scores between 0 and 7 indicate no clinical insomnia, scores of 8 to14 indicate subthreshold insomnia, scores between 15 and 21 suggest a moderate severity, and scores between 22 and 28 indicate severe insomnia symptoms. The internal reliability of the scale or Cronbach's alpha ranges from α = .87 to α = .92 (Morin et al., 2011). The ISI also has excellent test-retest reliability (r = .83, .77 & .73) (Savard et al., 2005). It has good divergent validity with the Beck Anxiety Inventory (r = .45) (Leyfer et al., 2006), and strong correlation with the PSQI global score (r = .76) (Kaufmann et al., 2019). The internal reliability of the ISI was α = .88 in the current study.

***The Nightmare Disorder Index (NDI, Dietch et al., 2021)*:** the scale consists of 5 items assessing symptoms of nightmares according to the DSM-5. The NDI assesses the presence or occurrence of nightmares in a given week measured as follows: 0 nights per week, < 1 night per week, 1-3 nights per week, 4-6 nights per week, and 7 nights per week. It also assesses the level of distress and impairment in social and occupational activities using a 5-point Likert scale from 0-4. The five items are summed to obtain a score between 0 and 20 with higher scores representing greater nightmare severity (Dietch et al., 2021). The NDI has good internal consistency (α = .80) (Dietch et al., 2021), and a good test-retest validity (r = .675–.977, p <.001) (Zhuang et al., 2003). It also has good convergent (r = .37–.41), and discriminant validity (r < 0.15) (Dietch et al., 2021). In the current study a Cronbach's α = .77 was calculated.

***PTSD Checklist for DSM-5 Scale (PCL-5, Weathers et al., 2013)*:** The PCL-5 is a 20-item self-report measure assessing PTSD symptoms experienced within the past 30 days. Utilising a 5-point Likert scale (0-4), respondents rate symptom severity from "Not at all" (0)

to "Extremely" (4), yielding total scores between 0 and 80. The PCL-5 provides a provisional PTSD diagnosis and demonstrates robust psychometric properties, including high internal consistency (α = .95), good test-retest reliability (.59-.86), and strong convergent validity with the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5; r = .77) (Blake, 1995; Blevins et al., 2015; Bovin et al., 2016; Krüger-Gottschalk et al., 2017). A cut-off score of 31 provides optimal sensitivity and specificity in detecting provisional diagnosis of PTSD (Krüger-Gottschalk et al., 2017). An alpha of α = .96 was detected in the current sample.

8.3.7.2 Secondary Measures

***Generalized Anxiety Disorder Questionnaire (GAD-7, Spitzer et al., 2006)*:** the scale is a 7-item, self-report measure assessing anxiety symptoms over a 2-week interval. Responses are recorded on a 4-point Likert scale from 0 to 3 with the following choices: not at all, several days, more than half the days, and nearly every day. Scores between 0 and 4 reflect minimal anxiety, 5-9 mild anxiety, 10-14 moderate anxiety, and scores greater than 15 indicate severe anxiety. A score is obtained by summing the seven items which ranges from 0 to 21. The GAD-7 has a good internal consistency with a Cronbach's α ranging between .82 and .93 at pre- and post-treatment (Johnson et al., 2019). A cut-off score of 10 was used to discriminate between mild and severe symptoms for diagnosing generalised anxiety disorder (89% specificity and 82% sensitivity) (Spitzer et al., 2006). The GAD-7 has good convergent validity with the Overall Anxiety Severity and Impairment Scale OASIS (r = .81), and a good discriminant validity with the Emotion Regulation Questionnaire (r = -.04) (Doi et al., 2018; Ito et al., 2015; Yoshizu et al., 2013). In the present study, Cronbach's α was .92 for the GAD-7.

***The Patient Health Questionnaire (PHQ-9, Kroenke et al., 2001)*:** the scale consists of nine items assessing symptoms of depression and how much an individual is bothered with each of the symptoms over the last 2 weeks. Response options to questions include not at all,

several days, more than half the days, and nearly every day. The items are scored between 0 and 3 on a 4-point Likert scale. The overall score, ranging between 0 and 27, is obtained by summing all the nine items with the following distinction: 5-9/mild, 10-14/moderate, 15-19/moderately-severe and 20-27/severe. A cut-off score of 10 is considered optimal in discriminating between mild and severe symptoms of depression (Kroenke et al., 2001). The PHQ-9 had good concurrent validity with the Beck Depression Inventory ($r = 0.67$, $p < .001$), and a good one-month test–retest reliability ($r = .89$) (Adewuya et al., 2006; Beck et al., 1961). In the present study, Cronbach's α for the PHQ-9 was .86.

Pittsburgh Sleep Quality Index (PSQI, Buysse et al., 1989): the PSQI consists of 19 items with an additional five questions rated by a bed partner. The scale assesses sleep quality and disturbances related to sleep over a month interval. Scores for items are measured on a 4-point Likert scale from 0 to 3. A global score is generated by summing the following seven components: sleep latency; subjective sleep quality; habitual sleep efficiency; sleep duration; sleep disturbances; daytime dysfunction; and use of sleeping medications. A global score ranges between 0 and 21, with higher scores indicating worse sleep quality. A global PSQI score > 5 is considered a sensitive and specific cut-off score to discriminate between good and poor quality of sleep (Backhaus et al., 2002). The PSQI has a good internal validity with a Cronbach's α ranging between .79 and .81, and test–retest reliability ranging between .87 and .91 (Backhaus et al., 2002; Tzeng et al., 2012). A Cronbach's α of .70 was detected for the PSQI in the current sample.

8.3.7.3 Objective and Subjective Sleep Measures

Fitbit Inspire 2 (Fitbit, Inc San Francisco, California, USA): Fitbits are now widely used in research as an objective measure of sleep (Haghayegh et al., 2019; Lim et al., 2023). In this study, Fitbit Inspire 2 was utilised. It collects data about sleep using regular intervals of waking and sleeping times through heartrate and a motion sensor. The Fitbit Inspire 2 also

provides data of not only sleep parameters but also stages of sleep including: wake, light sleep, deep sleep, and Rapid Eye Movement (REM) sleep. Total sleep time or Minutes Asleep/MS is calculated by adding all the time of sleep during the sleep stages from light, deep and REM epochs within each sleep period, whereas WASO is calculated by adding all the wake epochs after the first epoch of sleep. Sleep efficiency is calculated by dividing MS/ TIB* 100. The mean average of 7 days recordings was used at each assessment point to calculate MS and SE for each group on the Fitbit Inspire 2. At the end of the trial, participants were given instructions about how to download their sleep data from their Fitbit registered account and submit it via email to the research team. Not all participants provided the Fitbit data (n = 6 for the treatment group, and n = 5 for the waitlist group). In the current study, the Fitbit-MS, and Fitbit-SE were calculated and analysed. A comparison of the Fitbit Inspire 2 with polysomnography (PSG) data revealed a significant difference in total sleep time (TST), with the Fitbit Inspire 2 overestimating TST (p = 0.02). In contrast, no significant difference was observed between the two devices in terms of sleep efficiency (Lim et al., 2023).

***Sleep Diary (Carney et al., 2012)*:** the sleep diary is regarded as the "gold standard" for assessing subjective sleep. The sleep diary used in the current study consisted of nine questions that collect information about total time in bed, hours of actual sleep, number of awakenings, rating sleep quality and any additional comments that participants wished to add. The sleep diary collects parameters about sleep onset latency (SOL), time awake after sleep onset but before final awakening (WASO), total sleep time (TST) and sleep efficiency (SE). TST is computed by subtracting time being awake (time to fall asleep+ time awake during the night+ time being awake before getting out of bed) from the total time in bed (TIB). Sleep efficiency on the other hand is calculated by dividing TST by TIB (minutes from bedtime to rise time) and multiplied by 100 to get a percentage. In the current study,

sleep diary TST (SD-TST) and sleep diary SE (SD-SE) were the main outcome measures that were calculated and analysed for the two groups.

8.3.7.4 Other Measures

Brief Qualitative Questions: participants were asked to provide their feedback about Sleep Best-i at the end of week 2, week 3 and week 4 of receiving treatment. The qualitative questions were: (1) how do you think the modules helped with your sleep; (2) how do you think the modules helped with trauma symptoms; (3) what did you find helpful in relation to the modules; (4) any difficulties that you have encountered with the modules; (5) if you could change anything about the modules, what would it be; (6) how are you finding wearing the Fitbit and getting a reading about your sleep; (7) and do you have any questions or concerns.

***Satisfaction and Level of Engagement with Treatment*:** One question was designed for this study to measure satisfaction with Sleep Best-i. Participants were asked to rate how likely they were to revisit Sleep Best-i modules on a 5-point Likert scale from strongly disagree to strongly agree (0-4 respectively). To assess level of engagement with treatment we decided to monitor the number of logins and duration of time each participant spent on the site.

8.3.8 Data Analysis

Data analyses were conducted using Stata statistical software package (Version 18) (StataCorp, 2023). All variables were inspected for normality and outliers. An inspection of histograms, and Q-Q Plots revealed normally distributed data. Upon inspection of Boxplots on all scales, two outliers were identified on the PHQ-9 and PCL-5 at 3-months follow-up assessment. An additional outlier was detected on the PSQI at waitlist assessment. Results did not differ upon removing the outliers from analyses therefore, the outliers were retained (Hoaglin & Iglewicz, 1987; Pallant, 2020). To ensure a robust evaluation of the intervention's feasibility, the Intention-To-Treat (ITT) analysis was utilised with $n = 30$, as well as Per

Protocol (PP) analysis with a sample of $n = 20$, allowing for a comprehensive assessment of treatment outcomes, thereby enhancing the accuracy and generalisability of findings (McCoy, 2017; Ranganathan et al., 2016; Schulz et al., 2010). Thematic analysis, as outlined by Braun and Clarke (2006), was employed to identify key themes within the qualitative data.

Missing data was addressed using multiple imputation by chained equations (MICE). This approach is more robust than other methods, such as single imputation, because it generates multiple predictions for each missing value, accounting for uncertainty in the imputations and yielding more accurate standard errors (Azur, 2011). Key background variables such as age, sex, education, employment, country, and relationship status, along with the baseline measures and the most recent observations of each outcome, were used to impute missing values.

To address uncertainty, each missing value was imputed twenty times, using predictive mean matching based on the three nearest values, across multiple iterations to create 100 imputed datasets. The imputed values were then averaged to create the final estimates (Von Hippel, 2018). Predictive mean matching, a partially parametric method, is preferable to fully parametric linear regression, as it remains effective even when the normality assumption of the underlying variable is violated. This method also helps preserve the distribution of observed values in the missing data (Morris et al., 2014). Background variables and the time trend were used to impute data on Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE at the 3-months follow-up for both the waitlist and treatment groups. Missing value analysis indicated that data was Missing Completely at Random (Little's MCAR test, $\chi^2 = 0.00$; $df = 867$, $p = 1.00$) meaning that differences between the missing and observed data were related to observed characteristics (Sterne et al., 2009).

Adjusted analyses of intervention effects were conducted using mixed-effects linear regression models. Both fixed and random effects were estimated to assess the impact of the

intervention on the change in all outcomes (primary and secondary) over time and by condition. Given that observed covariates were balanced between the two conditions (waitlist and treatment), the difference-in-difference (DID) effect for the fixed part of the mixed-effects models by including interaction terms for time point and condition was tested. DID is considered the most appropriate measure to assess causal effects in time series design as it effectively controls for time-invariant confounding variables. By doing so, DID reduces bias and enhances internal validity, providing a more accurate estimate of the treatment effect (Wing et al., 2018).

The appropriateness of the mixed-effects model for each outcome was assessed using Chi-squared statistics (p <.05). Random-intercept linear models was compared with random-intercept random-slope models using likelihood ratio tests. The random-intercept random-slope model was reported only if the likelihood ratio test indicated p <.05; otherwise, the simpler random-intercept model was selected. A significant effect of the intervention or difference in outcome between groups was assessed with a two-tailed test of significance with p <.05.

A sensitivity analysis was conducted to test whether the model and covariance structures were mis-specified. Several major types of covariance structures, including independent, unstructured, exchangeable, identity, and autoregressive were examined. Additionally, we estimated the model parameters using both maximum likelihood and restricted maximum likelihood methods. Although the results were generally consistent across different covariance structures, the model with an exchangeable structure was deemed the best fit.

8.3.9 Clinical Significance

Clinical significance was assessed for the two groups, from baseline to 3-months follow-up. To evaluate the clinical significance on sleep and trauma measures, specific

criteria were employed for each scale. For example, for the ISI a cut-off score of ≤ 8 with a six-point or more reduction in scores was used to assess if participants reached a minimal clinically significant change (MCSC) (Ulmer et al., 2011; Yang et al., 2009). For the NDI, there is no established criteria for MCSC, therefore a cut-off score of ≤ 7 as suggested by Dietch et al. (2021) was used. Marx and colleagues recommend a score of ≤ 28 and a drop of 18 points or more on the PCL-5 as a guide for MCSC (Marx et al., 2022).

8.4 Results

Four participants were excluded from the PP analysis for the following reasons: two participants, who completed the pilot trial and provided complete set of data revealed they had restless leg syndrome that was not initially reported during the screening process; one participant received one treatment module, however, withdrew from the study due to illness providing only baseline measures; and a fourth participant who provided and completed 50% of data and modules withdrew due to illness and family commitments. Therefore, the PP analysis was conducted on a sample of $n = 20$. Six participants provided baseline data; however, they did not initiate treatment and did not respond to emails sent by the research team. No significant differences in demographic variables between the intervention and waitlist groups at baseline assessment were found (all $p > .05$) (Table 8.1).

To address hypothesis 1, ITT analysis of the mixed-effects regression, including the effect sizes of the DID in the fixed-effects component and the variability in the random effects component showed that at baseline, the waitlist group had mean scores of 3.16, 0.39, and 45.29 for ISI, NDI and PCL-5, respectively. At post-intervention, main effect of time, these scores significantly decreased by 1.64 points on the NDI ($p = .001$) and 10.64 points on the PCL-5 ($p = .009$), but no significant change was detected on the ISI. The treatment group showed slightly lower baseline scores compared to the waitlist group, with mean differences of 0.45, 0.04, and 9.20 for ISI, NDI, and PCL-5, suggesting that the two groups were

relatively balanced at baseline. The adjusted DID effects following the treatment indicated that the treatment group experienced greater improvements in mental health measures compared to the waitlist group, with differences of 1.54 points for ISI, 1.22 points for NDI, and 4.98 points for the PCL-5. Notably, the improvement in the NDI was marginally significant (p =.06), while the improvements in the ISI and the PCL-5 were not statistically significant (Table 8.2).

In the random effects part, there was substantial variability among individuals, with average deviations of 1.41, 0.82, and 10.82 points for the ISI, NDI, and PCL-5 around both the baseline and post-intervention mean. This suggests considerable individual variability in the outcomes. The positive correlation coefficients between the time point and the intercept indicate that participants with higher baseline scores (above the overall sample mean) were more likely to experience greater decreases in their scores over time compared to those with lower baseline scores. All mixed-effects models for the ISI, NDI, and PCL-5 were statistically significant (p <.05). Specifically, the random-intercept, random-slope models were appropriate for the ISI and NDI (p <.05), while a random-intercept only model was sufficient for the PCL-5, which also fit the data but with a non-significant p-value (p >.05) (Table 8.2). Figure 8.2 shows the changes in primary outcome measures (ISI, NDI, and PCL-5) from baseline to post-treatment, based on the ITT analysis.

For completers only, the PP analysis of the mixed-effects regression showed that at baseline the waitlist group had mean scores of 5.58, 0.46, and 13.37 on the ISI, NDI and PCL-5, respectively. At post-intervention, these scores did not significantly change. The treatment group baseline scores were balanced compared to the waitlist group, with mean differences of 0.99, 0.04, and 3.05 for the ISI, NDI, and PCL-5 (p >.05). However, the adjusted DID effects indicated an interaction effects of condition x time with the treatment group experiencing significant reduction of nightmare symptoms on the NDI with a decrease

of 2.27 points (p = .049), and a decrease of 13.46 points on the PCL-5 (p = .03), but no significant improvements on the ISI (Table 8.3).

There was a substantial variability among individuals, with average deviations of 3.41, 1.81, and 9.42 points for the ISI, NDI, and PCL-5 at post-intervention suggesting a considerable individual variability in the outcomes. All mixed-effects models for the ISI, NDI, and PCL-5 were statistically significant (p <.05) with a random-intercept model being appropriate for the three measures (Table 8.3).

Table 8.2

Mixed-Effects Linear Regression Analysis of the Effect of Intervention on Primary Outcome Measures (ITT Analysis, n =30)

Variables	Model 1 (n = 60[a]) (ISI)		Model 2 (n = 60[a]) (NDI)		Model 3 (n = 60[a]) (PCL-5)	
	Beta (95%CI[b])	*p*-value	Beta (95%CI[b])	*p-value*	Beta (95%CI[b])	*p-value*
Fixed effects						
Intercept	3.16 (-0.77, 7.08)	.12	0.39 (-1.05, 1.83)	.60	45.29 (37.27, 53.30)	<.001
Time						
Baseline	reference		reference		reference	
Post-intervention	-1.88 (-3.86, 0.10)	.06	-1.64 (-2.58, -0.71)	.001	-10.64 (-18.65, -2.64)	.009
Condition						
Waitlist	reference		reference		reference	
Intervention	-0.45 (-2.56, 1.66)	.68	-0.04 (-1.04, 0.97)	.95	-9.20 (-20.17, 1.78)	.10
Time x Condition	-1.54 (-4.26, 1.17)	.26	-1.22 (-2.50, 0.06)	.06	-4.98 (-15.94, 5.98)	.37
Random effects						
SD (Time, intercept)	1.41 (0.82, 2.42)		0.82 (0.55, 1.20)		10.82 (7.26, 16.14)	
Correlation (Time, intercept)	0.99 (-1.00, 1.00)		1.00 (-1.00, 1.00)		NA	
SD of residual	2.48 (1.86, 3.31)		1.23 (0.86, 1.47)		10.81 (8.39, 13.92)	
Model fit						
Wald χ^2		<.001		<.001		<.001
χ^2 (LRT)[c]		.03		.001		.19

[a]n = represents the number of observations in data with long format to support mixed-effects modelling; [b]95% = confidence intervals; [c]χ^2 = p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue, except for model 3 where baseline measure was excluded for simplicity and convergence. NA= not applicable as the random-intercept model better fits data than the random-intercept random-slope model. Given its better fit, random-intercept model parameters were reported; ISI = Insomnia Severity Index; NDI = Nightmare Disorder Index; PCL-5 = PTSD Checklist for DSM-5 Scale.

Table 8.3

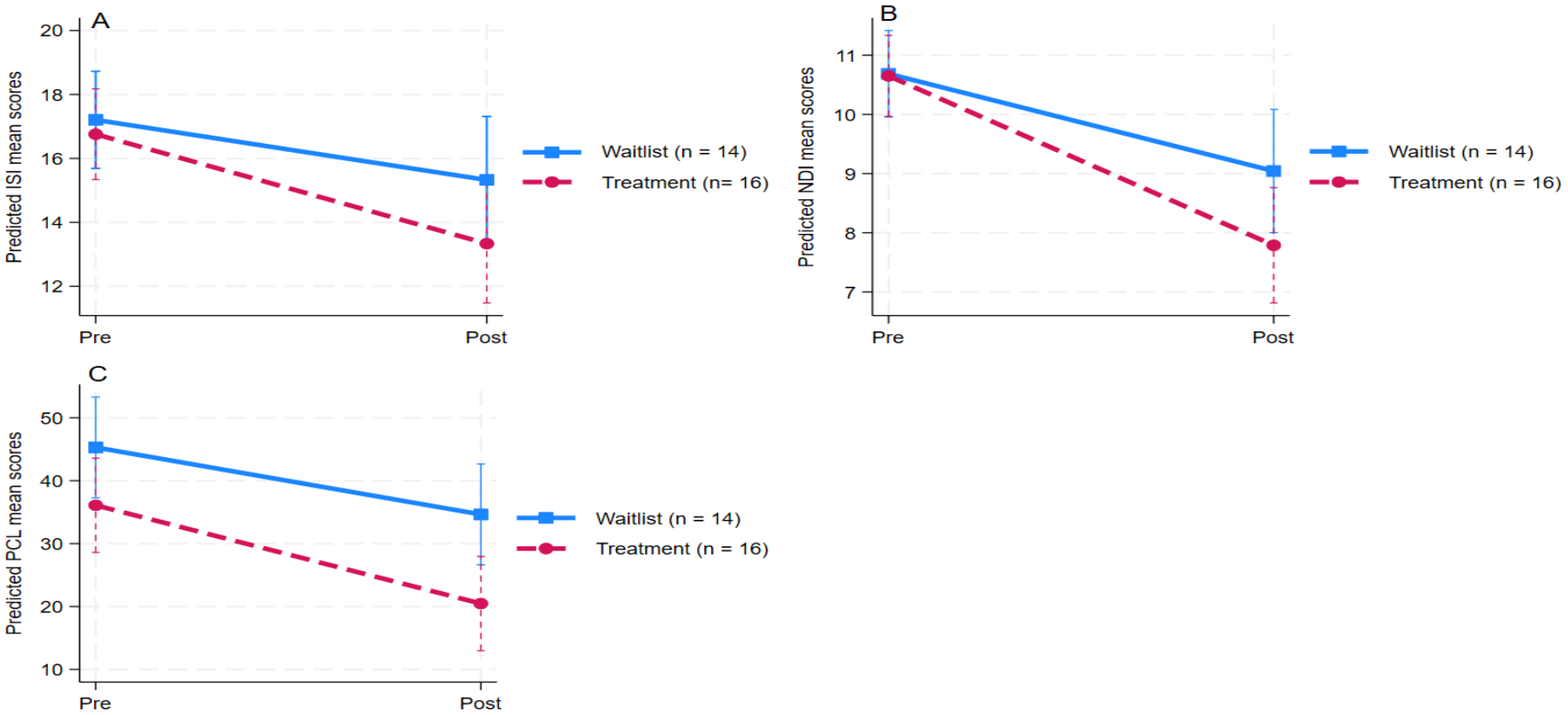
Mixed-Effects Linear Regression Analysis of the Effect of Intervention on Primary Outcome Measures for Completers Only (PP Analysis, n = 20)

Variables	Model 1 (n = 40[a]) (ISI)		Model 2 (n = 40[a]) (NDI)		Model 3 (n = 40[a]) (PCL-5)	
	Beta (95%CI[b])	*p*-value	Beta (95%CI[b])	*p-value*	Beta (95%CI[b])	*p-value*
Fixed effects						
Intercept	5.58 (1.12, 10.04)	.01	0.46 (-1.70, 2.61)	.68	13.37(3.71, 23.03)	.007
Time						
Baseline	reference		reference		reference	
Post-intervention	-0.67 (-3.82, 2.48)	.68	-1.00 (-2.67, 0.67)	.24	-4.11 (-12.81, 4.59)	.35
Condition						
Waitlist	reference		reference		reference	
Intervention	-0.99 (-4.06, 2.04)	.53	-0.04 (-1.65, 1.56)	.96	-3.05 (-11.52, 5.42)	.48
Time x Condition	-2.48 (-6.72, 1.77)	.25	-2.27 (-4.53, -0.01)	.049	-13.46 (-25.19, -1.73)	.03
Random effects						
SD of residual	3.41 (2.74, 4.24)		1.81(1.46, 2.26)		9.42 (7.57, 11.73)	
Model fit						
Wald χ^2		<.001		<.001		<.001
χ^2 (LRT)[c]		1.00		1.00		1.00

[a]n = the number of observations in data with long format to support mixed-effects modelling; [b]95% confidence intervals; [c]χ^2 = p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue; ISI = Insomnia Severity Index; NDI = Nightmare Disorder Index; PCL-5 = PTSD Checklist for DSM-5 Scale.

Figure 8.2

Change of Adjusted Estimates in Primary Outcome Measures Including the Insomnia Severity Index (ISI), the Nightmare Disorder Index (NDI), and the PTSD Checklist – Civilian Version (PCL-5) from Pre-to Post-intervention, as Determined by ITT Analysis (n = 30)



In relation to the second hypothesis, the ITT analysis showed that at baseline, the waitlist group had mean scores of 1.66, 12.01, and 0.69 on the GAD-7, PHQ-9 and PSQI, respectively (Table 8.4). Only the depression scores decreased significantly (p <.001) by 6.48 points for the treatment group at post-treatment (main effect of time) in comparison to the waitlist group. The treatment group showed slightly lower baseline scores compared to the waitlist group on the secondary measures, with mean differences of 0.47, 0.90, and 0.04 on the GAD-7, PHQ-9 and PSQI, respectively, suggesting that the two groups were balanced at baseline. The adjusted effects at post-intervention indicate that the treatment group experienced greater improvements than the waitlist group on all measures but with only significant results on the PSQI (with a difference of 2.22 points, p <.001).

There was variability among individuals, as shown in Table 8.4, with average deviations of 0.91, 4.89, and 0.73 points for the GAD-7, PHQ-9 and PSQI around both the baseline and post-intervention mean. The positive correlation coefficients for the GAD-7 and PSQI between the time point and the intercept indicate that participants with higher baseline scores (above the overall sample mean) were more likely to experience greater decrease in their scores over time compared to those with lower baseline scores. Mixed-effects models for the three measures were statistically significant (p <.001). Specifically, the random-intercept, random-slope models being appropriate for the PHQ-9 and PSQI (p <.05), while a random-intercept only model was sufficient for the GAD-7 (p >.05). Figure 8.3 shows the decrease of scores between the intervention and the waitlist groups on the GAD-7, PHQ-9 and PSQI as determined by the ITT analysis.

For those who completed the study, the PP analysis showed that the waitlist baseline scores were 11.78, 12.22, and 13.00 for the GAD-7, PHQ-9 and the PSQI, respectively. These scores deceased significantly only for the PHQ-9 measure by 6.22 points at post-

treatment (p <.001). There was also a main effect of condition on the GAD-7 measure with a decrease of 4.14 points (p = .04) for the treatment group, and an interaction effect of time x condition on the PSQI (p = .02), suggesting that the treatment group experienced a significantly better sleep quality than the waitlist group following the treatment (see Table 8.5).

Table 8.5 also shows a great variability among individuals, on the random effects with average deviations of 3.69, 3.16, and 2.82 points for the GAD-7, PHQ-9 and PSQI around both the baseline and post-intervention mean. This suggests substantial individual variability in the outcome measures. Mixed-effects models for the three measures were statistically significant (p <.001) with the random-intercept, random-slope model being appropriate for the PHQ-9 (p <.05), while a random-intercept only model was sufficient for the GAD-7 and the PSQI (p >.05) (Table 8.5).

Table 8.4

Mixed-Effects Linear Regression Analysis of the Effect of Intervention on Secondary Outcome Measures (ITT Analysis, n = 30)

Variables	Model 1 (n = 60[a]) (GAD-7)		Model 2 (n = 60[a]) (PHQ-9)		Model 3 (n = 60[a]) (PSQI)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects						
Intercept	1.66 (-0.14, 3.45)	.07	12.01 (9.46, 14.57)	<.0001	0.69 (-1.33,2.71)	.50
Time						
Baseline	reference		reference		reference	
Post-intervention	0.16 (-1.29, 1.62)	.83	-6.48 (-9.04, -3.92)	<.001	-0.58 (-1.43, 0.27)	.18
Condition						
Waitlist	reference		reference		reference	
Intervention	-0.47 (-2.01, 1.07)	.55	-0.90 (-4.40,2.61)	.62	-0.04 (-0.96, 0.87)	.92
Time x Condition	-1.62 (-3.62, 0.38)	.11	1.28 (-2.23,4.78)	.48	-2.22 (-3.39, -1.06)	<.001
Random effects						
SD (Time, intercept)	0.91 (0.47, 1.74)		4.89 (3.89, 6.13)		0.73 (0.49, 1.09)	
Correlation (Time, intercept)	1.00 (-1.00, 1.00)		-0.79 (-0.89, -0.61)		0.99 (-1.00, 1.00)	
SD of residual	1.86 (1.39, 2.50)		6.50E-05 (6.65E-07, 0.01)		1.03 (0.78, 1.34)	
Model fit						
Wald χ^2		<.001		<.001		<.001
χ^2 (LRT)[c]		.08		.007		.001

[a]n = the number of observations in data with long format to support mixed-effects modelling; [b]95% confidence intervals; [c]χ^2 = p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue; GAD-7 = Generalized Anxiety Disorder Questionnaire; PHQ-9 = The Patient Health Questionnaire; PSQI = Pittsburgh Sleep Quality Index.

Table 8.5

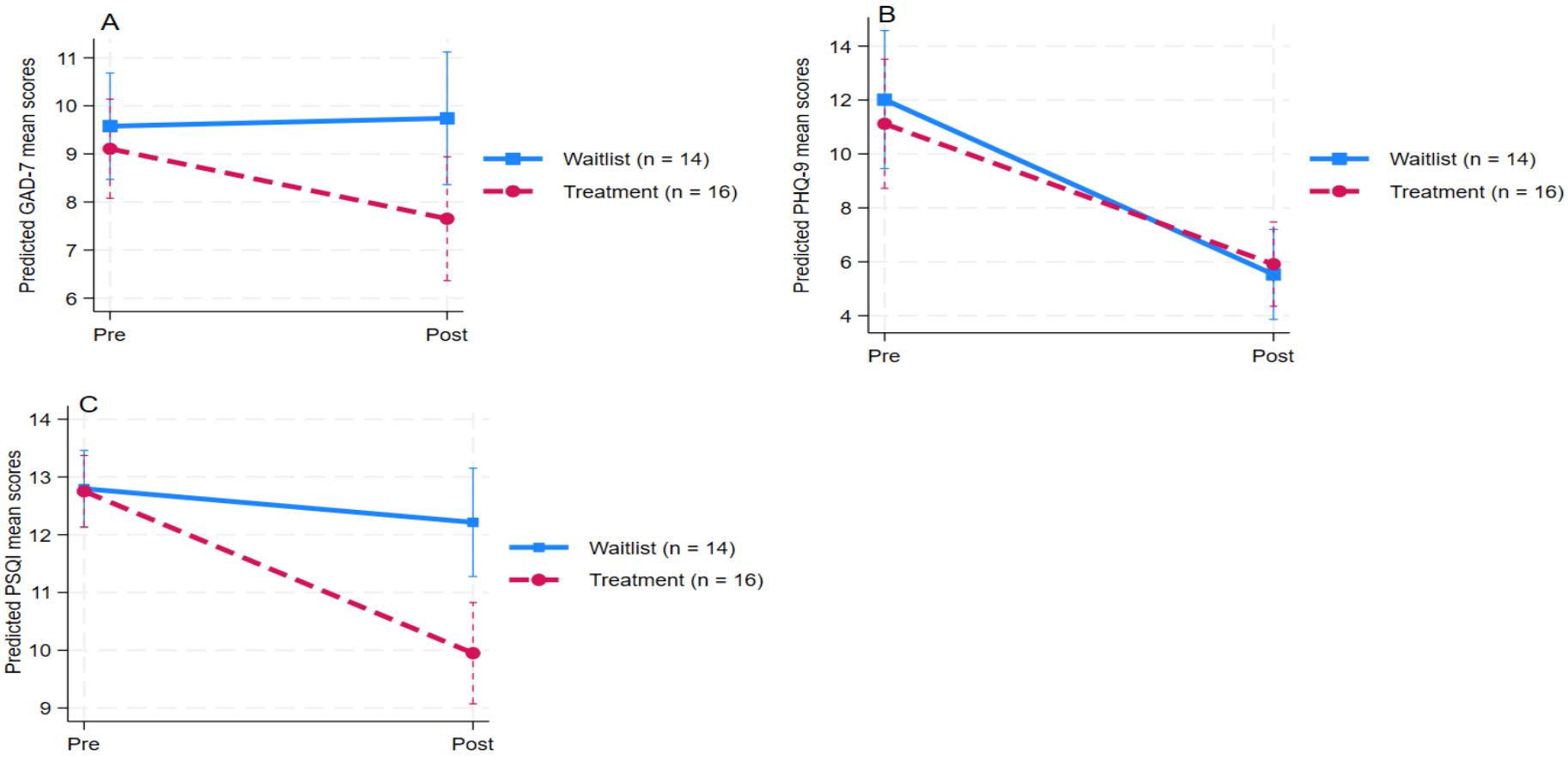
Mixed-Effects Linear Regression Analysis of the Effect of Intervention on Secondary Outcome Measures for Completers Only (PP Analysis, n =20)

Variables	Model 1 (n = 40[a]) (GAD-7)		Model 2 (n = 40[a]) (PHQ-9)		Model 3 (n = 40[a]) (PSQI)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects						
Intercept	11.78 (8.89, 14.66)	<.001	12.22(9.44, 15.00)	<.001	13.00 (10.87, 15.13)	<.001
Time						
Baseline	reference		reference		reference	
Post-intervention	1.33 (-0.90, 3.57)	.24	-6.22(-8.86, -3.59)	<.001	-0.67 (-2.19, 0.86)	.39
Condition						
Waitlist	reference		reference		reference	
Intervention	-4.14 (-8.03, -0.25)	.04	-1.60(-5.35, 2.15)	.40	-1.00 (-3.88, 1.88)	.50
Time x Condition	-2.70(-5.71, 0.32)	.08	1.14(-2.41, 4.70)	.53	-2.42(-4.48, -0.37)	.02
Random effects						
SD (intercept)	3.69(2.52, 5.41)		3.16(2.01, 4.98)		2.82 (1.95, 4.07)	
Correlation (Time, intercept)	NA		-0.68(-0.85, -0.37)		NA	
SD of residual	2.42(1.78, 3.30)		2.85 (2.09, 3.89)		1.65(1.21, 2.25)	
Model fit						
Wald χ^2		< .001		< .001		< .001
χ^2 (LRT)[c]		.28		.004		1.00

[a]n = the number of observations in data with long format to support mixed-effects modelling; [b]95% confidence intervals; [c]χ^2 and p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue; NA = not applicable as the random-intercept model better fits data than the random-intercept random-slope model. Given its better fit, random-intercept model parameters were reported; GAD-7 = Generalized Anxiety Disorder Questionnaire; PHQ-9 = The Patient Health Questionnaire; PSQI = Pittsburgh Sleep Quality Index.

Figure 8.3

Change of Adjusted Estimates in Secondary Outcome Measures Including the Generalized Anxiety Disorder Questionnaire (GAD-7), the Patient Health Questionnaire (PHQ-9) and the Pittsburgh Sleep Quality Index (PSQI) from Pre-to Post-Intervention, as Determined by the ITT Analysis (n = 30)



To address the third hypothesis, separate mixed-effects linear models' analyses were performed for each group (intervention and waitlist) on all primary and secondary outcome measures. The analysis incorporated data from the following time points: baseline, post-treatment, and 3-months follow-up for the intervention group, and pre-treatment, post-treatment, and 3-months follow-up for the waitlist group. ITT analysis for the intervention group showed a significant reduction of insomnia, nightmares and trauma symptoms as measured by the ISI, NDI and PCL-5 both at post-treatment ($p \leq .001$) with the effect of 3.42, 2.86 and 15.62 points, respectively, and at 3-months follow-up with p values <.001 and an effect of 8.64, 4.20, 22.83 points on ISI, NDI and PCL-5, respectively (Table 8.6).

A great variability among individuals was detected on the random effects with average deviations of 1.56, 0.32, and 11.09 points for the ISI, NDI and PCL-5 around both post-intervention and at 3-months follow-up. Mixed-effects models for the three measures were statistically significant ($p < .001$) with the random-intercept, random-slope models being appropriate for the ISI and the PCL-5 ($p < .05$) while the random-intercept model was appropriate for the NDI ($p > .05$) (Table 8.6). See Figure 8.4 for the decrease of scores over time at post-intervention and at 3-months follow-up for the intervention group on the primary measures.

For those who completed the study, the PP analysis showed comparable results to those reported in the ITT analysis with a significant reduction of symptoms at both post-intervention and at 3-months follow-up (all $p \leq .04$). The adjusted effects showed a continued reduction of symptoms from post-intervention to 3-months follow-up with a difference of 7.81, 4.86 and 23.71 points on the ISI, NDI and PCL-5, respectively (Table 8.7).

The analysis also showed a substantial variability among individuals, with average deviations of 1.64, 1.03, and 1.81 points for the ISI, NDI, and PCL-5 around both post-

intervention and at 3-months follow-up means. The positive correlation coefficients between the time point and the intercept on the NDI indicate that participants with higher baseline scores (above the overall sample mean) were more likely to experience greater decreases in their scores over time compared to those with lower baseline scores. All mixed-effects models for the ISI, NDI, and PCL-5 were statistically significant (p <.001) with a random-intercept model being sufficient for all the three measures with a non-significant p-value (p >.05) (Table 8.7).

Table 8.6

Mixed-Effects Linear Regression Analysis of the Change of Primary Outcome Measures Over Time in the Intervention Group (ITT Analysis, n = 16)

Variables	Model 1 (n = 48[a]) (ISI)		Model 2 (n = 48[a]) (NDI)		Model 3 (n = 48[a]) (PCL-5)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects						
Intercept	3.23 (-1.66, 8.12)	.20	3.37 (1.12, 5.61)	.003	-17.52 (-27.73, -7.30)	.001
Time						
Baseline	reference		reference		reference	
Post-intervention	-3.42 (-5.47, -1.38)	.001	-2.86 (-4.51, -1.21)	.001	-15.62 (-21.87, -9.37)	<.001
3-month post-intervention	-8.64 (-10.68, -6.60)	<.001	-4.20 (-5.85, -2.55)	<.001	-22.83 (-29.08, -16.58)	<.001
Random effects						
SD (Time, intercept)	1.56 (0.91, 2.67)		0.32 (7.51E-05, 1.33E+04)		11.09 (7.06, 17.43)	
Correlation (Time, intercept)	0.99 (-1.00, 1.00)		NA		0.99 (-1.00, 1.00)	
SD of residual	2.73 (2.11, 3.55)		2.38 (1.86, 3.04)		4.45 (3.36, 5.89)	
Model fit						
Wald χ^2		<.001		<.001		<.001
χ^2 (LRT)[c]		.007		.16		.02

[a]n = the number of observations in data with long format to support mixed-effects modelling; [b]95% confidence intervals; [c]χ^2 = p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue; NA: not applicable as the random-intercept model better fits data than the random-intercept random-slope model. Given its better fit, random-intercept model parameters were reported; ISI = Insomnia Severity Index; NDI = Nightmare Disorder Index; PCL-5 = PTSD Checklist – Civilian Version.

Table 8.7

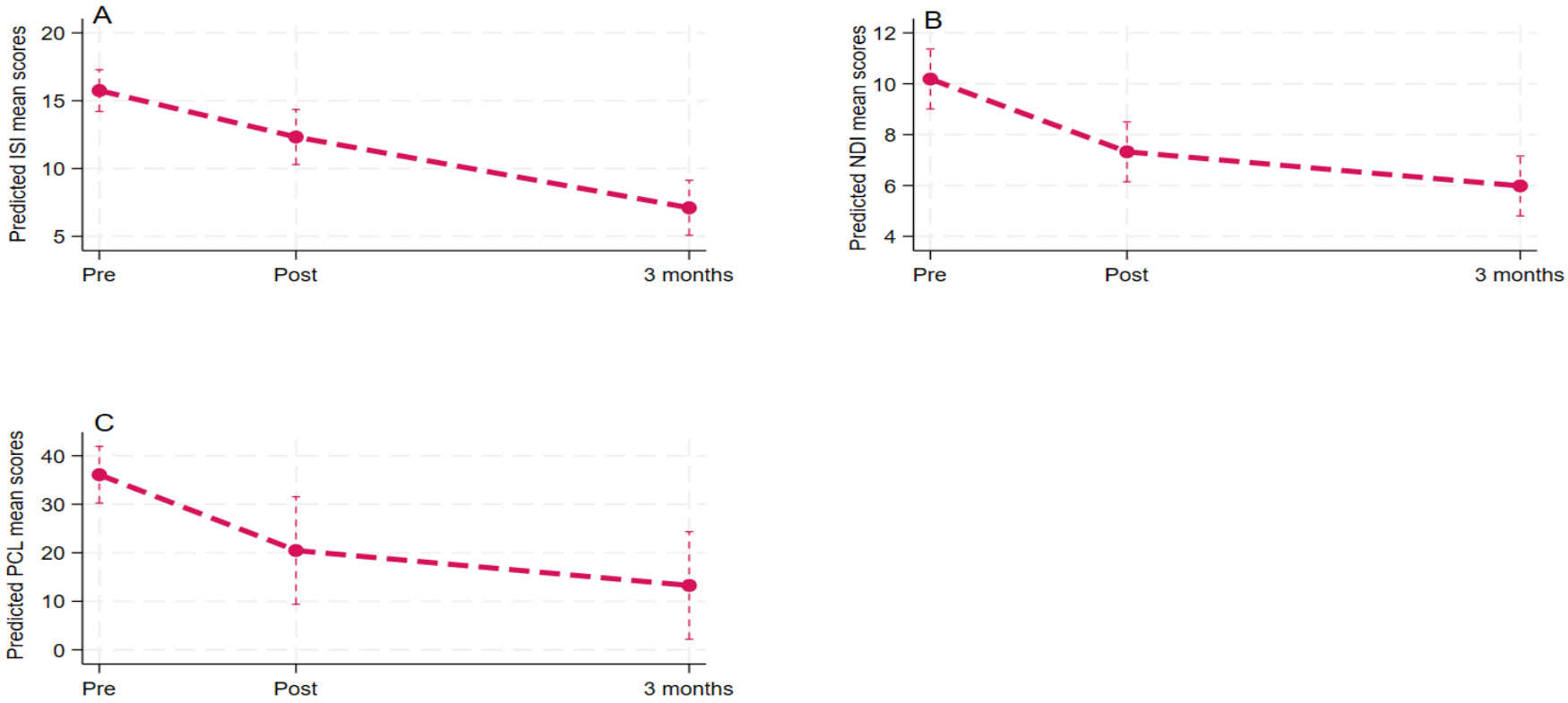
Mixed-Effects Linear Regression Analysis of the Change of Primary Outcome Measures Over Time in the Intervention Group for Completers Only (PP Analysis, n = 11)

Variables	Model 1 (n = 33[a]) (ISI)		Model 2 (n = 33[a]) (NDI)		Model 3 (n = 33[a]) (PCL-5)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects						
Intercept	6.50 (-1.03, 11.97)	.002	0.24 (-4.19, 4.66)	.92	16.05 (7.49, 24.61)	<.001
Time						
Baseline	reference		reference		reference	
Post-intervention	-3.14 (-6.17, -0.12)	.04	-3.27 (-4.66, -1.89)	<.001	-17.57 (-25.45, -9.69)	<.001
3-months post-intervention	-7.81 (-10.84, -4.79)	<.001	-4.86 (-6.24, -3.47)	<.001	-23.71 (-31.59, -15.83)	<.001
Random effects						
SD (intercept)	1.64 (0.49, 5.44)		1.03 (0.24, 4.48)		1.81 (0.01, 260.12)	
SD of residual	3.62(2.70, 4.87)		1.49 (0.71, 3.10)		9.43 (7.02, 12.67)	
Model fit						
Wald χ^2		<.001		<.001		<.001
χ^2 (LRT)[c]		.18		.07		.42

[a]n = the number of observations in data with long format to support mixed-effects modelling; [b]95% confidence intervals; [c]χ^2 = p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue; ISI = Insomnia Severity Index; NDI = Nightmare Disorder Index; PCL-5 = PTSD Checklist – Civilian Version.

Figure 8.4

Change in Insomnia Severity Index (ISI), the Nightmare Disorder Index (NDI), and the PTSD Checklist – Civilian Version (PCL-5) Scores for the Intervention Group from Baseline- to Post- Intervention to 3-Months Follow-up, as Determined by the ITT Analysis



On the secondary measures, the ITT analysis showed that the intervention group experienced significant improvements on the PHQ-9 and PSQI both at post-treatment and at 3-months follow-up (p <.001). No significant reduction of symptoms was observed for the GAD-7 at post-treatment (p = .21) (Table 8.8). However, all participants in the intervention group experienced significant reduction of symptoms at 3-months follow-up (p <.001) on the three measures with adjusted effects showing a decrease of 4.05, 7.50 and 5.12 points on the GAD-7, PHQ-9, and PSQI, respectively. Table 8.8 also shows variability among individuals on the random effects with average deviations of 0.001, 5.46, and 0.82 points for the GAD-7, PHQ-9, and PSQI around post-intervention and 3-months follow-up. The three models were statistically significant (p <.001) with the random-intercept, random-slope models being appropriate for the PHQ-9 and PSQI (p <.05), and the random-intercept model was appropriate for the GAD-7 (p >.05). Figure 8.5 shows a change in secondary outcome scores over time in the intervention group as determined by the ITT analysis.

Comparable results were also detected on the PP analysis, with individuals experiencing significant reductions of symptoms at post-intervention, and also at 3-months assessments (all p <.001) except for the GAD-7 which was found to be not significant at post-intervention. Participants experienced greater reduction of symptoms at 3-months assessment with adjusted effects indicating a reduction of 3.88, 6.98 and 4.62 points on the GAD-7, PHQ-9, and PSQI, respectively (see Table 8.9). The three models were statistically significant (p <.001) with the random-intercept model being appropriate for the three measures (p >.05).

Table 8.8

Mixed-Effects Linear Regression Analysis of the Change of Secondary Outcome Measures Over Time in the Intervention Group (ITT Analysis, n = 16)

Variables	Model 1 (n = 48[a]) (GAD-7)		Model 2 (n = 48[a]) (PHQ-9)		Model 3 (n = 48[a]) (PSQI)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects						
Intercept	3.64 (1.58, 5.70)	.001	-8.64 (-12.69, -4.59)	.001	0.92 (-2.45, 4.29)	.59
Time						
Baseline	reference		reference		reference	
Post-intervention	-1.46 (-3.73, 0.82)	.21	-5.20 (-7.88, -2.53)	<.001	-2.80 (-3.82, -1.78)	<.001
3-month post-intervention	-4.05 (-6.32, -1.77)	<.001	-7.50 (-10.17, -4.82)	<.001	-5.12 (-6.14, -4.11)	<.001
Random effects						
SD (Time, intercept)	0.001 (1.98E-05, 1.73E-02)		5.46 (4.01, 7.42)		0.82 (0.53, 1.37)	
Correlation (Time, intercept)	NA		0.78 (0.54, 0.90)		0.99 (-1.00, 1.00)	
SD of residual	3.28 (2.69, 4.01)		.001 (5.49E-06, 0.20)		1.34 (1.04, 1.73)	
Model fit						
Wald χ^2		<.001		<.001		<.001
χ^2 (LRT)[c]		.34		.03		.002

[a]n = the number of observations in data with long format to support mixed-effects modelling; [b]95% confidence intervals; [c]χ^2 and p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue; NA = not applicable as the random-intercept model better fits data than the random-intercept random-slope model. Given its better fit, random-intercept model parameters were reported; GAD-7 = Generalized Anxiety Disorder Questionnaire; PHQ-9 = The Patient Health Questionnaire; PSQI = Pittsburgh Sleep Quality Index.

Table 8.9

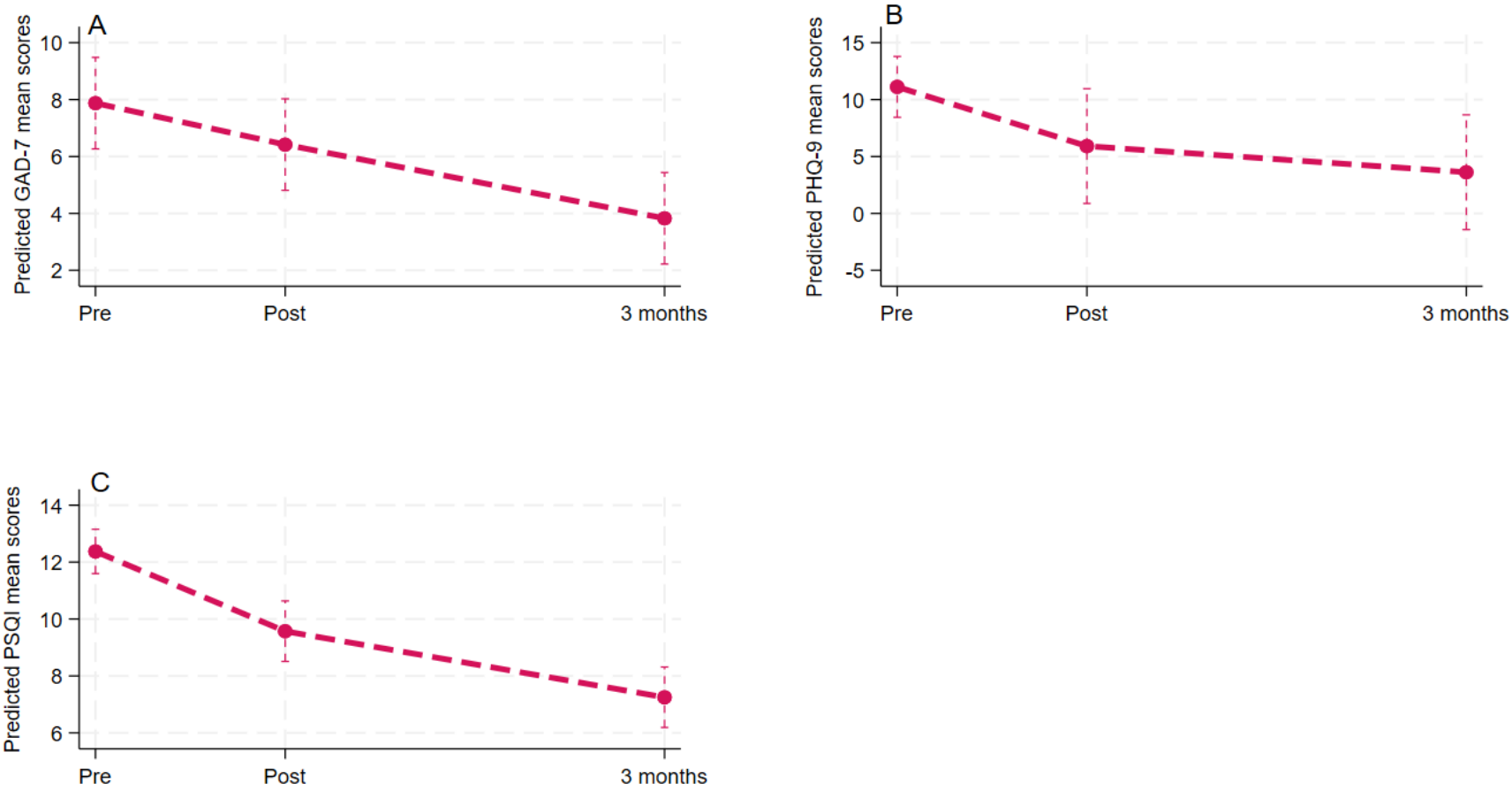
Mixed-Effects Linear Regression Analysis of the Change of Secondary Outcome Measures Over Time in the Intervention Group (PP Analysis, n = 11)

Variables	Model 1 (n = 33[a]) (GAD-7)		Model 2 (n = 33[a]) (PHQ-9)		Model 3 (n = 33[a]) (PSQI)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects						
Intercept	2.85 (0.31, 5.39)	.03	10.63 (8.28, 12.98)	<.001	0.85 (-3.05, 4.76)	.67
Time						
Baseline	reference		reference		reference	
Post-intervention	-1.36 (-3.86, 1.14)	.29	-5.08 (-7.80, -2.36)	<.001	-3.09 (-4.50, -1.68)	<.001
3-month post-intervention	-3.88 (-6.38, -1.38)	.002	-6.98 (-9.71, -4.26)	<.001	-4.62 (-6.03, -3.21)	<.001
Random effects						
SD (intercept)	0.90 (0.10, 8.32)		2.28 (1.100, 4.73)		1.12 (0.52, 2.41)	
SD of residual	2.99(2.23, 4.02)		3.26 (2.42, 4.38)		1.69 (1.26, 2.27)	
Model fit						
Wald χ^2		<.001		<.001		<.001
χ^2 (LRT)[c]		.32		.56		.05

[a]n = the number of observations in data with long format to support mixed-effects modelling; [b]95% confidence intervals; [c]χ^2 and p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue; GAD-7 = Generalized Anxiety Disorder Questionnaire; PHQ-9 = The Patient Health Questionnaire; PSQI = Pittsburgh Sleep Quality Index.

Figure 8.5

Change in Secondary Outcome Measures Including Generalized Anxiety Disorder Questionnaire (GAD-7), the Patient Health Questionnaire (PHQ-9) and the Pittsburgh Sleep Quality Index (PSQI) Scores from Baseline-to Post-Intervention to 3-Months Follow-up, as Determined by the ITT Analysis for the Intervention Group



Similarly, the ITT analysis results of the mixed-effects regression for the waitlist group showed that at baseline participants had mean scores of 10.79, 5.42 and 13.93 on the ISI, NDI and PCL-5, respectively. The adjusted effects at post-intervention indicated that symptoms significantly reduced by 6.36, 5.78 and 19.37 points (p <.001), and a significant reduction of 8.21, 7.74 and 27.96 points was observed at 3-months follow-up for the ISI, NDI and PCL-5, respectively (p <.001) (see Table 8.10).

In the random effects part, there was substantial variability among individuals, with average deviations of 9.80, 6.18, and 1.73 points on the ISI, NDI, and PCL-5 around both post-intervention and at 3-months follow-up means. This suggests considerable individual variability in the outcomes. All mixed-effects models for ISI, NDI, and PCL-5 were statistically significant (p <.001) with a random-intercept model being appropriate for the three measures with a non-significant p-value (p >.05) (Table 8.10). Figure 8.6 shows change in primary outcome scores over time for the waitlist group at post-intervention and at 3-months follow-up.

The PP analysis showed similar results with significant improvements at both post-intervention and at 3-months follow-up assessments on the ISI, NDI and PCL-5 (all $p \leq .001$) (Table 8.11). The mixed-effects models for ISI, NDI, and PCL-5 were all statistically significant (p <.001). The random-intercept model was sufficient for the three measures (p >.05) (Table 8.11).

Table 8.10

Mixed-Effects Linear Regression Analysis of the Change of Primary Outcome Measures Over Time in the Waitlist Group Receiving the Intervention (ITT Analysis, n = 14)

Variables	Model 1 (n = 42[a]) (ISI)		Model 2 (n = 42[a]) (NDI)		Model 3 (n = 42[a]) (PCL-5)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects						
Intercept	10.79 (5.89, 15.70)	<.001	5.42 (2.74, 8.10)	<.001	13.93 (4.95, 22.92)	.002
Time						
Baseline	reference		reference		reference	
Post-intervention	-6.36 (-9.16, -3.57)	<.001	-5.78 (-8.02, -3.53)	<.001	-19.37 (-26.62, -12.13)	<.001
3-months post-intervention	-8.21 (-11.01, -5.41)	<.001	-7.74 (-9.98, -5.49)	<.001	-27.96 (-35.20, -20.71)	<.001
Random effects						
SD (intercept)	9.80E-05 (-0.21, 0.21)		6.18E-05 (-0.14, 0.14)		1.73 (0.01, 302.24)	
SD of residual	3.78 (3.05, 4.68)		3.03 (2.44, 3.75)		9.78 (7.53, 12.71)	
Model fit						
Wald χ^2		<.001		<.001		<.001
χ^2 (LRT)[c]		.45		.59		.14

[a]n = the number of observations in data with long format to support mixed-effects modelling; [b]95% confidence intervals; [c]χ^2 and p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; As the random-intercept model better fits data than the random-intercept random-slope model, random-intercept model parameters were reported; All models adjusted for pre-treatment measure to address the regression-to-mean issue. ISI = Insomnia Severity Index; NDI = Nightmare Disorder Index; PCL-5 = PTSD Checklist – Civilian Version.

Table 8.11

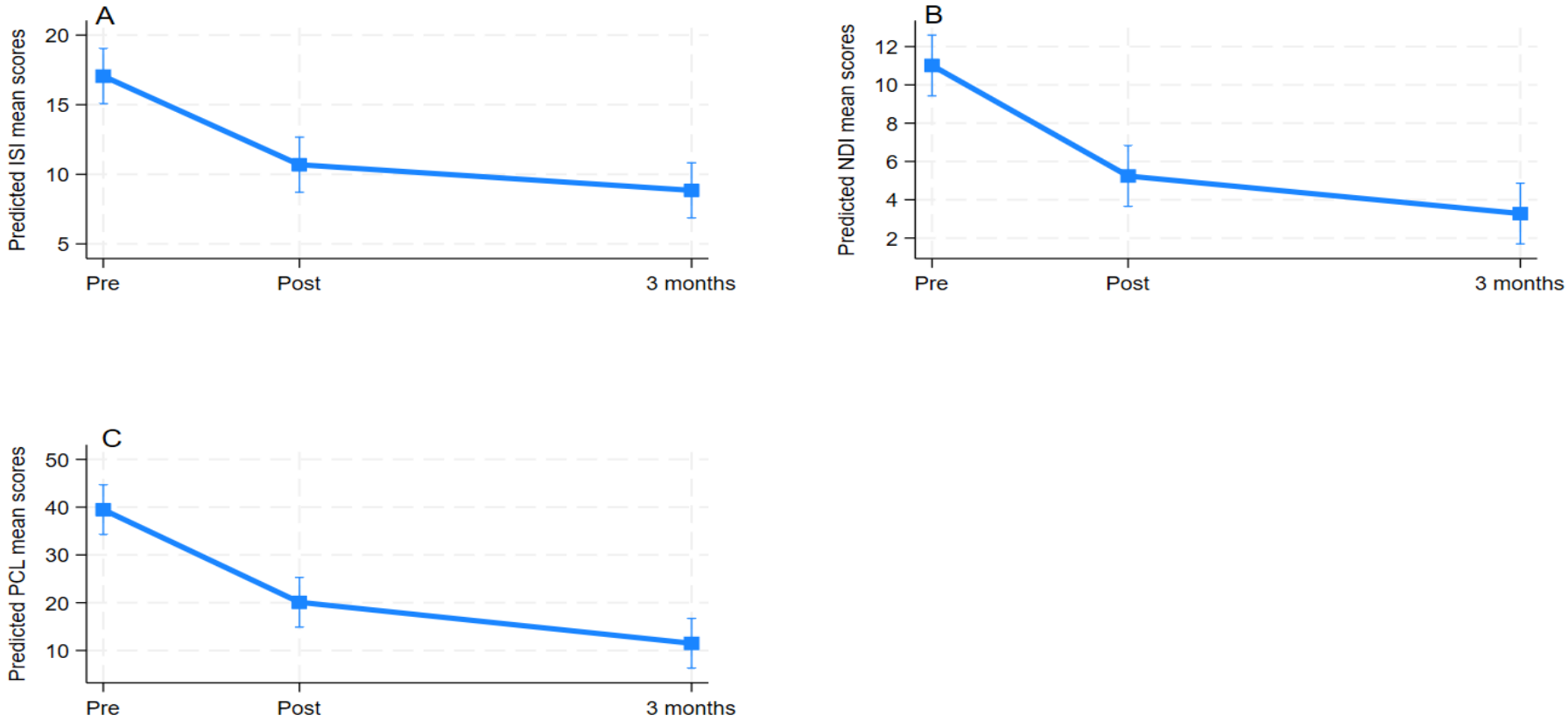
Mixed-Effects Linear Regression Analysis of the Change of Primary Outcome Measures Over Time in the Waitlist Group Receiving the Intervention (PP Analysis, n = 9)

Variables	Model 1 ($n = 27$[a]) (ISI)		Model 2 ($n = 27$[a]) (NDI)		Model 3 ($n = 27$[a]) (PCL-5)	
	Beta (95%CI[b])	*p*-value	Beta (95%CI[b])	*p*-value	Beta (95%CI[b])	*p*-value
Fixed effects						
Intercept	11.65 (5.59, 17.71)	<.001	5.06 (1.47, 8.66)	.006	12.85 (-1.41, 27.11)	.08
Time						
Baseline	reference		reference		reference	
Post-intervention	-6.56 (-10.49, -2.63)	.001	-5.44 (-8.59, -2.30)	.001	-20.89 (-30.98, -10.79)	<.001
3-month post-intervention	-7.00 (-10.93, -3.07)	<.001	-7.11 (-10.26, -3.96)	<.001	-28.44 (-38.54, -18.35)	<.001
Random effects						
SD (intercept)	0.01 (0.01, 0.6)		.01 (NA)		3.31 (0.29, 38.15)	
SD of residual	4.25(3.26, 5.55)		3.41 (2.61, 4.45)		10.93 (7.89, 15.15)	
Model fit						
Wald χ^2		<.001		<.001		<.001
χ^2 (LRT)[c]		1.00		1.00		.34

[a]*n* = the number of observations in data with long format to support mixed-effects modelling; [b]95% confidence intervals; [c]χ^2 = *p*-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue; NA = not applicable; ISI = Insomnia Severity Index; NDI = Nightmare Disorder Index; PCL-5 = PTSD Checklist – Civilian Version.

Figure 8.6

Change in Insomnia Severity Index (ISI), the Nightmare Disorder Index (NDI), and the PTSD Checklist – Civilian Version (PCL-5) Scores for the Waitlist Group from Pre- to Post-Intervention to 3-Months Follow-up, as Determined by the ITT Analysis



For the secondary measures, ITT analysis showed that the waitlist group had a baseline mean scores of 0.78, 0.36 and 3.31 on the GAD-7, PHQ-9 and the PSQI, respectively. The adjusted effects at post-intervention indicated that these scores significantly decreased by 4.72 and 5.07 points for the GAD-7 and the PSQI, respectively (p <.001). However, no significant changes were observed on the PHQ-9 at post-intervention. Furthermore, adjusted effects showed a significant reduction of 6.51 points on the GAD-7 and 5.00 points on the PSQI (p <.001) against the baseline, but no changes on the PHQ-9 at 3-months follow-up (Table 8.12).

There was variability among individuals, with deviations of 1.47, 0.06, and 0.92 points for the GAD-7, PHQ-9 and PSQI around post-intervention and 3-months follow-up mean. The positive correlation coefficients between the time point and the intercept indicate that participants with higher baseline scores (above the overall sample mean) were more likely to experience greater decreases in their scores over time compared to those with lower baseline scores. All mixed-effects models for GAD-7, PHQ-9 and PSQI were statistically significant (p <.001). Specifically, the random-intercept, random-slope models were appropriate for the GAD-7 and the PSQI (p <.05), while a random-intercept only model was sufficient for the PHQ-9, which also fit the data but with a non-significant p-value (p >.05) (Table 8.12). Figure 8.7 shows change in secondary outcomes at post-intervention and at 3-months follow-up for the waitlist group.

For those who completed the study, the PP analysis showed similar results for the waitlist group with significant reduction at post-intervention and at 3-months assessments only for the GAD-7 and the PSQI (p <.001), however, no significant changes were detected for the PHQ-9 either at post-intervention or at 3-months follow-up (Table 8.13). For those who experienced significant reductions, there was great variability with deviations of 1.98,

and 1.00 points for the GAD-7, and PSQI around post-intervention and 3-months follow-up mean. All mixed-effects models for the GAD-7, PHQ-9 and PSQI were statistically significant (p <.001). Specifically, the random-intercept models were appropriate for the three measures with a non-significant p-value (p <.05) (Table 8.13).

Table 8.12

Mixed-Effects Linear Regression Analysis of the Change of Secondary Outcome Measures Over Time in the Waitlist Group Receiving the Intervention (ITT Analysis, n = 14)

Variables	Model 1 (n = 42[a]) (GAD-7)		Model 2 (n = 42[a]) (PHQ-9)		Model 3 (n = 42[a]) (PSQI)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects						
Intercept	0.78 (-2.68, 4.24)	.66	0.36 (-1.00, 1.72)	.61	3.31 (-0.62,7.25)	.10
Time						
Baseline	reference		reference		reference	
Post-intervention	-4.72 (-6.24, -3.19)	<.001	-0.42 (-1.84, 1.00)	.56	-5.07 (-6.42, -3.71)	<.001
3-month post-intervention	-6.51 (-8.03, -4.99)	<.001	-0.40 (-1.82, 1.02)	.58	-5.00 (-6.35, -3.65)	<.001
Random effects						
SD (Time, intercept)	1.47 (0.87, 2.48)		0.06 (2.72E-64, 1.30E+61)		0.92 (0.48, 1.77)	
Correlation (Time, intercept)	0.99 (-1.00, 1.00)		NA		0.99 (-1.00, 1.00)	
SD of residual	1.78 (1.33, 2.37)		1.91 (1.48, 2.48)		1.71 (1.28, 2.78)	
Model fit						
Wald χ^2		<.001		<.001		<.001
χ^2 (LRT)[c]		<.001		.17		.02

[a]n = the number of observations in data with long format to support mixed-effects modelling; [b]95% confidence intervals; [c]χ^2 and p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue; NA = not applicable as the random-intercept model better fits data than the random-intercept random-slope model. Given its better fit, random-intercept model parameters were reported; GAD-7 = Generalized Anxiety Disorder Questionnaire; PHQ-9 = The Patient Health Questionnaire; PSQI = Pittsburgh Sleep Quality Index.

Table 8.13

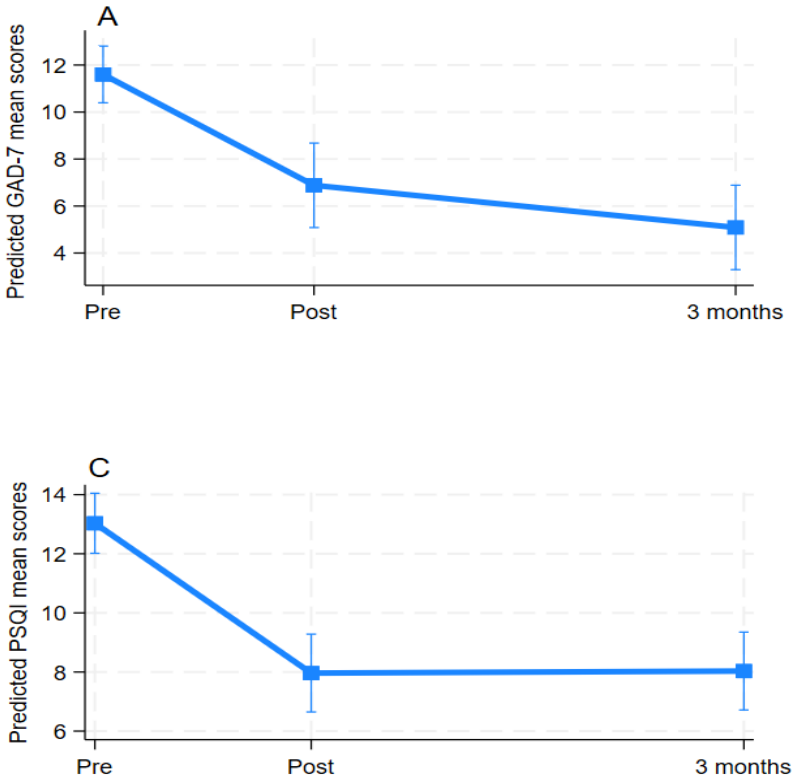
Mixed-Effects Linear Regression Analysis of the Change of Secondary Outcome Measures Over Time in the Waitlist Group Receiving the Intervention (PP Analysis, n = 9)

Variables	Model 1 (n = 27[a]) (GAD-7)		Model 2 (n = 27[a]) (PHQ-9)		Model 3 (n = 27[a]) (PSQI)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects						
Intercept	3.85 (-8.29, -3.04)	.22	0.43 (-1.61, 2.48)	.68	5.89 (1.55, 10.22)	.008
Time						
Baseline	reference		reference		reference	
Post-intervention	-5.67 (-8.29, -3.04)	<.001	-0.56 (-2.69, 1.58)	.61	-4.78 (-7.05, -2.50)	<.001
3-month post-intervention	-7.78 (-10.40, -5.15)	<.001	-0.11 (-2.25, 2.03)	.92	-4.78 (-7.05, -2.50)	<.001
Random effects						
SD (intercept)	1.98 (0.88, 4.46)		0.29 (1.20e-06, 69857.52)		1.00 (0.21, 4.67)	
SD of residual	2.84 (2.05, 3.94)		2.31 (1.67, 3.21)		2.46 (1.78, 3.41)	
Model fit						
Wald χ^2		<.001		<.001		<.001
χ^2 (LRT)[c]		.05		.47		.24

[a]n = represents the number of observations in data with long format to support mixed-effects modelling; [b]95% confidence intervals; [c]χ^2 = p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue; GAD-7 = Generalized Anxiety Disorder Questionnaire; PHQ-9 = The Patient Health Questionnaire; PSQI = Pittsburgh Sleep Quality Index.

Figure 8.7

Change in Secondary Outcome Measures Including the Generalized Anxiety Disorder Questionnaire (GAD-7), the Patient Health Questionnaire (PHQ-9) and the Pittsburgh Sleep Quality Index (PSQI) Scores for the Waitlist Group from Pre-to Post-Intervention to 3-Months Follow-up, as Determined by the ITT Analysis



ITT analysis of the mixed-effects regression was used to address the fourth hypothesis. The effect sizes of the DID in the fixed-effects component and the variability in the random effects component showed that at baseline, the waitlist group had mean scores of 4.28, 85.37, 1.49 and 66.15 on the Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE, respectively. At post-intervention, the treatment group experienced significantly more improvements on the Fitbit-SE, SD-TST, and SD-SE with a difference of effect of 2.85 (p = .006), 1.56 *(p* <.001) and 8.73 (p =.049) points, respectively, than the waitlist group. However, no significant change was detected on the Fitbit-MS.

The treatment group showed slightly lower baseline scores compared to the waitlist group, with mean differences of 0.25, 0.54, 0.31 and 10.01 for Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE, respectively, suggesting that the two groups were relatively balanced at baseline. No significant interaction effects were observed on either the Fitbit or the sleep diary measures (Table 8.14). Figure 8.8 shows changes in sleep measures including Fitbit-MS, Fitbit-SE, SD-TST, SD- SE between the two groups from baseline to post-intervention.

In the random effects part, there was substantial variability among individuals, with average deviations of 17.39, 3.91, 1.35 and 14.26 points for the Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE around both the baseline and post-intervention mean. The positive correlation coefficients, on the Fitbit-MS, between the time point and the intercept indicated that participants with higher baseline scores (above the overall sample mean) were more likely to experience greater decreases in their scores over time compared to those with lower baseline scores. However, a negative correlation on the Fitbit-SE, and SD-SE suggested that people with lower baseline scores were more likely to experience greater decrease of symptoms. All mixed-effects models for Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE were statistically significant (p <.05). Specifically, the random-intercept, random-slope models

were appropriate for Fitbit-MS, Fitbit-SE, and SD-SE (p <.05), while a random-intercept only model was sufficient for SD-TST, which also fit the data but with a non-significant p-value (p >.05) (Table 8.14). Figure 8.8 shows the changes in Fitbit-MS, Fitbit-SE, SD-TST, SD- SE over time based on the ITT Analysis.

For completers only, the PP analysis of the mixed-effects regression showed that at baseline the waitlist group had mean scores of 60.48, 34.02, 1.49 and 64.14 on the Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE, respectively. At post-intervention, only scores on the Fitbit-SE (p = .02), and SD-TST (p <.001) improved significantly for the treatment group in comparison to the waitlist group. There was also a main effect of condition on the SD-SE (p = .03), suggesting that only the treatment group experienced significant improvement on sleep efficiency as recorded using the sleep diary. The treatment group baseline scores were balanced compared to the waitlist group, with mean differences of 6.07, 0.03, and 0.43 for Fitbit-MS, Fitbit-SE, SD-TST, respectively (p >.05) (Table 8.15). All mixed-effects models for the Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE were statistically significant (p <.05) with a random-intercept model being appropriate for the four measures (p >.05) (Table 8.15).

Table 8.14

Mixed-Effects Linear Regression Analysis of the Effect of Intervention on Sleep Measures Including the Fitbit-MS, Fitbit-SE, SD-TST and SD-SE (ITT Analysis, n = 30)

Variables	Model 1 *(n* = 60[a]) (Fitbit-MS)		Model 2 (*n* = 60[a]) (Fitbit-SE)		Model 3 (*n* = 60[a]) (SD-TST)		**Model 4 (*n* = 60[a]) (SD-SE)**	
	Beta (95%CI[b])	*p*-value	Beta (95%CI[b])	*p*-value	Beta (95%CI[b])	***p*-value**	**Beta (95%CI[b])**	***p*-value**
Fixed effects								
Intercept	-4.28 (-71.50, 62.93)	.90	85.37 (83.32, 87.42)	<.001	1.49 (0.73, 2.25)	<.001	66.15 (58.04, 74.26)	<.001
Time								
Baseline	reference		reference		reference		reference	
Post-intervention	-4.45 (-23.46,14.56)	.65	2.85 (0.81, 4.90)	.006	1.56 (1.02, 2.09)	<.001	8.73 (0.02, 17.43)	.049
Condition								
Waitlist	reference		reference		reference		reference	
Intervention	0.25 (-20.51,21.00)	.98	0.54 (-2.26, 3.34)	.71	0.31 (-0.23, 0.85)	.27	10.01 (-1.10, 21.12)	.08
Time x Condition	10.09 (-15.95,36.12)	.45	-0.75 (-3.55, 2.05)	.60	-0.63 (-1.37, 0.11)	.10	-1.31 (-13.23, 10.60)	.83
Random effects								
SD (Time, intercept)	17.39 (12.26, 24.68)		3.91 (3.09, 4.93)		1.35E-07 (-7.05E-04, 7.06E-04)		14.26 (9.24, 22.01)	
Correlation (Time, intercept)	0.99 (-1.00, 1.00)		-0.83 (-0.91, -0.69)		NA		-0.88 (-0.98, -0.47)	
SD of residual	22.52 (17.48, 29.03)		1.38E-03 (3.09E-05, 6.16E-02)		0.73 (0.61, 0.87)		6.03 (1.46, 24.90)	
Model fit								
Wald χ^2		<.001		.006		<.001		.002
χ^2 (LRT)[c]		.001		.001		.38		.005

[a]*n* = represents the number of observations in data with long format to support mixed-effects modelling; [b]95% = confidence intervals; [c]χ^2 = *p*-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue. NA= not applicable as the random-intercept model better fits data than the random-intercept random-slope model. Given its better fit, random-intercept model parameters were reported; Fitbit-MS= Fitbit Minutes Asleep; Fitbit-SE= Fitbit Sleep Efficiency; SD-TST= Sleep Diary Total Sleep Time; SD-SE= Sleep Diary Sleep Efficiency.

Table 8.15

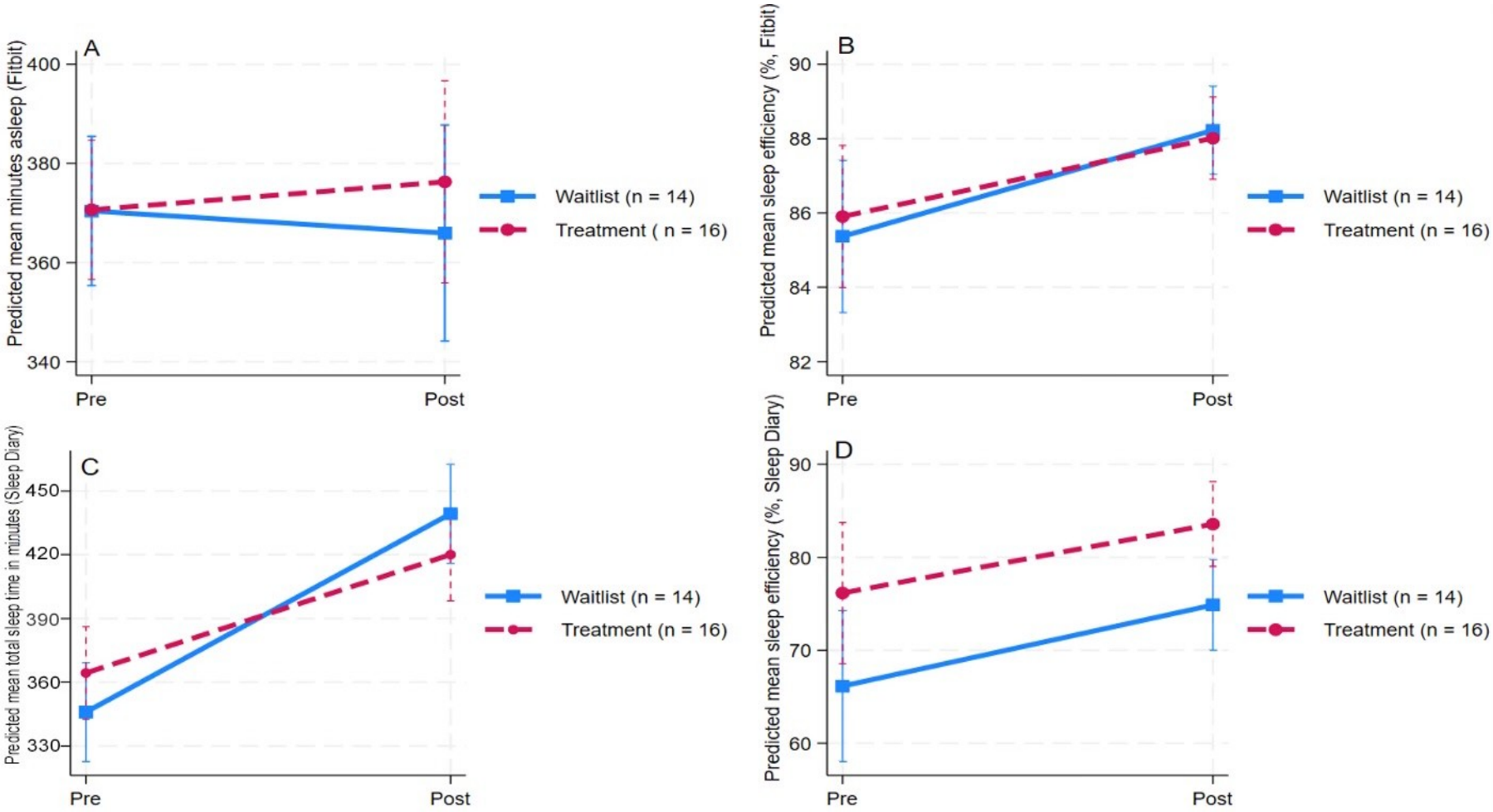
Mixed-Effects Linear Regression Analysis of the Effect of Intervention on Sleep Measures Including Fitbit-MS, Fitbit-SE, SD-TST and SD-SE (PP Analysis for Completers Only, n =20)

Variables	Model 1 (n = 40[a]) (Fitbit-MS)		Model 2 (n = 40[a]) (Fitbit-SE)		Model 3 (n = 40[a]) (SD-TST)		Model 4 (n = 40[a]) (SD-SE)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects								
Intercept	-60.48 (-131.25, 10.29)	.09	34.02 (20.73, 47.32)	<.001	1.49 (0.65, 2.33)	<.001	64.14 (54.89, 73.39)	<.001
Time								
Baseline	reference		reference		reference		reference	
Post-intervention	-18.38 (-47.41,10.65)	.22	2.56 (0.46, 4.66)	.02	1.67 (0.97, 2.38)	<.001	5.95 (-6.47, 18.38)	.35
Condition								
Waitlist	reference		reference		reference		reference	
Intervention	6.07 (-22.43, 34.58)	.68	0.03 (-1.97, 2.03)	.98	0.43 (-0.27, 1.12)	.23	14.13(1.66, 26.61)	.03
Time x Condition	21.81 (-17.34, 60.96)	.28	-0.38 (-3.21, 2.45)	.79	-0.84 (-1.78, 0.11)	.08	2.18 (-14.58, 18.93)	.80
Random effects								
SD (Time, intercept)	8.68e-06		8.96E-06 (NA)		2.51E-07(NA)		4.44 (0.47, 41.60)	
SD of residual	31.42 (25.24, 39.12)		2.27 (1.82, 2.83)		0.76 (0.61, 0.95)		13.45 (9.86, 18.33)	
Model fit								
Wald χ^2		<.001		<.001		<.001		.004
χ^2 (LRT)[c]		1.00		1.00		1.00		.33

[a]n = represents the number of observations in data with long format to support mixed-effects modelling; [b]95% = confidence intervals; [c]χ^2 = p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue. NA= not applicable as the random-intercept model better fits data than the random-intercept random-slope model. Given its better fit, random-intercept model parameters were reported; Fitbit-MS= Fitbit Minutes Asleep; Fitbit-SE= Fitbit Sleep Efficiency; SD-TST= Sleep Diary Total Sleep Time; SD-SE= Sleep Diary Sleep Efficiency.

Figure 8.8

Change of Adjusted Estimate in Sleep Measures Including Fitbit-Minutes Asleep (Fitbit-MS), Fitbit-Sleep Efficiency (Fitbit-SE), Sleep Diary-Total Sleep Time in Minutes (SD-TST), Sleep Diary-Sleep Efficiency (SD- SE) Over Time as Determined by the ITT Analysis (n = 30)



To address the fifth hypothesis, for the intervention group, the ITT analysis of the mixed-effects regression, including the effect sizes of the DID in the fixed-effects and the variability in the random effects components showed that at baseline, the intervention group had mean scores of 26.24, 4.45, 0.25, and 36.34, on the Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE, respectively. At post-intervention, the following measures improved significantly for the intervention group in comparison to the waitlist group: Fitbit-SE, SD-TST, SD-SE (all p <.001), and the improvements were maintained for the same measures at 3-months follow-up assessment. No improvements were detected for the Fitbit-MS (Table 8.16). Figure 8.9 shows changes in the Fitbit-MS, Fitbit-SE, SD-TST, SD- SE over time for the intervention Group.

In the random effects part, there was substantial variability among individuals, with average deviations of 12.28, 0.65, 0.39 and 1.62 on the four measures around both the post-intervention and 3-motnhs assessment means. This suggests considerable individual variability in the outcomes. The positive correlation coefficients between the time point and the intercept indicate that participants with higher baseline scores (above the overall sample mean) were more likely to experience greater improvements in their scores over time compared to those with lower baseline scores. All mixed-effects models for the four measures were statistically significant (p <.05). Specifically, the random-intercept, random-slope models were appropriate for Fitbit-MS, Fitbit-SE, SD-TST, (p <.05), while a random-intercept model was sufficient for and SD-SE (p >.05) (Table 8.16).

For completers only, the PP analysis of the mixed-effects regression showed that at baseline the intervention group had mean scores of 57.36, 20.72, 2.05 and 42.92 for the Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE, respectively. At post-intervention, the intervention group experienced significant improvements on the Fitbit-SE, SD-TST, and SD-

SE (p <.001, p = .005 and p = .03, respectively). The improvements were maintained at 3-months assessment on the same three measures (Table 8.17).

There was a substantial variability among individuals, with average deviations of 16.44, 0.31, 0.27, and 11.41 suggesting a considerable individual variability in the outcomes. All mixed-effects models for Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE, were statistically significant (p <.05) with a random-intercept model being appropriate for the four measures (p >.05) (Table 8.17).

Table 8.16

Mixed-Effects Linear Regression Analysis of the Change of Sleep Measures Including the Fitbit-MS, Fitbit-SE, SD-TST and SD-SE at Post-Intervention and at 3-Months Follow-up Assessments in the Intervention Group (ITT Analysis n = 16)

Variables	Model 1 (n = 48[a]) (Fitbit-MS)		Model 2 (n = 48[a]) (Fitbit-SE)		Model 3 (n = 48[a]) (SD-TST)		Model 4 (n = 48[a]) (SD-SE)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects								
Intercept	-26.24 (-92.07,39.58)	.44	4.45 (-8.41,17.32)	.50	0.25 (-1.05,1.56)	.70	36.34 (23.21, 49.48)	<.001
Time								
Baseline	reference		reference		reference		reference	
Post-intervention	5.64 (-8.96, 20.24)	.45	2.11 (1.47,2.74)	<.001	0.93 (0.57,1.29)	<.001	7.41 (1.90, 12.92)	<.001
3-months post-intervention	12.12 (-2.48,26.72)	.10	7.10 (6.46,7.73)	<.001	3.33 (2.97,3.69)	<.001	20.89 (15.38, 26.40)	<.001
Intercept								
Random effects								
SD (Time, intercept)	12.28 (7.62, 19.80)		0.65 (0.33, 1.30)		0.39 (0.20, 0.79)		1.62E-4 (-0.38, 0.38)	
Correlation (Time, intercept)	0.99 (-1.00, 1.00)		0.99 (-1.00, 1.00)		0.99 (-1.00, 1.00)		NA	
SD of residual	19.19 (14.91, 24.71)		0.79 (0.57, 1.10)		0.44 (0.31, 0.62)		7.95 (6.12, 9.72)	
Model fit								
Wald χ^2		<.001		<.001		<.001		<.001
χ^2 (LRT)[c]		.002		.001		.001		.15

[a]n = represents the number of observations in data with long format to support mixed-effects modelling; [b]95% = confidence intervals; [c]χ^2 = p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue. NA= not applicable as the random-intercept model better fits data than the random-intercept random-slope model. Given its better fit, random-intercept model parameters were reported; Fitbit-MS= Fitbit Minutes Asleep; Fitbit-SE= Fitbit Sleep Efficiency; SD-TST= Sleep Diary Total Sleep Time; SD-SE= Sleep Diary Sleep Efficiency.

Table 8.17

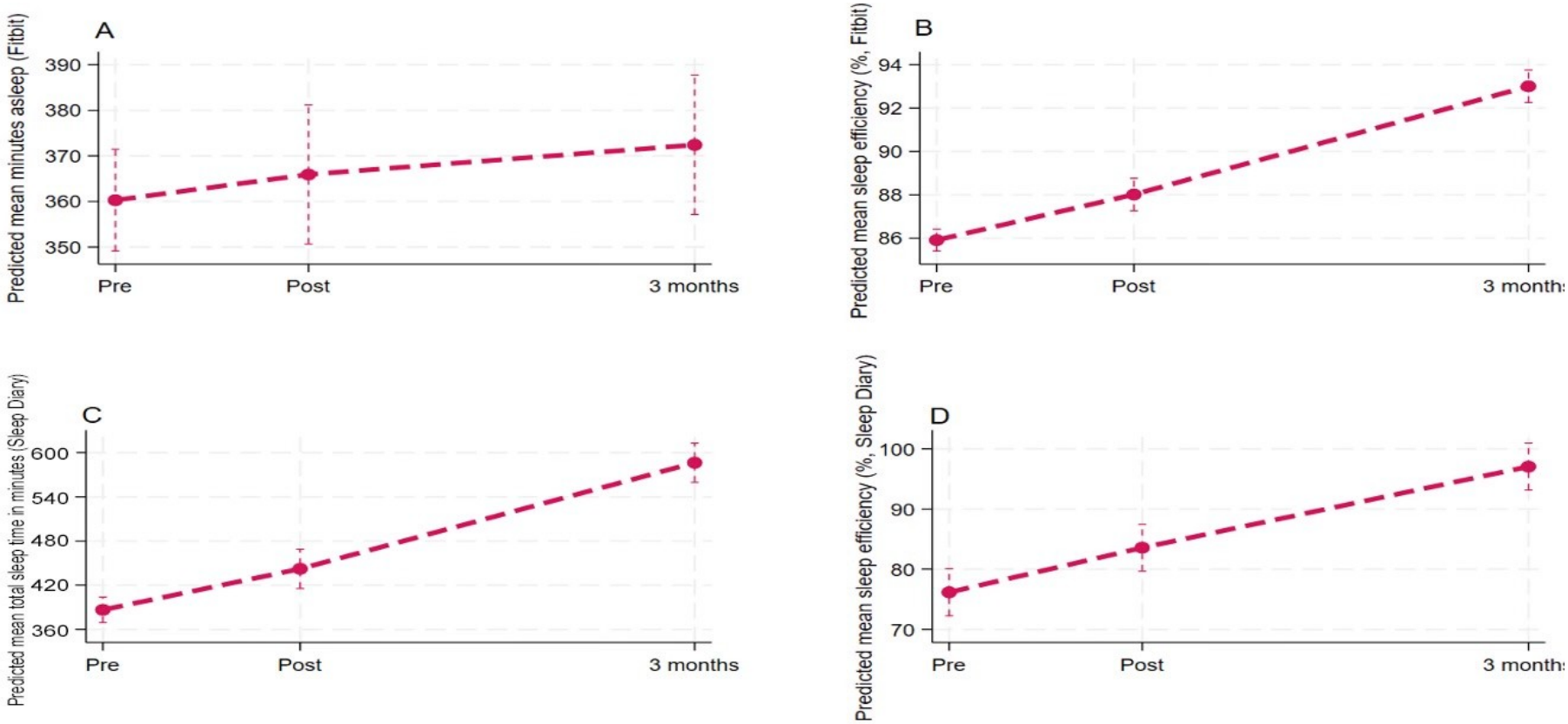
Mixed-Effects Linear Regression Analysis of the Change of Sleep Measures Including the Fitbit-MS, Fitbit-SE, SD-TST and SD-SE at Post-Intervention and at 3-Months Follow-up Assessments in the Intervention Group of Completers only (PP Analysis, n = 11)

Variables	Model 1 (n = 33[a]) (Fitbit-MS)		Model 2 (n = 33[a]) (Fitbit-SE)		Model 3 (n = 33[a]) (SD-TST)		Model 4 (n= 33[a]) (SD-SE)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects								
Intercept	-57.36 (-137.95, 23.22)	.16	20.72 (10.95, 30.49)	<.001	2.05 (0.88,3.23)	.001	-42.92 (-68.03, -17.81)	.001
Time								
Baseline	reference		reference		reference		reference	
Post-intervention	3.43 (-17.64, 24.51)	.75	2.18 (1.22, 3.15)	<.001	0.84 (0.25,1.42)	.005	8.13 (0.78, 15.48)	.03
3-months post-intervention	7.79 (-13.28, 28.87)	.47	6.94(5.97, 7.91)	<.001	3.21 (2.63, 3.80)	<.001	20.44 (13.09, 27.79)	<.001
Intercept								
Random effects								
SD (Time, intercept)	16.44 (7.53, 35.89)		0.31 (0.02, 5.01)		0.27 (0.06, 1.22)		11.41 (5.36, 24.30)	
Correlation (Time, intercept)	NA		NA				NA	
SD of residual	25.22 (18.77, 33.89)		1.16 (0.86, 1.56)		0.70 (0.52, 0.94)		3.50 (0.65, 18.92)	
Model fit								
Wald χ^2		<.001		<.001		<.001		<.001
χ^2 (LRT)[c]		.05		.36		.24		1.00

[a]n = represents the number of observations in data with long format to support mixed-effects modelling; [b]95% = confidence intervals; [c]χ^2 = p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue. NA= not applicable as the random-intercept model better fits data than the random-intercept random-slope model. Given its better fit, random-intercept model parameters were reported; Fitbit-MS= Fitbit Minutes Asleep; Fitbit-SE= Fitbit Sleep Efficiency; SD-TST= Sleep Diary Total Sleep Time; SD-SE= Sleep Diary Sleep Efficiency.

Figure 8.9

Change of Adjusted Estimate in Sleep Measures Including Fitbit-Minutes Asleep (Fitbit-MS), Fitbit-Sleep Efficiency (Fitbit-SE), Sleep Diary-Total Sleep Time (SD-TST), Sleep Diary-Sleep Efficiency (SD- SE) Over Time for the Intervention Group (ITT Analysis, n = 16)



The ITT analysis of the mixed-effects regression showed that participants in the waitlist group after receiving the treatment had mean scores of 401.98, 23.39, 9.64 and 60.91 on the Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE, respectively. Those scores improved significantly at post-intervention, with an increase of 1.27 points (p = .006) only for the Fitbit-SE. At 3-months follow-up assessment, the Fitbit-SE significantly increased by 3.81 points, and the SD-TST significantly increased by 0.99 points (all p <.001). No other improvements were reported for any other measures (Table 8.18). Figure 8.9 shows changes in the Fitbit-MS, Fitbit-SE, SD-TST, SD- SE over time for the Waitlist Group.

In the random effects part, there was substantial variability among individuals, with average deviations of 37.13, 0.71, 0.42 and 2.88 points for the Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE around both post-intervention and 3-months follow-up means. This suggests considerable individual variability in the outcomes. The positive correlation coefficients between the time point and the intercept for the Fitbit-SE and SD-TST indicate that participants with higher baseline scores (above the overall sample mean) were more likely to experience greater improvements in their scores over time compared to those with lower baseline scores. Mixed-effects models were significant for only the Fitbit-SE, SD-TST (p <.05). Specifically, the random-intercept, random-slope models were appropriate for the Fitbit-SE, and SD-TST (p <.05), while a random-intercept only model was sufficient for the Fitbit-MS and SD-SE, which also fit the data but with a non-significant p-value (p >.05) (Table 8.18).

For completers only, the PP analysis of the mixed-effects regression showed that at baseline the waitlist group had mean scores of 405.80, 52.51, 9.31 and 64.24 for the Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE, respectively. No significant improvement on any of the measures was reported. At 3-months follow-up significant improvements were observed with 3.35 points (p <.001) increase on the Fitbit-SE and 1.03 points on the SD-TST (p = .004).

There was substantial variability among individuals, with average deviations of 22.98, 0.95, 0.50 and 4.20 points for the Fitbit-MS, Fitbit-SE, SD-TST, and SD-SE, respectively, around both post-intervention and 3-months follow up mean. This suggests considerable individual variability in the outcomes. The positive correlation coefficients between the time point and the intercept indicate for the Fitbit-MS, and SD-TST indicate that participants with higher baseline scores (above the overall sample mean) were more likely to experience greater improvements in their scores over time compared to those with lower baseline scores. Mixed-effects models were significant only for the Fitbit-SE, Fitbit-SE, SD-TST (p <.05). Specifically, the random-intercept, random-slope models were appropriate for the Fitbit-MS, and SD-TST (p <.05), while a random-intercept only model was sufficient for the Fitbit-SE and SD-SE, which also fit the data but with a non-significant p-value (p >.05) (Table 8.19).

Table 8.18

Mixed-Effects Linear Regression Analysis of the Change of Sleep Measures at Post-Intervention and at 3-Months Follow-up Assessments in the Waitlist Group Receiving the Intervention (ITT analysis n = 14)

Variables	Model 1 (n = 42[a]) (Fitbit-MS)		Model 2 (n = 42[a]) (Fitbit-SE)		Model 3 (n = 42[a]) (SD-TST)		Model 4 (n = 42[a]) (SD-SE)	
	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value	Beta (95%CI[b])	p-value
Fixed effects								
Intercept	401.98 (377.88, 426.08)	.001	23.39 (-11.79, 58.58)	.19	9.64 (7.05, 12.23)	<.001	60.91 (34.20, 87.63)	<.001
Time								
Baseline	reference		reference		reference		reference	
Post-intervention	-0.82 (-20.13, 18.48)	.94	1.27 (0.37, 2.17)	.006	-0.33 (-0.82, 0.16)	.19	0.28 (-8.05, 8.60)	.94
3-months post-intervention	-2.47 (-21.78, 16.84)	.83	3.81 (2.91, 4.71)	<.001	-0.99 (-1.48, -0.49)	<.001	0.83 (-7.50, 9.15)	.85
Intercept								
Random effects								
SD (Time, intercept)	34.13 (21.19, 54.97)		0.71 (0.38, 1.33)		0.42 (0.26, 0.68)		2.88 (0.21, 39.44)	
Correlation (Time, intercept)	NA		0.99 (-1.00, 1.00)		0.99 (-1.00, 1.00)		NA	
SD of residual	30.85 (23.74, 40.09)		1.11 (0.83, 1.50)		0.59 (0.45, 0.78)		11.24 (8.65, 14.61)	
Model fit								
Wald χ^2		.99		<.001		<.001		.77
χ^2 (LRT)[c]		.84		.008		.005		.05

[a]n = represents the number of observations in data with long format to support mixed-effects modelling; [b]95% = confidence intervals; [c]χ^2 = p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue. NA= not applicable as the random-intercept model better fits data than the random-intercept random-slope model. Given its better fit, random-intercept model parameters were reported; Fitbit-MS= Fitbit Minutes Asleep; Fitbit-SE= Fitbit Sleep Efficiency; SD-TST= Sleep Diary Total Sleep Time; SD-SE= Sleep Diary Sleep Efficiency.

Table 8.19

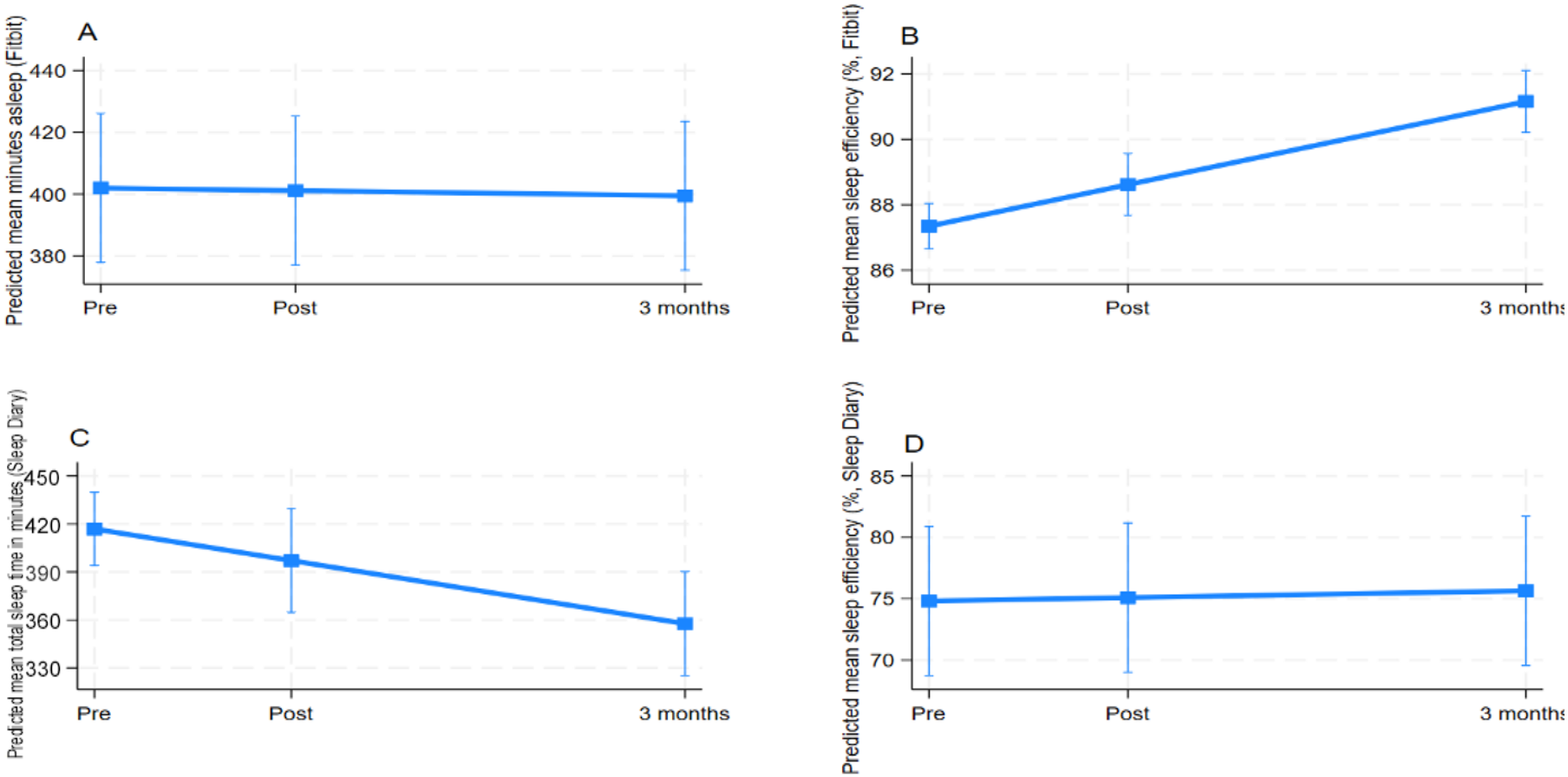
Mixed-Effects Linear Regression Analysis of the Change of Sleep at Post-Intervention and at 3-Months Follow-up Assessments in the Waitlist Group Receiving the Intervention (PP Analysis n = 9)

Variables	Model 1 (n = 27[a]) (Fitbit-MS)		Model 2 (n = 27[a]) (Fitbit-SE)		Model 3 (n = 27[a]) (SD-TST)		Model 4 (n = 27[a]) (SD-SE)	
	Beta (95%CI[b])	*p*-value	Beta (95%CI[b])	*p*-value	Beta (95%CI[b])	*p*-value	Beta (95%CI[b])	*p*-value
Fixed effects								
Intercept	405.80 (381.08, 430.51)	<.001	52.51 (-12.66,117.68)	.11	9.31 (5.70, 12.91)	<.001	64.24 (25.83, 102.65)	.001
Time								
Baseline	reference		reference		reference		reference	
Post-intervention	-6.65 (-38.22, 24.91)	.68	0.40 (-0.99, 1.79)	.57	-0.42 (-1.12, 0.27)	.23	-0.97 (-12.75, 10.81)	.87
3-months post-intervention	-6.84 (-38.41, 24.72)	.67	3.35 (1.96, 4.73)	<.001	-1.03 (-1.73, -0.34)	.004	0.28 (-11.50, 12.07)	.96
Intercept								
Random effects								
SD (Time, intercept)	22.98 (13.22, 39.96)		0.95 (0.39, 2.31)		0.50 (0.32, 0.79)		4.20 (0.50, 35.35)	
Correlation (Time, intercept)	0.99 (NA)				1.00 (1.00, 1.00)		NA	
SD of residual	30.05 (21.68, 41.66)		1.50 (1.08, 2.08)		0.66 (0.48, 0.91)		12.75 (9.20, 17.68)	
Model fit								
Wald χ^2		<.001		<.001		.013		.38
χ^2 (LRT)[c]		.004		.08		.007		.31

[a]n = represents the number of observations in data with long format to support mixed-effects modelling; [b]95% = confidence intervals; [c]χ^2 = p-value of likelihood ratio test (LRT) to compare the mixed-effects models with random-intercept linear models; All models adjusted for baseline measure to address the regression-to-mean issue. NA= not applicable as the random-intercept model better fits data than the random-intercept random-slope model. Given its better fit, random-intercept model parameters were reported; Fitbit-MS= Fitbit Minutes Asleep; Fitbit-SE= Fitbit Sleep Efficiency; SD-TST= Sleep Diary Total Sleep Time; SD-SE= Sleep Diary Sleep Efficiency.

Figure 8.10

Change of Adjusted Estimate in Sleep Measures Including the Fitbit-Minutes Asleep (Fitbit-MS), Fitbit-Sleep Efficiency (Fitbit-SE), Sleep Diary-Total Sleep Time (SD-TST), Sleep Diary-Sleep Efficiency (SD- SE) Over Time for the Waitlist Group (ITT Analysis, n = 14)



8.4.1 Clinical Significance

Figure 8.11 shows the number of participants who reached clinical significance as determined by the ITT analysis from baseline to 3-months follow-up assessment. Following receiving Sleep Best-i, a higher percentage of participants from the waitlist group achieved MCSC on symptoms of nightmares and PTSD than the treatment group. Nevertheless, a higher percentage of participants in the treatment group reached MCSC in insomnia symptoms than the waitlist group (Table 8.20). Two participants did not provide a 3-months follow-up data on the ISI, NDI and the PLC-5. Table 8.21 shows comparable results of the PP analysis to those reported in the ITT analysis with higher percentage of participants from the waitlist group reaching MCSC on the NDI and the PCL-5 than the treatment group, and a higher percentage of participants reached MCSC on the ISI from the treatment group than the waitlist group. Notably, differences between the two groups were not significant.

Table 8.20

Distribution of Clinically Significant Responders by Condition (ITT Analysis, n =30)

Outcome (n)	Waitlist (n = 14) n (%)	Treatment (n = 16) n (%)	p-value
ISI	8 (57.14)	10 (62.50)	.77
NDI	13 (92.86)	10 (62.50)	.05
PCL-5	11 (78.57)	9 (56.52)	.20

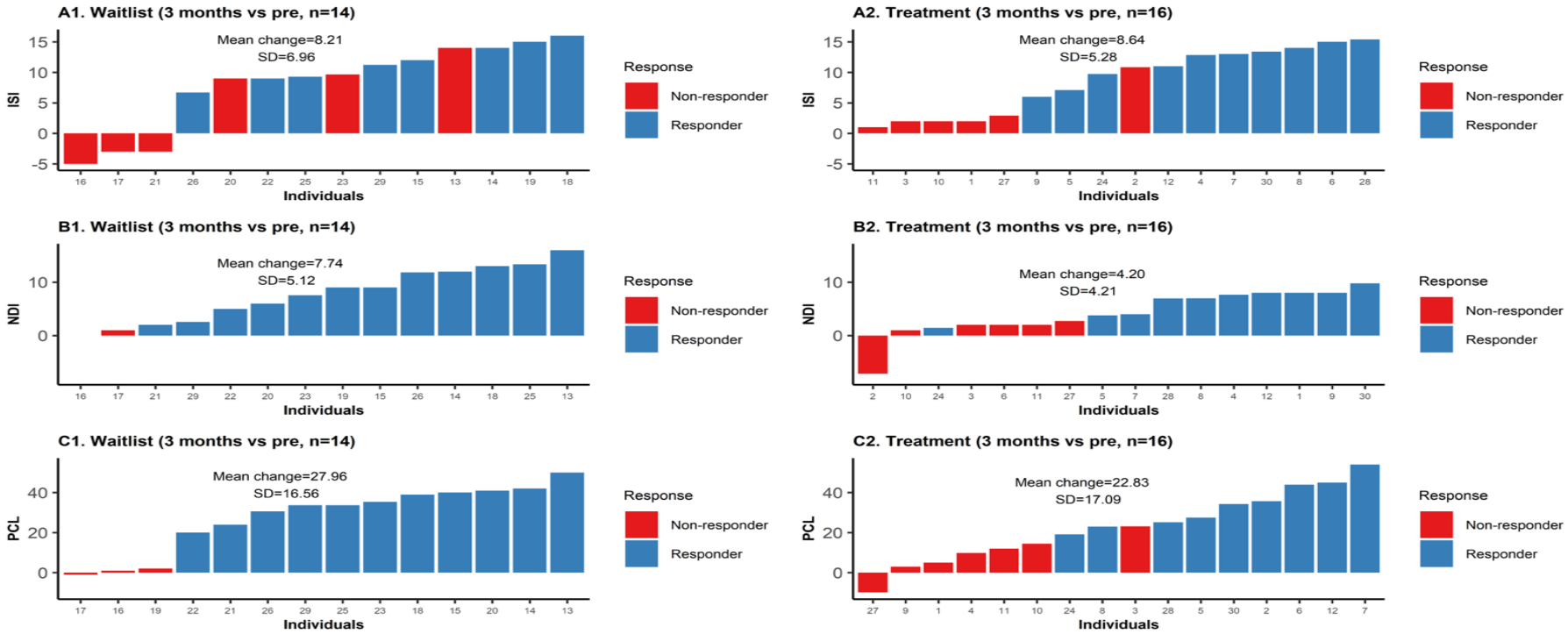
Table 8.21

Distribution of Clinically Significant Responders by Condition (PP Analysis, n=18)

Outcome (n)	Waitlist (n = 9) n (%)	Treatment (n = 9) n (%)	p-value
ISI	4 (44.44)	5 (55.56)	.64
NDI	8 (88.89)	5 (55.56)	.11
PCL-5	7 (77.78)	4 (44.44)	.15

Figure 8.11

Distribution of Clinically Significant Responders in the Intervention Group vs the Waitlist Group from Baseline to 3-Months Follow-up Assessments on the Insomnia Severity Index (ISI), the Nightmare Disorder Index (NDI) and the PTSD Checklist – Civilian Version (PLC-5) (ITT Analysis, n = 30)



Note. Responders are presented in blue and non-responders are presented in red. Number of participants achieving minimal clinically significant change (MCSC) in insomnia (ISI), nightmares (NDI), and PTSD (PCL-5) symptoms from baseline to 3-months follow-up. Responders were defined as those meeting specific MCSC criteria: for the ISI, a score of ≤ 8 with a ≥ 6-point reduction; for the NDI, a score of ≤ 7; and for the PCL-5, a score of ≤ 28 with a ≥ 18-point reduction.

8.4.2 Satisfaction and Engagement with Treatment

Participants were asked to rate how likely they were to revisit the treatment modules on a 5-point, single-item Likert scale. A frequency analysis showed that the majority of participants responded with strongly agree 9 (45%), and moderately agree 7 (35%). Two participants (10%) reported moderately disagree and two participants (10%) did not respond to this question. The number of logins into the site was observed as an indicator of the level of engagement by participants with the modules and it was found that the 20 participants who were included in the PP analysis had an average of $M = 8.5$ login times during their engagement with Sleep Best-i. Approximately 5% logged in 12 times to the site, 5% logged in 5 times, 5% logged in 7 times, 10% logged in 6 times, 15% logged in 11 times, 20% logged in 8, 9, and 10 times respectively. On average, participants spent 116 minutes onsite visiting modules and completing assessments.

8.4.3 Qualitative Data and Subjective Reports About Sleep Best-i

Participants were also invited to provide their feedback by writing a few lines about Sleep Best-i. Some of the comments were:

"I enjoyed the wisdom of the modules but not the music. There is great information within the modules and the time limit (meaning the duration of each module) makes it easy to do". (Participant #1)

"I am very big on learning new things and bettering myself in whichever way I can. Due to this, if I feel I need to refresh on the content of the modules, I will most definitely revisit the modules". (Participant #5)

"I understand better the difference between quality vs quantity of sleep. They've given me (meaning the modules) strategies to use for getting higher quality sleep, i.e., setting sleep/awake times, not taking naps, not reading Kindle in bed before trying to sleep. The mindfulness video was also helpful. I do have problems opening up the

modules, even for the first time and not sure why……How do I save these videos so that I can continue forward to use them? They really have been the key that has turned my trauma into something I have more control over vs it controlling me. I'd like to be able to use them even after my participation is over, months from now". (Participant #7).

"I'm finding it to be very helpful for both myself and my husband, thank you for the effort and knowledge which has gone into this study. I know I will return to the videos, I found them very helpful. I believe that my sleep has improved. I am very aware of the need to go to bed earlier, I'm using my Fitbit to remind me to prepare for bed, and it buzzes me awake at the same time every morning of the week. My nightmares continue, but I have a lot more knowledge of them now and I am less concerned about them……participating in the program has improved my life and my knowledge about sleep". (Participant #11)

"I have found that my sleep is improving since I first started". (Participant #17). "Well organised, easy to follow, and valuable information I was able to use to aid me in sleeping better". (Participant #20).

8.4.4 Brief Qualitative Questions

Seven brief qualitative questions were administered at week 2, 3 and 4. Three participants (15%) reported that the program did not improve their sleep and/or their trauma. Using the method of thematic analysis suggested by Braun and Clarke (2006), some of the dominant themes that were distilled in responding to the first question "how do you think the modules helped with your sleep" were: gaining knowledge about what causes sleep problems, and finding ways to deal with them such as becoming more consistent with going to bed and waking up, working out what times work better to go to bed, using self-talk as a soothing method, rethinking the daily routine, learning different techniques to prepare for sleep, learning relaxation techniques before going to bed,

feeling better physically and having more energy, sleep monitoring with the Fitbit, breathing exercises and mindfulness have been helpful in getting better sleep. The negative comments were that sleep has not improved.

Major themes emerging from responding to the second question “how do you think the modules helped with trauma symptoms” were: being able to concentrate on falling asleep instead of what has happened in the past, learning how to deal with the flashbacks and stress in general by using cognitive restructuring, changing perspective about trauma when “remembering the bad experiences”, shifting the focus from trauma, reduction in “nightmares or vivid dreams”, feeling more rested led to less anxiety, gaining insight into the scientific aspects of trauma has proven effective in alleviating trauma symptoms, dealing with flashbacks and being in control of one’s own life, being more accepting of the trauma and being able to move past it, maintaining a calm and relaxed mood before bedtime was crucial in preventing nightmares, the decrease in trauma symptoms is linked to a diminished inclination to dwell on the traumatic experience, acknowledging that the past cannot be changed, normalising the feelings and the thoughts have eased the symptoms, breathing exercise, and recognising the triggers to trauma.

Negative feedback in relation to the second question included, no noticeable effect, even though the modules aided in relaxation before bedtime, they failed to prevent nightmares or disturbances during the night, life circumstances such as a relationship breakup triggered symptoms of trauma, watching Module 3 brought back the trauma of wildfires and it increased thoughts about it.

In relation to the third question, “what did you find helpful in relation to the modules”, the primary themes encompassed understanding sleep patterns and the reasons behind sleep difficulties, acquiring strategies for sleep preparation, learning about the various sleep stages, recognising the significance of deep sleep for brain rest and

recovery, the visual aids were helpful in understanding the contents, learning how to get back to sleep if woken up during the night, gaining tools to re-set the biological clock, the mindfulness module, knowing that the modules are available and can be viewed any time, refreshed previously learned materials, the easiness of the materials presented, being able to leave the past in the past, making the trauma easier to deal with, learning how to relax before bed time, easy access anytime anywhere, the visual animation, learning to appreciate life, the role plays played a pivotal role in normalising traumatic experiences and created opportunities for engagement in therapy, easy and quick videos with no information overload, ways to cope with symptoms, re-settling during the night when woken with bad dreams, and not waking up as frequently.

The main negative themes emerging in answering this question were, no change has been noted, the modules did not help with trauma symptoms, however they provided ways to manage them.

The main themes emerging from the fourth question “did you encounter any difficulties with the modules” were, no major concerns, not being able to complete the modules on time, concerns about losing access to the modules once the study is completed, poor sound quality in the first two modules, first module containing harsh sibilance, the absence of complete captions, life getting in the way which made commitment to the modules difficult, not following the treatment methods suggested in the modules, difficulties with the platform, not being able to open certain modules, and loud background music covering the speaker.

Regarding the fifth question “if you could change anything about the modules, what would it be”, the prevalent theme was a general satisfaction with the modules with majority of participants suggesting no changes were necessary, however, some participants suggested incorporating of “de-essing” software, the use of a wider range and

longer cycle/s of music in the videos, increasing the pace of the videos, simplifying the platform login process, and featuring a speaker with less of a monotone voice.

Participants were also requested to share their experience in relation to this question “how are you finding wearing the Fitbit and getting a reading about your sleep”. Dominant themes included participants feeling disturbed about the quality of their sleep, dissatisfaction with the Fitbit’s accuracy about sleep duration and pattern, experiencing discomfort in wearing it, difficulty in getting used to it, forgetting to wear it, the Fitbit causing skin irritation, and inconvenience during activities like showering. Some of the positive feedback was that the Fitbit provided information about the amount of sleep and sleep cycles, offered “interesting” information about sleeping patterns, finding it “enlightening”, provided an insight into the severity of sleep problems, enjoying getting a sleep score, assisted in tracking sleep, getting a reading about the number of steps and heart rate, motivated participants to be more active, validated sleep, and some participants reported that it was easy to wear.

When participants were asked if they had any questions or concerns, one participant reported concerns about not having clear instructions about the study, while the majority reported no concerns.

8.5 Discussion

The aim of this pilot trial was to assess the feasibility of a brief (6 modules over four weeks), self-paced, digital intervention for the treatment of insomnia, nightmares, and PTSD symptoms in an international sample of wildfire survivors. The first hypothesis received partial support. The PP analysis revealed a significant interaction effect of condition x time on both the NDI and the PCL-5 indicating that Sleep Best-i effectively reduced symptoms of nightmares and PTSD from pre- to post-intervention for the treatment group in comparison to the waitlist group. However, no significant changes were observed in insomnia symptoms. The ITT analysis yielded similar findings, with a significant main effect of time showing a reduction in nightmare and PTSD symptoms at post-treatment for the intervention group, but no significant changes in insomnia symptoms. In examining the two groups separately, Sleep Best-i significantly reduced symptoms of insomnia, nightmares and PTSD from baseline to post-intervention and this improvement in symptoms was maintained at 3-months assessment for the two groups across both the PP and ITT analyses. The current study's findings differ from previous research using CBT-I to treat insomnia in wildfire survivors (Belleville et al., 2023; Krakow et al., 2002) and veterans (Gehrman et al., 2020; Margolies et al., 2013; Ulmer et al., 2011). Unlike Sleep Best-i, these programs reported a significant reduction of insomnia symptoms following treatment. Notably, all the aforementioned programs applied face-to-face therapy, with only Belleville et al.’s (2023) study offering a therapist-assisted digital CBT-I program.

This discrepancy may be attributed to the brief duration of insomnia treatment in the current study, which spanned over the first two weeks, unlike other clinical trials that employed CBT-I in six or more sessions. Research suggests that an average of 6-8

sessions is typically required to significantly reduce insomnia symptoms (Isaac et al., 2023; Rhudy et al., 2008). Furthermore, the shorter sessions (17 minutes per module) utilised in the current study may have contributed to the differing outcomes. Nevertheless, the maintenance of improvements at 3-month follow-up is a promising indicator of the intervention's long-term effectiveness. It is noteworthy to highlight that it is possible that symptoms of trauma and nightmares are more malleable and responsive to brief interventions, whereas insomnia symptoms may be more entrenched and less amenable to change with brief treatments, suggesting a potential explanation for the improvement in nightmares and PTSD but not insomnia symptoms in the treatment outcomes.

The current results add more credibility to ERRT being an effective treatment in reducing nightmares' severity and frequency (Balliett et al., 2015; Davis & Wright, 2007; Pruiksma et al., 2018b; Rhudy et al., 2008). Unlike other clinical trials (Balliett et al., 2015; Davis & Wright, 2007; Pruiksma et al., 2018b), Sleep Best-i consisted of only one session of ERRT, this is a novel finding and one that needs to be confirmed in future research. It is possible that the therapeutic role-play of rescripting the nightmare and the ability to access the ERRT module as convenient may have provided participants with the opportunity of multiple doses of the ERRT treatment, potentially enhancing its impact.

The current clinical pilot trial also found that the treatment group experienced significant decrease of PTSD symptoms in comparison to the waitlist group following treatment with Sleep Best-i. When examining the effectiveness of Sleep Best-i for each group, the two groups experienced significant reduction of PTSD symptoms from baseline to post-treatment and at 3-months follow-up assessments. The current results corroborate other clinical trials which have also demonstrated that CBT-I and ERRT can lead to significant reductions in PTSD symptoms at post-treatment (Davis & Wright,

2007). Research conducted by Talbot et al. (2014) found that 8 sessions of CBT-I led to a significant reduction in PTSD symptoms across intervals of baseline, post-treatment and 6-months follow-up ($p = .04$, $\eta^2 = .01$), and there was also a main effect of time from baseline to mid and post-treatment ($p < .001$, $\eta^2 = .02$) for the treatment group but not the waitlist group. Furthermore, the combination of CBT-I and IRT showed reduction of severity of PTSD symptoms for those receiving treatment (Belleville et al., 2023; Margolies et al., 2013; Ulmer et al., 2011). Similarly, ERRT led to a reduction of symptoms in a study of 43 participants randomised to treatment condition with 3 sessions of ERRT and a control group. Following treatment, the frequency and severity of PTSD symptoms significantly decreased, whereby only 33% of participants in the treatment group vs 64% of participants in the waitlist group meeting PTSD criteria. This decrease of symptoms was maintained at 6-months follow-up with only 21% of participants in the treatment group meeting criteria for PTSD (Davis & Wright, 2007).

The PP analysis supported the second hypothesis, demonstrating that Sleep Best-i effectively alleviated symptoms of anxiety and depression, and improved sleep quality. Specifically, the treatment group exhibited significant reductions in anxiety symptoms (main effect of condition) and depressive symptoms (main effect of time) at post-intervention compared to the waitlist group. Moreover, sleep quality improved substantially more in the treatment group, as evidenced by a significant time x condition interaction effect, indicating enhanced sleep benefits at post-intervention. The ITT analysis yielded similar findings, with significant reductions in symptoms of depression at post-intervention and a significant interaction effect of time x condition on sleep quality. The current findings are also in line with other studies which found improved sleep quality on the PSQI following the application of 6 sessions of CBT-I (Cook et al., 2010). In a systematic review of 20 studies assessing the effectiveness of CBT-I in the

treatment of chronic insomnia, it was found that sleep quality as measured by the PSQI improved significantly at post-treatment (Trauer et al., 2015).

However, the reduction in anxiety symptoms was no longer significant in the ITT analysis. This is notable, as research suggests a strong relationship between insomnia and anxiety symptoms, with the expectation that successful insomnia treatment would lead to a reduction in anxiety symptoms (Sweetman et al., 2020a). In the current study, the absence of significant reduction of insomnia symptoms suggests that anxiety symptoms would remain unchanged, consistent with the observed outcome of no significant reduction in symptoms of anxiety.

When analysing the two groups separately, and in line with the third hypothesis, both the PP and ITT analyses yielded similar results, with a few exceptions. Notably, both groups demonstrated significant reductions in anxiety symptoms at 3-months follow-up, although this improvement was significant only for the waitlist group at post-intervention assessment. Symptoms of depression showed significant reductions in the intervention group, both at post-intervention and at 3-months follow-up. In contrast, no significant changes were found for the waitlist group at either assessment. In terms of sleep quality, both groups showed significant improvements at both post-intervention and at 3-month follow-up assessments.

The current study's findings align with existing research demonstrating the effectiveness of CBT-based treatments for comorbid conditions (Isaac et al., 2023; Mirchandaney et al., 2022). A chart review of 455 patient who received an outpatient CBT-I program between 2004 and 2015 found that symptoms of anxiety along with symptoms of depression and stress improved by 41-43%, following treatment, with moderate to large effect size (p <.001) (Sweetman et al., 2020a). Other clinical trials also found that anxiety levels were reduced following the application of CBT-I (effect size =

.42, 95% CI = .044-.797) (Belleville et al., 2023). While part of the current findings corroborates previous studies showing a significant reduction in symptoms of depression following CBT-I (Belleville et al., 2023; Carney et al., 2017; Krakow et al., 2002), the lack of improvements in symptoms of depression for the waitlist group is not well understood. One possible explanation is that the non-significant improvements in insomnia symptoms may have contributed to the absence of change in symptoms of depression (Mirchandaney et al., 2022). Notably, the two groups had distinct intervention experiences, which may have impacted the outcomes. Specifically, the 3-months follow-up assessment for the waitlist group occurred four weeks after the treatment group's follow-up, potentially introducing passage-of-time effects that may have influenced the results.

The fourth hypothesis was partially supported. For the objective sleep measure both the ITT and PP analyses showed that only the Fitbit-SE was improved at post-intervention for the treatment group in comparison to the waitlist group. When the groups were analysed separately, and in line with the fifth hypothesis, both groups experienced significant improvements at post-intervention and at 3-months follow-up on the Fitbit-SE, with the exception of no significant improvements at post-intervention on the Fitbit-SE for the waitlist group as determined by the PP analysis. No significant findings were reported on the Fitbit-MS.

The lack of significant results regarding the Fitbit-MS may be attributed to the limited reliability of the Fitbit Inspire 2 in measuring sleep parameters, as evidenced by its low specificity (13.1%), high sensitivity (93.9%), and moderate-to-low accuracy (76.0%) (Lim et al., 2023). As indicated by participants in the current study, some found the Fitbit to be inaccurate in reflecting their actual sleep. One study found a significant difference between polysomnography, a gold standard tool in measuring sleep

objectively, and the Fitbit Inspire 2 recording approximately 18 minutes longer TST. There was also a significant difference between polysomnography and the Fitbit Inspire 2 on deep sleep, and rapid eye movement REM sleep (p <.001) (Lim et al., 2023). Similarly, in a systematic review of studies, the Fitbit tended to overestimate TST and SE (Haghayegh et al., 2019).

In relation to the subjective sleep measure, the ITT analysis showed that at post-intervention the treatment group experienced significant improvements on both the SD-TST and SD-SE in comparison to the waitlist. The PP analysis showed similar results with the intervention group experiencing improvements at post-intervention on SD-TST and a significant main effect of condition on the SD-SE in comparison with the waitlist group. When the groups were analysed separately, the intervention group showed significant improvements on the SD-TST, and SD-SE at both post-intervention and at 3-months follow up on both the ITT and PP analyses. However, the waitlist group showed significant improvements on the SD-TST at 3-months follow-up only as determined by both the PP and ITT analysis.

Literature examining the effectiveness of CBT-I on sleep diary measures is consistent in showing significant improvements in TST among wildfire survivors (Krakow et al., 2002) and veterans (Pruiksma et al., 2020; Taylor et al., 2017, 2018). However, when analysed separately, significant differences emerged between the two groups, potentially due to the sleep restriction component of CBT-I. This technique initially reduces time in bed, gradually increasing it by 30 minutes from week four onwards (Sweetman, et al., 2020b). Introduction of sleep restriction in week two in the current trial may have led to inconsistent adherence, contributing to the observed disparities between groups (Kyle et al., 2014).

Notably, the current study's findings in relation to sleep diary TST are inconsistent with the Fitbit-MS data. Research findings show no correlation between subjective and objective measures of sleep, suggesting that the two measures are independent sleep parameters that do not necessarily correlate (Werner et al., 2021).

The importance of accurately measuring sleep parameters is highlighted when examining sleep efficiency (SE), considered the most important measure indicative of treatment effectiveness (Reed & Sacco, 2016). It is logical to assume that an increase in total sleep time following treatment, as observed in the current study, would translate to improved sleep efficiency. Although the current findings reflected this correlation when comparing the two groups from baseline to post-treatment, when the groups were analysed separately, only the intervention group maintained this relationship. Notably, studies suggest that sleep diary's SE should be measured differently to the conventional method currently used. In the current study, SE was calculated by dividing TST by TIB (minutes from bedtime to rise time)*100. TIB includes activities that do not add to sleep time such as watching TV, texting and reading before falling asleep and after the final awakening. The concept of sleep efficiency pertains to total sleep time in relation to the duration spent initially trying to fall asleep and sleep disruptions (Reed & Sacco, 2016). Non-sleep-related activities in bed are not indicative of this construct. Additionally, the time spent out of bed during night-time awakenings, which is indicative of sleep discontinuity, should be considered in the denominator when calculating sleep efficiency. To address these limitations, Reed and Sacco (2016) propose an alternative calculation: SE = TST / DSE × 100. DSE encompasses sleep onset latency (SOL), TST, wake after sleep onset (WASO), and time spent attempting to sleep after final awakening (TASAFA). This revised formula provides a more accurate representation of sleep efficiency.

In terms of clinical significance, a substantial proportion of participants who completed the study (PP analysis) achieved MCSC in insomnia (50%), nightmares (72.22%), and PTSD symptoms (61.11%). Notably, the MCSC rates for insomnia and PTSD in the current study were slightly higher than those reported in previous clinical trials utilising CBT-I and IRT. For example, Ulmer et al. (2011) found that 55.4% and 50% of their sample (n = 22) achieved clinical significance in insomnia and PTSD, respectively. In contrast, the current percentages were lower than those reported by Belleville and colleagues (2023), who found that 64.7% and 70.6% of participants achieved MCSC for insomnia and PTSD at post-treatment, and 64.7% and 58.8% at 3-months follow-up. The discrepancy in MCSC rates between our study and others may be attributed to the shorter treatment duration of Sleep Best-i (4 weeks) compared to the other trials (6-12 weeks) (Belleville et al., 2023; Ulmer et al., 2011).

A significant proportion of participants expressed a high level of satisfaction with the intervention, with around 80% of users reporting a positive experience. Furthermore, participants demonstrated engagement with Sleep Best-i, dedicating an average of 116 minutes to completing various modules and assessments, indicating an investment of time and effort.

Most participants expressed satisfaction with the treatment and provided feedback about what can be improved in relation to Sleep Best-i. The treatment's brief duration of four weeks and the concise modules, each lasting less than 20 minutes, may have contributed to treatment adherence with 83% of participants completing the study. While guided therapies with the presence of a therapist offer an advantage over self-paced interventions in terms of providing feedback and having the support of a therapist (Provoost et al., 2020), digital-self-paced interventions are more cost-effective and accessible to individuals (Riper et al., 2010). Self-paced digital therapies are beneficial

for individuals motivated to pursue treatment, irrespective of the severity of their symptoms. Studies indicate that participants' ability to relate to digital interventions increases their persistence with the provided programs (Donkin & Glozier, 2012). Additionally, employing techniques such as maintaining participants' curiosity about the program and using reminders are crucial for keeping them "hooked" to the treatment, ultimately enhancing motivation and engagement and improving adherence (Donkin & Glozier, 2012). Our decision in this domain was informed by clinical practice experience, recognising that clients usually expect to acquire strategies during their intake session. Consequently, in the present trial, two modules were provided to participants in the first week of treatment, presenting behavioural strategies to enhance their sleep from the outset. This approach along with the constant reminders about the upcoming modules may have contributed to increased motivation and adherence to Sleep Best-i.

One major concern in relation to Sleep Best-i is the PTSD module/module 3. One participant expressed that this module triggered memories of wildfire trauma. Although this risk was anticipated, participants were provided with emergency numbers. Additionally, during the initial two weeks of treatment, participants were provided with cognitive and behavioural techniques to manage stress. The same participant confirmed having acquired sufficient coping strategies to address trauma-related symptoms despite experiencing them. Eighty percent of participants reported being satisfied with Sleep Best-i vs 15%.

The qualitative data revealed several key themes. Sleep Best-i proved valuable by offering insights, strategies, and scientifically grounded explanations about insomnia, nightmares, and trauma. It played a crucial role in normalising participants' trauma experiences and symptoms, providing easily comprehensible materials, and employing effective visual animations and role-plays of therapeutic sessions. The Fitbit, on the other

hand, provided valuable information on sleep patterns and stages, motivating participants to maintain an active lifestyle. Recommendations for improvement included enhancing sound quality and background music, incorporating captions, reorganisation of the platform login process, and using a speaker with a less monotone voice.

8.5.1 Limitations

The clinical trial has limitations that warrants consideration. The sample consisted of self-selected individuals, and the absence of clinical assessments to confirm diagnoses of insomnia, nightmares, and PTSD disorders introduces a potential source of bias. Participants may have either exaggerated or downplayed their symptoms during the intake questionnaire, influencing the accuracy of reported data. Furthermore, despite the trial's international scope, it's noteworthy that only one participant from the USA and two from Canada were included, limiting the generalisability of results primarily to Australian wildfire survivors. The small sample size is another impediment, underscoring the need for further testing with a larger and more diverse population to establish the external validity of the intervention.

8.5.2 Conclusion

Taken together, the present findings indicated that Sleep Best-i incorporating CBT-I and ERRT improved nightmares, PTSD, sleep quality, and symptoms of depression from baseline to post-treatment. This positive impact was sustained at the 3-month follow-up for the two groups with some variations on anxiety, and depression. The intervention group, when assessed separately, improved on all measures from pre- to post-treatment and at 3-months follow-up, except for anxiety symptoms at post-treatment. The waitlist group experienced significant reduction of symptoms on all measures from pre-treatment to post-treatment and 3-months follow-up, expect for symptoms of

depression. This clinical trial is the first in the field of sleep disturbances employing a concise, digital, self-paced intervention over four weeks among wildfire survivors.

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Chapter 9: General Discussion

The increase in temperature and resulting droughts have exacerbated the occurrence of wildfires, causing an environmental crisis (Hess, 2020; Zhong, 2022). Countries like Canada, the United States of America (USA), and Australia are particularly susceptible to wildfires (Abatzoglou & Williams, 2016; Gillett et al., 2004; Milman, 2013; To et al., 2021). In addition to environmental and wildlife destruction, wildfires pose significant risks to humans by increasing the occurrence of psychological conditions such as insomnia, nightmares, and post-traumatic stress disorder (PTSD) (Agyapong et al., 2019; Berry et al., 2010; Lowe et al., 2019). The thesis aimed to establish prevalence rates of sleep disturbances and trauma symptoms in an international sample of wildfire survivors, and to develop and test the feasibility of a digital cognitive behavioural therapy-based intervention to treat insomnia, nightmares and PTSD symptoms. We addressed the following five research questions: 1) what is the prevalence of sleep disturbances reported in the literature in wildfire survivors; 2) what is the prevalence of insomnia, nightmares and trauma symptoms in wildfire survivors from Canada, the USA and Australia; 3) how effective are sleep-specific psychological interventions for treating insomnia and nightmares in individuals presenting with PTSD as reported in the literature; 4) is a digital program integrating cognitive behavioural therapy for insomnia (CBT-I) and a brief exposure, relaxation, and rescripting therapy (ERRT) feasible in reducing insomnia and nightmare symptoms in wildfire survivors - the intervention group - in comparison to a waitlist group; 5) and is a digital CBT-I and ERRT treatment program feasible in reducing PTSD or trauma related symptoms as a result of treating insomnia and nightmares in wildfire survivors - the intervention group - in comparison to a waitlist group.

9.2 Overall Findings Addressing Research Questions 1& 2

Findings from the first systematic review addressed the first research question, as highlighted in Chapter 2, revealing a significant variability in the prevalence of sleep disturbances in wildfire survivors, with insomnia affecting 63-72.5% and nightmares affecting 33.3-46.5% of individuals as reported in the literature (Isaac et al., 2021). The review also suggested a possible link between prevalence and severity of sleep disturbances and proximity to fires (Isaac et al., 2021). To advance the knowledge in this area further, findings from the international survey addressed the second research question, as highlighted in Chapter 3. Specifically, the survey showed that 49.2% (n = 126) of wildfires survivors from Australia, Canada and the USA reported experiencing insomnia symptoms, 28.7% reported having nightmares, and 77.8% exhibited symptoms of PTSD (Isaac et al., 2023a).

Rates of insomnia, nightmares and PTSD symptoms drawn from the systematic review and the international survey, highlighted above, suggest that sleep disturbances and trauma symptoms are highly prevalent and are to some extent higher than rates reported by other researchers (Belleville et al., 2019, 2021; Jang et al., 2020; Krakow et al., 2004; Lai et al., 2020; Matsumoto et al., 2015; Nadorff et al., 2011). While methodological variations, severity of wildfires, number of losses during the fires, and data collection timelines may contribute to these disparities, we believe the emphasis should shift towards understanding the underlying factors driving these consistently high rates in the context of wildfires, rather than solely attributing them to differences in research approaches.

9.3 Discussion and Implications for Policy Reform Drawn from Prevalence Rates in the Context of Disaster Risk Management

The current findings should be viewed within the broader context of disaster risk management. The development and progression of mental health conditions may be governed by factors preceding, during, and following wildfires. Notably, research on pre-disaster preparedness, particularly mental preparedness, is limited and poorly understood by vulnerable communities and emergency responders (Eriksen & Prior, 2013). More specifically, the current model falls short in providing comprehensive psychological preparedness as it primarily focuses on disseminating information on staying calm during the fires and understanding fire elements (Eriksen & Prior, 2013). Research shows that most countries neglect to prioritise psychological preparedness in their disaster management programs (Roudini et al., 2017). There is a need to shift the understanding of effective mental preparedness in disaster management onto awareness, emotional regulation, motivation, coping, decision-making, and education about wildfire disasters (Reser & Morrissey, 2009). Notably, many Australian communities have a low level of knowledge about mental disorders (Jorm, 2012; Reavley et al., 2015), underscoring the need for a more holistic approach to disaster preparedness and mental health support. To bridge this gap, we propose incorporating comprehensive psychoeducation programs about mental health conditions commonly triggered by wildfires such as insomnia, nightmares, and PTSD into the pre-fire preparedness period, educating the public about available treatment options following the fires, and access to support services. By adopting a proactive and holistic strategy that combines disaster preparedness with mental health support, we can more effectively mitigate the psychological toll of wildfires and safeguard vulnerable individuals.

During the fires, it's also essential to consider factors that exacerbate the psychological impact of wildfires, including fear of mortality, proximity to and severity of fires, and anticipated losses (Isaac et al., 2021; Psarros et al., 2018). While some factors are uncontrollable, others can be addressed through targeted interventions to minimise the psychological toll of wildfires. For instance, providing timely support, such as suitable housing, replacement of lost belongings, and assistance with resettlement, including employment and schooling, can significantly mitigate trauma and sleep difficulties. Prompt provision of these essential services to affected individuals is crucial to minimise the long-term psychological impact of wildfires. By acknowledging and addressing these factors, we can develop more effective strategies to support individuals and communities affected by wildfires.

In the aftermath of wildfires, it's also essential to tackle the challenges hindering access to support and treatment for insomnia, nightmares, and PTSD. Research has identified key barriers to treating sleep disorders including inadequate training for general practitioners, resource and consultation time constraints, and patients' reluctance to adopt lifestyle changes (Hassed et al., 2012). To improve care, training for general practitioners is needed to recognise sleep disorders as standalone conditions, rather than symptoms of other mental health issues like depression, anxiety, and PTSD (American Psychiatric Association, 2013). Moreover, it is crucial to address post-fire challenges. This includes providing support during relocation, enhancing and fostering community support, and implementing initiatives to minimise job losses. This comprehensive approach in addressing post-fire challenges can significantly reduce the impact of mental illness on communities following the fires. For example, a Canadian study revealed alarming rates of low resilience (52%, n = 298) and PTSD symptoms (39.3%) among wildfire survivors, with unemployed participants being three times more likely to experience low resilience

and PTSD (Adu et al., 2024). By taking the aforementioned proactive steps, the potential risks associated with the development of complex and chronic mental health conditions can be significantly reduced.

In light of the abovementioned findings, and particularly in relation to prevalence, Chapter 4 revealed significant differences in mental health conditions between participants from the USA, Australia, and Canada (Isaac et al., 2023b). Specifically, participants from the USA scored significantly higher on the GAD-7 (p = .009), ISI (p = .003), and PCL-5 (p = .021) than their Australian and Canadian counterparts. Further analysis showed that participants in the USA reported lower employment and income rates in comparison to the other two countries which also influenced the higher insomnia and anxiety rates (Isaac et al., 2023b). While differences in resources availability, land management, and preparedness levels may contribute to difference in prevalence rates among the three countries, each country adopts a different philosophy in how they manage wildfires, perhaps explaining the disparities further. Australia adopts the "Prepare, Act, Survive" strategy which may act as a buffer against mental health illnesses (ACT Emergency Services Agency, 2009). This approach emphasises comprehensive community preparation for all scenarios, including worst-case outcomes by encouraging individuals to plan and make informed decisions (ACT Emergency Services, 2009). In contrast, the USA policy in managing disasters focuses on evacuation-preparedness, potentially neglecting individuals who cannot or choose not to evacuate (Congressional Research Service, 2011). This difference in adopted philosophies may explain the variations in anxiety, insomnia, and PTSD prevalence. Australia's holistic strategy includes developing communication plans, emergency kits, and addressing other essential aspects of preparedness, whereas the USA policy prioritises identifying evacuation routes and shelter locations, potentially putting individuals at a greater risk (ACT Emergency

Services Agency, 2009; Congressional Research Service, 2011). Research highlights that limited preparation time, evacuation difficulties, relocation stress, financial losses, inadequate support, and property inaccessibility after the fires can significantly impact disaster response and recovery, influencing rates of wildfire-related mental health disorders (Thériault et al., 2021).

Finally, encouraging a culture that prioritises seeking professional help over self-help may significantly reduce prevalence rates of sleep and trauma symptoms in wildfire survivors. Research shows that survivors prefer self-help and this preference may be associated with a number of factors including stigma associated with seeking help, costs associated with seeing a health professional, demographic factors, and also attitudes and beliefs towards seeking help (Binet et al., 2021; Koenen et al., 2003; Morin et al., 2006; Picco et al., 2016; Schomerus & Angermeyer, 2008; Slaunwhite, 2015; Smith, 2016; van Beljouw et al., 2010). Perhaps campaigns to increase knowledge about the importance of seeking professional help and making accessing mental health services easier and more affordable may also contribute to lower prevalence rates, particularly for insomnia, nightmares and PTSD symptoms (Jorm, 2012).

9.4 The Role of Pre-Existing Mental Health Conditions in Exacerbating PTSD Symptoms

While the trauma of wildfires leads to insomnia, nightmares, and PTSD symptoms, pre-existing mental health conditions play an equally significant role in the development of these issues. Chapter 5 indicated that a history of depression, an anxiety disorder or PTSD diagnosis elevated the risks of developing PTSD symptoms following wildfires (p =.014, p = .01, p = .012, respectively) (Isaac, Toukhsati, Klein et al., 2024). Our findings in Chapter 5 align with existing research, indicating a correspondence between prior diagnoses of depression, anxiety, and PTSD and the development of PTSD

following wildfires (Agyapong et al., 2019; Mao et al., 2022; Parslow et al., 2006; Schoedl et al., 2014). Despite this, the relationship between mental health conditions and PTSD is complex, with factors like socioeconomic status including- limited employment opportunities and low-income rates- also mediating and contributing to an increased vulnerability to PTSD. A recent study revealed that individuals with a history of mental health conditions and a history of unemployment were three to four times more likely to develop PTSD compared to those without these risk factors (Adu et al., 2024). Our findings, along with those of other researchers, highlight the need for personalised treatments for individuals with pre-existing conditions. This requires increased public awareness about the connection between PTSD and prior mental health diagnoses, as well as more community-based resources to support those at risk before and after disasters (Silove et al., 2006). PTSD requires evidence-based treatments like cognitive behavioural and pharmacological interventions, which demand specialised care and ongoing monitoring (Silove et al., 2006). Therefore, a community is the optimal environment for recovery due to shared understanding, cultural sensitivity, ongoing care without interruptions, and the ability to prioritise health conditions without time constraints (Silove et al., 2006). Achieving lower rates of PTSD following disasters can potentially lead to lower rates of sleep disorders.

Implications derived from Chapter 5 include the need for more personalised and specialised treatment pathways for affected survivors, increased awareness about the link between PTSD and other mental health conditions, and provision of unrestricted community-based resources (Isaac, Toukhsati, Klein et al., 2024). Additionally, integrating screening and early intervention for PTSD, anxiety, and depression into healthcare systems is crucial for providing effective support to individuals affected by wildfires. To achieve this, several steps can be taken, including modifying existing

healthcare protocols to incorporate regular screening for PTSD, anxiety, and depression, particularly for those affected by wildfires, and using validated tools. Furthermore, training healthcare providers to deliver evidence-based treatments, such as CBT or trauma-focused CBT, through professional development programs, workshops, and online courses, can ensure that patients receive effective care. The integration of digital therapies, such as online CBT or mobile apps, can also provide patients with convenient and accessible treatment options, especially for those in rural or remote areas. Community-led programs can provide valuable support and resources to individuals with pre-existing mental health conditions by establishing community-based support groups, fostering a safe and supportive environment, and offering accessible treatment and guidance.

To maximise the impact of this research, the development of comprehensive guidelines for mental health preparedness and response is crucial. These guidelines can provide a structured framework for mental health preparedness and response, encompassing the use of validated screening tools, evidence-based treatments, and trauma-informed care pathways. Creating training programs for healthcare professionals can provide them with the necessary skills and knowledge to respond to the mental health needs of affected communities, including training on trauma-informed care, cultural competency, and evidence-based treatments. Additionally, establishing protocols for identifying and monitoring vulnerable individuals can help identify and monitor individuals who may be at risk of developing mental health conditions, including those with a history of depression, anxiety, or PTSD. Online and community group workshops that aim to raise awareness about sleep and trauma symptoms, as well as the potential contribution of previous trauma and mental health conditions to the development of PTSD. By making people aware of these risks and providing them with help numbers and

ways to seek help, individuals can be better equipped to cope with the aftermath of a disaster. Additionally, screening people for possible vulnerabilities and monitoring them through regular check-ups, such as 6-monthly reviews, or monthly check-ups during the fire season, can help identify those who may be at risk. Individuals with previous diagnoses of depression, anxiety, and PTSD can be offered support through community-led programs. By taking these proactive steps, it may be possible to avoid the development of complex PTSD following wildfires, and instead, provide individuals with the tools and resources they need to cope with the trauma and stress associated with wildfires.

9.5 Overall Findings Addressing Research Question 3

The first part of the thesis explored and provided prevalence rates of insomnia, nightmares, and PTSD in a global sample of participants from Australia, Canada, and the USA, and highlighted possible underlying mental health conditions contributing to the development of PTSD. Chapters 6 and 7 investigated the third research question, systematically synthesising existing evidence on the efficacy of psychological interventions for these conditions. The findings revealed that CBT-I, ERRT, and imagery rehearsal therapy (IRT) significantly reduced the frequency and severity of insomnia, nightmares, and PTSD, with medium to large effect sizes (Isaac et al., 2022; Isaac, Toukhsati, Di Benedetto, et al., 2023). Furthermore, and consistent with previous research, both in-person and online therapies improved sleep efficiency (Casement & Swanson, 2012; Ho et al., 2016; Isaac et al., 2022; Isaac, Toukhsati, Di Benedetto, et al., 2023; Savard et al., 2014; Taylor et al., 2017; Taylor & Pruiksma, 2014).

However, despite the success achieved in treating insomnia, nightmares and PTSD with CBT-based interventions, access to treatment remains challenging due to limited availability of sleep-specialised phycologists, costs associated with treatment, and

stigma around seeking help from a mental health professional (Australian Centre for Posttraumatic Mental Health, 2013; Australian Psychological Society, 2024; Graham et al., 2020). In a systematic review of 37 studies, researchers found that cultural inappropriateness of interventions, limited psychological resources, shortage in mental health professionals, misconception about treatment providers, transport difficulties, affordability, time constraints, and stigma were the most significant barriers to accessing treatment (Rowe & Nadkarni, 2023). The growing shift towards digital therapies offers a promising solution by providing immediate access, reducing costs, eliminating wait times, and increasing privacy (Isaac et al., 2022; Isaac, Toukhsati, Di Benedetto, et al., 2023). To address this need, and in line with the above findings, we developed a comprehensive treatment manual integrating CBT-I, ERRT, and psychoeducation about PTSD for the treatment of insomnia, nightmares and PTSD symptoms (Davis, 2009; Davis & Wright, 2007; Edinger, 2018; Edinger & Carney, 2014; Germain & Buysse, 2011; Lynch et al., 2015; Morin & Espie, 2007) (see Appendix M for the treatment manual). Subsequently, we created a digital treatment program, based on this manual, to support individuals affected by wildfires who cannot access treatment in a timely manner due to costs and stigma. The digital treatment innovatively combined different methods to make the intervention more engaging and applicable to individuals affected by the disaster of wildfires. For example, video animations and role-plays of therapeutic sessions were used to explain concepts and demonstrate the applicability of an intervention to increase adherence (Isaac, Klein, Nguyen et al., 2024).

9.6 Overall Findings Addressing Research Questions 4 & 5

Chapter 8 addressed the last two research questions by conducting a clinical trial over four weeks using a digital-self-paced intervention to treat insomnia, nightmares, and trauma symptoms in survivors of wildfires. A sample of 30 wildfire survivors were

randomised to either the intervention (n = 16, 53.33%) or the waitlist groups (n = 14, 46.67%). Only twenty participants completed the trial and provided data. Both Intention to Treat (ITT) and Per Protocol (PP) analyses showed comparable results on the Insomnia Severity Index (ISI), the Nightmare Disorder Index (NDI), and the PTSD Checklist – Civilian Version (PCL-5). Significant reduction (p = .001) of 1.64 points on the NDI and a reduction (p = .009) of 10.64 points on the PCL-5 were observed for the intervention group at post-intervention in comparison to the waitlist group suggesting significant improvements on nightmares and trauma symptoms (Isaac, Klein, Nguyen et al., 2024).

The findings are in line with other research showing improvements on nightmares and PTSD following successful treatment with CBT-I and ERRT (Balliett et al., 2015; Davis & Wright, 2007). Those improvements were also reflected on data collected from the Fitbit Inspire 2 and the sleep diary on total sleep time and sleep efficiency. Further to that, half (50%) of the sample experienced significant clinical reduction in insomnia symptoms, with greater improvements observed in PTSD (61.1% reduction), and nightmare symptoms (72.2% reduction). Nearly 80% of participants were satisfied with Sleep Best-i (Isaac, Klein, Nguyen et al., 2024).

We did not find an improvement in symptoms of insomnia at post-intervention, possibly, due to several reasons. The failure of CBT-I to improve insomnia symptoms may not be due to the therapy itself, but rather due to various factors that can influence its effectiveness. For example, several key factors can impact the success of CBT-I, including inappropriate delivery or failure to meet the specific needs of the patient, components of the treatment such as method of delivery, patient characteristics, presence of underlying conditions, lack of guidance and support for participants, unscreened medications, inconsistency in applying the treatment, and the presence of other medical conditions like chronic pain or motivation for change (Grander, Esquivel & Dawson,

2022). Patient characteristics, such as age, anxiety levels, delayed onset time, and educational level, also play a significant role in determining the effectiveness of CBT-I, with older patients, those with high anxiety symptoms, and those with lower educational levels being more likely to experience unstable treatment effects (Wei & Mao, 2024). Additionally, psychological factors like low confidence in the program, personal accountability towards treatment, motivation to change, environmental support, and empathy and hope conveyed by the therapist can influence the success of CBT-I (Grander et al., 2022). As noted by research, considering these factors and adopting a more personalised and supportive approach to treating insomnia is crucial, as a one-size-fits-all approach can lead to ineffective treatment for some patients (Grander et al., 2022).

Future research should prioritise assessing the needs and expectations of individuals regarding their anticipated therapy outcomes. This can be achieved through qualitative research methods, which can provide in-depth insights into individuals' experiences and perspectives. Regular feedback mechanisms can also be established to monitor individuals' progress with their treatment, ultimately enhancing treatment outcomes. Moreover, motivational interviewing can be employed as a strategy to improve adherence to CBT-I, as it can help address motivation factors and increase participant engagement (Grander et al., 2022). By exploring these avenues, researchers can develop more effective and patient-centred interventions that cater to the unique needs and expectations of individuals seeking therapy for insomnia and other sleep-related disorders.

Although improvements for insomnia were not observed at post-intervention, there was significant improvements at the 3-months follow-up assessment for both the intervention and the waitlist groups when analysed independently (Isaac, Klein, Nguyen et al., 2024). Findings from the Sleep Best-i trial were different to those reported by other

trials reporting significant reduction of insomnia symptoms following treatment using CBT-I (Belleville et al., 2023; Isaac, Klein, Nguyen et al., 2024; Krakow et al., 2002; Margolies et al., 2013; Ulmer et al., 2011). These discrepancies may be attributed to variations in treatment duration and modalities. The shorter duration of Sleep Best-i's trial is noteworthy, as other studies consisted of 6-12 sessions enabling assessments of insomnia symptoms at later time points (> 6 weeks), which could have led to the differing results. Notably, the Sleep Best-i's accelerated design, delivering three treatment modules over two weeks, potentially limited the opportunity to observe the gradual reduction of insomnia symptoms and may have overwhelmed participants with excessive amount of information. This may have been particularly challenging for individuals experiencing insomnia, nightmares, and PTSD symptoms simultaneously, as their attention may have shifted towards other symptoms during the final two weeks of the trial whereby modules for nightmares and PTSD were applied.

Another noteworthy factor is that Sleep Best-i utilised a self-paced approach. When individuals work with health professionals, they perhaps feel more accountable to comply with treatment which ultimately could lead to better and more significant improvements in outcomes (Belleville et al., 2023). However, Sleep Best-i is a viable option to those who are isolated, do not have access to treatment, waiting to initiate treatment with their psychologists, or those who want more privacy (Borghouts et al., 2021; Riper et al., 2010).

9.7 Informing the Development of Sleep Best-i

It is noteworthy to highlight the significant influence our research has had on the design and development of Sleep Best-i. The comprehensive findings from Chapters 2, 3, 4, 5, 6, and 7, which revealed a high prevalence of insomnia and nightmares in wildfire survivors, as well as the strong association between sleep disturbances and PTSD

symptoms, directly informed the conceptualisation and design of Sleep Best-i, our online sleep intervention. Sleep Best-i incorporates evidence-based strategies, such as CBT-I and IRT for nightmares, to provide a targeted and effective intervention for wildfire survivors. Furthermore, the intervention is designed to provide a personalised approach, taking into account the severity and frequency of sleep disturbances, and is grounded in trauma-informed care. Notably, the fact that Sleep Best-i comprises 6 modules administered over 4 weeks allows survivors who present with one, two, or all three disorders (insomnia, nightmares, and PTSD) to take advantage of this highly sophisticated self-paced approach, enabling them to work through the program at their own pace and address their unique needs, whether they are experiencing a single sleep disturbance or multiple co-occurring disorders.

The program's flexible design, offering both self-paced and guided approach, is particularly important for individuals who may be struggling with significant stress and limited attention span. Notably, the integration of mindfulness elements plays a vital role in alleviating the impact of trauma and loss. Furthermore, the design of the modules was shaped by research insights, which underscored the heightened vulnerability of individuals in the aftermath of wildfires. With a concise duration of approximately 17 minutes per module, the program is readily accessible and easily manageable for those with restricted time and attention constraints.

The methodological limitations identified in Chapter 6 have substantially influenced the design of Sleep Best-i. Specifically, the limited number of selected studies restricted the ability to draw definitive conclusions about the effectiveness of objective measures in assessing the efficacy of sleep-specific psychological treatments for individuals with PTSD symptoms. To address this knowledge gap, Sleep Best-i incorporated a multi-modal assessment approach, combining both self-report measures

and objective measures, such as data from Fitbit Inspire 2. Additionally, the fact that all studies were conducted in the USA limits the generalisability of the findings across cultures. Therefore, Sleep Best-i was designed to be culturally sensitive, with the potential to be tailored to different cultural contexts and populations. By addressing these limitations, Sleep Best-i provides a comprehensive and effective approach to addressing sleep disturbances and PTSD symptoms in individuals who have experienced trauma, and has the potential to be adapted and implemented in a variety of contexts and populations.

This is particularly important when considering the cultural differences in mental health attitudes and technology adoption, which can significantly impact the effectiveness of mental health interventions. Addressing cultural differences in mental health attitudes and technology adoption is crucial for providing effective and inclusive mental health care. The disparities in cultural backgrounds have far-reaching consequences for mental health care, resulting in diverse perspectives on wellness and disease, and help-seeking behaviours (Gopalkrishnan, 2018). Western cultures tend to emphasise individual experiences and pathology, whereas collectivist cultures view health as an integral part of community and family processes (Tribe, 2005). Moreover, cultural variations significantly influence emotional expression, with some cultures perceiving crying as acceptable for females but discouraged for males, and discussing mental illness is stigmatised as it may tarnish the family's reputation (Hechanova & Waeldle, 2017).

The interplay between shame, stigma, and cultural factors significantly influences attitudes towards mental health, leading to delayed help-seeking, social isolation, and non-compliance with treatment. According to Hechanova and Waeldle (2017), shame plays a crucial role in this context, as individuals may hesitate to seek help for mental health issues due to fears of being perceived as weak or "crazy" by their healthcare providers. The stigma surrounding mental health issues can also cause delays in seeking

help, as individuals may fear being discriminated against, leading to a decline in mental health (Ahad, Sanchez-Gonzalez, & Junquera, 2023). This stigma, in turn, can lead to isolation, non-compliance with treatment, and even the avoidance or discontinuation of treatment for fear of being labelled as mentally ill (Ahad et al., 2023). Moreover, stigma can perpetuate misconceptions about individuals with mental health issues, portraying them as dangerous, unpredictable, or responsible for their condition, ultimately leading to inadequate funding and support for mental health services (Ahad, et al., 2023). This highlights the need for culturally sensitive approaches to address the complex interplay between shame, stigma, and cultural factors in mental health care.

Considering the cultural differences in mental health attitudes and behaviours, it is essential to recognise that technology use also varies significantly across cultures. A study conducted by Mitchell (2019) utilised a representative sample of 1,336 adults, comprising White, Black, and Hispanic individuals aged 54 years and older, to investigate the role of ethnicity in shaping health-related technology use. The findings highlighted the significant role of ethnicity in shaping how people leverage technology to manage their health. Older Black and Hispanic adults were substantially less likely to utilise technology for treating illnesses, receiving or making phone calls, browsing the web for health-related purposes, and using online resources to manage their health ($p < 0.01$) (Mitchell, 2019). To address these cultural differences, it is essential to develop culturally sensitive approaches, targeted interventions, and community-based initiatives that promote mental health awareness, reduce stigma, and encourage help-seeking behaviours. Additionally, technology-based solutions that are culturally sensitive and accessible to diverse populations can help bridge the gap in mental health care. By acknowledging and addressing these cultural differences, mental health professionals can develop more

effective and inclusive treatment strategies that promote help-seeking behaviours and improve treatment outcomes for individuals from diverse cultural backgrounds.

9.8 Barriers to Accessing Digital Programs

Many factors influence the ability to access digital therapies. For example, a qualitative systematic review of 81 studies conducted by Berardi and colleagues (2024) revealed that individuals' previous beliefs about the effectiveness of digital therapies can hinder their willingness to engage with them. Specifically, some individuals hold negative beliefs about the effectiveness of digital therapies, perceiving them as less effective and less rigorous than traditional face-to-face therapies. Additionally, some individuals are uncomfortable with the mode of delivery, feeling that discussing emotions using technological devices is less personal than face-to-face interactions (Berardi et al., 2024). They may also perceive digital providers as less qualified than those conducting face-to-face therapies. Furthermore, those who cannot afford devices that support digital therapies, data, and internet connections may be unable to access these services (Berardi et al., 2024).

Furthermore, individuals' own technological skills can be a barrier to using digital therapies, with some reporting a lack of knowledge, education, and training in using these technologies (Berardi et al., 2024). Moreover, digital technologies are often not tailored to users' language, gender orientation, religion, and culture, which can create additional barriers (Berardi et al., 2024).

Some individuals may also be reluctant to engage with digital therapies due to feelings of being scrutinised and a general unwillingness to spend additional time with technology after work (Berardi et al., 2024). These findings highlight the need for digital therapies to be designed with cultural sensitivity, accessibility, and user-friendliness in mind, as well as the importance of addressing individuals' concerns and misconceptions

about digital therapies. By doing so, we can increase the uptake and effectiveness of digital therapies, particularly among underserved populations (Berardi et al., 2024).

By considering the theoretical frameworks that underlie digital intervention efficacy, we can design digital therapies that are more effective and accessible to individuals with trauma symptoms. Our research contributes to the theoretical understanding of digital intervention efficacy by validating and challenging existing theories, ultimately providing a framework for designing and evaluating effective digital interventions for insomnia. Specifically, the findings support the Health Belief Model (Baranowski et al., 2003), which suggests that individuals with trauma symptoms engage in online CBT because they believe in its benefits and perceive the benefits to outweigh the barriers. In our research, this is evident in the fact that online CBT has been shown to be effective in reducing symptoms of insomnia, highlighting the importance of considering individuals' beliefs and perceptions when designing digital interventions. In contrast, our findings challenge the Transtheoretical Theory (Prochaska, Redding, & Evers, 2008) and the Theory of Planned Behaviour (Montaño & Kasprzyk, 2008), which propose that behaviour change occurs in stages and is determined by attitudes, perceived control, and subjective norms, respectively. However, our findings support the Social Cognitive Theory (Montaño & Kasprzyk, 2008), which suggests that social influences play a crucial role in behaviour change, and that individuals with trauma symptoms may be more likely to engage in online CBT if they observe others successfully using it. Furthermore, our research also provides support for the Dynamic Model of Behaviour (Spruijt-Metz & Nilsen, 2014) and the Behavioral Intervention Technology (BIT) model (Moher et al., 2014), which propose that behaviour change occurs through a dynamic and reciprocal process of interaction between individual, environmental, and social factors, and that digital interventions can be designed to support behaviour change by targeting

specific behavioural, cognitive, and emotional processes. Overall, our research highlights the importance of considering the complex interplay between individual, environmental, and social factors when designing digital interventions for insomnia, and provides a foundation for the development of effective and tailored interventions that address the unique needs of individuals with trauma symptoms.

9.9 Implications of the Sleep Best-i Trial

Treating mental health conditions through digital interventions raises several unique challenges. Specifically, digital interventions ignore the lived experience of individuals, and their implementation in clinical settings can be formidable (Smith et al., 2023). There are also concerns about efficacy and quality, inadequate training of medical practitioners, and shortage of standardised manuals (Smith et al., 2023). Finally, inconsistent reporting of intervention frequency and intensity, difficulties in managing sensitive medical and private information, and the potential for harm further complicate their use (Smith et al., 2023).

Despite the above challenges, Sleep Best-i provides a flexible treatment approach, accommodating a diverse range of users and trauma types. For example, Sleep Best-i can be utilised as a self-paced intervention suitable for individuals confident with technology requiring timely and cost-effective treatment. Alternatively, by pre-recording the modules, individuals who have concerns about online access and sharing personal or medical information can potentially access Sleep Best-i through their general practitioners. This approach also allows healthcare providers to monitor patients' progress. Additionally, a coach-supported approach can be another option, whereby individuals access the program online and receive regular weekly or fortnightly check-ins (Graham et al., 2020). The modules can be offered as a package wherein individuals choose the most relevant modules that address specific presenting concerns with an

adjustment of frequency as needed. The flexibility of Sleep Best-i enables it to be used as a primary treatment or as an adjunct to existing therapies. Another alternative is the possibility of using Sleep Best-i as a community-led program. This approach can potentially empower community leaders and mental health activists to lead weekly sessions, delivering Sleep Best-i modules to those affected by wildfires or other natural disasters. Community-driven care activates social support, collective healing, and strengthens cohesion (Silove et al., 2006). Consistent with this approach, research shows that interventions that are community-led and incorporate social support have a significant impact in the recovery of affected communities following disasters (Pike et al., 2024).

As the community-led approach highlights the importance of social support and collective healing, it is essential to consider the cultural context that may influence the delivery of Sleep Best-i. To ensure the effectiveness of Sleep Best-i in diverse cultural contexts, it is crucial to understand the cultural values, beliefs, and practices of the target population. For instance, cultures that emphasise autonomy and individualism, such as those in Western societies, may respond well to the self-paced and guided approach of Sleep Best-i, as it aligns with values of self-reliance and independence. In contrast, collectivist cultures, such as those in many Indigenous communities, may benefit from a community-based delivery approach, where the program is implemented in community centres to foster social support and community spirit.

The development of culturally sensitive digital interventions is crucial for ensuring their effectiveness and accessibility in diverse cultural contexts. To achieve this, it is essential to consider the complex interplay between culture, language, and technology. Language adaptation plays a vital role in this process, as it involves translating interventions into culturally relevant expressions, concepts, and metaphors that

resonate with the target audience (Chowdhary et al., 2014). Using native speakers to record audio components or incorporating culturally relevant imagery should also be considered. Additionally, simplification of the intervention is necessary to cater to individuals with varying literacy levels, while flexibility in delivery methods enables the treatment to be administered in a convenient and accessible manner (Chowdhary et al., 2014). The Mental Health Cultural Adaptation and Contextualisation for Implementation (mhCACI) framework, proposed by Sangraula and colleagues (2021), offers a comprehensive 10-step approach to cultural adaptation, encompassing aspects such as identifying the mechanism of action, reviewing the intended culture, training trainers, translating the intervention, and evaluating its effectiveness. However, cultural adaptation in digital health is not without its challenges, including the need to define culture in the context of health and technology, integrate sub-cultures, and ensure the fidelity of the intervention (Nittas et al., 2024). By acknowledging and addressing these challenges, developers can create digital interventions that are not only effective but also culturally sensitive and accessible to diverse populations. Ultimately, the incorporation of cultural adaptation strategies, such as those outlined in the mhCACI framework, can facilitate the development of digital interventions that are tailored to the unique needs of diverse cultural contexts, thereby promoting greater equity and inclusivity in healthcare (Nittas et al., 2024). The adapted program should also be tested with users from the target culture to ensure that it is accessible, effective, and culturally sensitive. By adapting Sleep Best-i to diverse cultural contexts, we can increase its accessibility, effectiveness, and cultural sensitivity, ultimately improving sleep outcomes and reducing symptoms of trauma and stress in diverse populations.

Building on the importance of cultural sensitivity in the delivery of Sleep Best-i, it is also essential to consider the broader policy implications of disaster response

frameworks. The Sendai Framework for Disaster Risk Reduction, adopted by Australia and other UN members, emphasises the importance of understanding disaster risk, strengthening disaster risk governance, investing in disaster risk reduction, and enhancing disaster preparedness (Australian Government Department of Home Affairs, 2018). Furthermore, the National Response Framework in the USA prioritises community lifelines and coordinated response, which include safety and security, providing food, water, shelter, health and medical, energy, communications, and transportation (Department of Homeland Security, 2019). The framework also highlights the importance of initial assessments of community lifelines to establish incident priorities and objectives, and continuously reassessing the status of community lifelines to adjust operations and accelerate incident stabilisation (Department of Homeland Security, 2019). The Disaster Risk Reduction in Australia Status Report, 2020, also highlights the importance of considering vulnerable factors, such as income, employment, age, disability, gender, and English language skills, in disaster response and recovery efforts. The report also notes that individuals belonging to the LGBTIQ+ groups may seek help from organisations or faith-based organisations due to fear of disclosing their gender identity or sexual orientation (UN Office for Disaster Risk Reduction, 2020). Additionally, the report emphasises that economic considerations, such as housing prices, cost of transport, and low-income, can force individuals to live in remote areas, making them more vulnerable to disasters (UN Office for Disaster Risk Reduction, 2020). Women who are single parents can be highly disadvantaged when affected by wildfires, and men can be impacted more severely by trauma or other mental health issues, yet do not access support due to values of masculinity (UN Office for Disaster Risk Reduction, 2020). The Sleep Best-i framework provides a community-led approach to addressing sleep difficulties and PTSD in disaster-affected populations, and can be tailored to

address the unique needs of vulnerable populations, such as those living in temporary housing or shelters, who may experience increased anxiety and feelings of isolation. By incorporating these frameworks into disaster response and recovery efforts, governments and international organisations can provide a comprehensive and coordinated approach to addressing sleep difficulties and PTSD in disaster-affected populations (UN Office for Disaster Risk Reduction, 2020). This includes providing ongoing financial assistance, amending public assets, such as banks and health centres, schools, and places of employment, and promoting international collaboration and knowledge sharing, ultimately providing support and reducing the risk of developing these conditions (UN Office for Disaster Risk Reduction, 2020). This can be achieved by implementing public awareness and education campaigns, considering vulnerable factors, establishing national response frameworks, and promoting international collaboration and knowledge sharing, as recommended by the outlined frameworks.

In order to effectively address the sleep health needs of disaster-affected populations, it is also essential to consider the scalability and integration of Sleep Best-i into existing disaster recovery programs. To address these issues, future research could investigate the feasibility of integrating it with other interventions or services that are already being provided to disaster-affected populations. One such program is the National Disaster Mental Health and Wellbeing Framework, which provides guidance to recovery workers to support disaster-affected communities' mental health and wellbeing (National Mental Health Commission, 2020). This framework outlines guiding principles for effective mental health support and services, roles and responsibilities between levels of government and the private/non-government sector, and key components of care. Additionally, resources such as Phoenix Australia Hub and the Disaster and Emergency Recovery panel offer valuable information and services for health professionals and

individuals affected by disasters (Families Fairness and Housing, 2025; Phoenix Australia, 2025). For instance, Phoenix Australia Hub provides resources and information on available services, while the Disaster and Emergency Recovery panel offers a range of psychological services in group settings, both in-person and online. By integrating Sleep Best-i into these existing programs and resources, it is possible to enhance its usability to reach a wider audience. Additionally, evaluating the cost-effectiveness and resource requirements of Sleep Best-i could help to inform decisions about its potential for scale-up and widespread implementation.

To facilitate the potential integration of Sleep Best-i into existing disaster recovery programs, it is also vital to develop a comprehensive training plan that equips facilitators with the necessary skills and knowledge to deliver the program effectively to disaster-affected populations. This training plan should include regular workshops, webinars, supervision, and feedback sessions that cover the program's objectives, modules, and underlying theories. Furthermore, facilitators working with diverse communities, such as ethnic minorities, specific groups, and disadvantaged populations, should receive additional training to ensure they are equipped to address the unique needs and challenges of these communities. To overcome technological barriers, strategies such as assessing infrastructure, including internet and device availability, should be considered. If necessary, alternative methods like offline access, recording modules, and user-friendly manuals can be used, especially in areas with limited technology access. Technical support should also be available to address any unforeseen technical difficulties. Moreover, it's also important to provide accessible materials, to cater for people with disabilities, encourage community engagement by involving community leaders, and offer language support for non-English speaking communities or those from indigenous backgrounds.

The development of a comprehensive training plan and implementation strategies for Sleep Best-i can inform its potential use in various contexts, including its application to survivors of other disasters and individuals experiencing trauma-related sleep difficulties. Although initially designed for survivors of wildfires, Sleep Best-i has a broader relevance to survivors of other disasters, such as hurricanes, floods, and earthquakes. Furthermore, the program's principles can be beneficial for individuals seeking treatment for insomnia, nightmares, and PTSD resulting from a range of traumatic experiences, including the trauma of migration, life-threatening accidents, domestic violence, sexual trauma, and conflict and war.

Our research has the potential to inform global health policies, particularly those related to mental health, as outlined by the World Health Organization (WHO). The WHO's Comprehensive Mental Health Action Plan 2013-2030 (World Health Organization, 2021) provides a framework for strengthening mental health systems globally, and our research aligns with key objectives of this plan, specifically: providing comprehensive, integrated, and responsive mental health and social care services, implementing strategies for promotion and prevention in mental health, and strengthening information systems. By promoting the use of digital tools to address real-world mental health problems, such as sleep disorders, and providing education about psychological interventions, our research can help bridge the gap in mental health services, particularly in low-resource settings. The findings of our research, potentially, can be further integrated into WHO's Mental Health Gap Action Programme, which aims to expand services and resources for mental health in low-resource settings, and can also be aligned with other programs, such as Be Healthy, Be Mobile, which has been successful in reaching millions of people globally (World Health Organization, 2025). Overall, our research can contribute to the development of more effective mental health programs and

improve health outcomes globally by addressing the shortage of health providers trained in the use of psychological services, promoting digital tools and education about psychological interventions, and increasing access to mental health services through coordinated services from the health and social sectors.

9.10 Limitations

This research has several limitations that should be acknowledged. Firstly, the systematic review in Chapter 2 was based on a relatively small pool of studies, constraining the breadth of conclusions that can be made. Additionally, variations in methodologies and data collection time intervals compromised our understanding of the evolution and progression of sleep disturbances following wildfires, influencing the prevalence rates presented in the systematic review (Isaac et al., 2021; Krakow et al., 2004; Psarros et al., 2017).

The international survey conducted for studies presented in Chapters 3, 4 and 5 failed to consider demographic and sociodemographic factors that can increase vulnerability to mental illness following disasters such as relocation, unemployment, and housing replacement. Additionally, resilience factors that act as buffers against vulnerability to sleep disturbances and trauma symptoms such as community and family support were overlooked in our research.

Furthermore, the differences in prevalence rates between the three countries could have been influenced by cultural variations and people’s attitudes towards mental illness, which were not considered in our research. Of a particular mention, the USA's history of multiple wildfires was not controlled for in the analysis. Additionally, reliance on self-report measures rather than clinical evaluations may have resulted in inflated or underreported symptoms of insomnia, nightmares, and PTSD. Notably, our sample was

predominantly females, who are also more likely to develop PTSD, depression, and anxiety symptoms (Perrin et al., 2014; Borooah, 2010).

In relation to the clinical trial, two notable limitations were present: a small sample size and a self-selected sample, which may have introduced potential bias. These limitations may impact the reliability and generalisability of our findings, as the small sample size may lead to reduced statistical power, and the potential biases may result in overestimation or underestimation of the true effects, limiting the validity of our conclusions. Furthermore, the lack of diversity in our sample may limit the ability to generalise our findings to other populations, particularly those from different cultural or socioeconomic backgrounds. We acknowledge the importance of addressing these limitations in future research. To mitigate the issue of small sample size, future studies could consider recruiting a larger, more diverse sample of participants, thereby providing a more robust and generalisable understanding of the research topic. Additionally, utilising advanced statistical analysis techniques, such as multivariate analysis or machine learning algorithms, could help to identify complex patterns and relationships in the data that may not be apparent with a smaller sample size. Furthermore, incorporating multiple data collection methods, such as surveys, interviews, and observational data, could provide a more comprehensive and nuanced understanding of the research phenomenon. By taking these steps, future researchers could build on our findings and provide a more complete and accurate understanding of the topic, ultimately contributing to the development of more effective interventions and strategies.

Moreover, omitting wildfire trauma severity and timing from the analysis may have obscured critical relationships with treatment outcomes. Furthermore, the absence of rigorous controls for confounding factors, including social support, resilience, and treatment blinding, may have impacted observed improvements in insomnia, nightmares,

and PTSD symptoms following Sleep Best-i application. These limitations underscore the need for further research with more diverse samples, consideration of cultural and demographic factors, control for confounding variables, blinded randomisation and clinical assessments.

9.11 Future Directions

To obtain more precise prevalence rates of insomnia, nightmares, and PTSD symptoms among wildfire survivors, longitudinal studies are needed. Future studies should account for demographic and sociodemographic factors, pre-existing mental health conditions, cumulative trauma, severity of and proximity to wildfires, as well as the relationship between exposure and symptom onset. By accounting for these variables and examining the natural trajectory of symptoms over time, studies can provide a more accurate prevalence rates of insomnia, nightmares and PTSD following the fires. Furthermore, exploring the types and effectiveness of treatments and support services received by individuals after the fires will help clarify the factors influencing prevalence rates, ultimately informing the development of targeted interventions to mitigate these mental health conditions.

The clinical trial demonstrated the feasibility of Sleep Best-i in reducing symptoms of nightmares and PTSD at post-intervention as well as the reduction of insomnia symptoms at 3-months follow-up. Future studies can build upon the findings by extending the application of insomnia modules over 3-4 weeks. As well as incorporating weekly assessments of insomnia symptoms to determine the onset of symptom reduction and identifying the specific components of CBT-I that drive the greatest improvement (Smith et al., 2023).

In addition to testing the effectiveness of Sleep Best-i in a larger sample, future research on Sleep Best-i should prioritise blinded trials to confirm its effectiveness and

establish dose-response relationships. Additionally, comparing Sleep Best-i with other treatment modalities to determine its relative effectiveness will also be essential. For example, comparing Sleep Best-i's self-paced approach to its implementation via community-led, coach-monitored models, and/or pharmacological treatments. Developing additional modules to provide individuals with a broader range of options tailored to their specific needs can add to the credibility of Sleep Best-i and broaden its applicability. Qualitative studies can also contribute to gaining understanding of sleep difficulties and trauma symptoms, uncovering critical factors that promote recovery. Subsequently, studies can gauge end-users to guide the development of additional modules. These future research directions will help refine Sleep Best-i, optimise its delivery, and inform its integration into existing healthcare frameworks.

Expanding the scope of the research to investigate the application of Sleep Best-i in non-wildfire-related traumas, such as floods, earthquakes, refugee experiences, and violence, can provide valuable insights into its potential as a viable intervention for non-wildfire survivors. This would not only demonstrate the generalisability of Sleep Best-i but also highlight its potential for broader impact. Furthermore, collaborating with disaster response agencies, including the Australian Red Cross, National Council for Fire and Emergency Services, National Emergency Management Agency, and Disaster Relief Australia, could offer a unique perspective on the real-world implementation of Sleep Best-i. By partnering with these organisations, we can identify areas for improvement and optimise the intervention for maximum effectiveness. Moreover, developing new modules or adaptations to address the specific challenges associated with different types of trauma can enhance the overall effectiveness of Sleep Best-i, making it more accessible to a wider range of individuals by increasing its potential to support those in need.

Comparing Sleep Best-i with face-to-face methods would provide valuable insights into the effectiveness of digital interventions in addressing sleep difficulties and trauma symptoms. This can be achieved by comparing the outcomes of participants who receive Sleep Best-i with those who receive traditional face-to-face therapy, this would allow for identifying the strengths and limitations of each approach and determine which method is most effective for specific populations and contexts. Furthermore, emphasising implementation science would allow researchers to examine the practical aspects of introducing and sustaining Sleep Best-i in real-world settings, including the identification of key factors that influence its adoption, implementation, and sustainability. This could involve reassessing of the content of the program, tracking time and usage, resources usage, evaluation, specifying plans for monitoring and addressing safety concerns, investigate the role of organisational support, provider training and support, monitoring patient engagement, and monitoring technological infrastructure in facilitating the successful implementation of Sleep Best-i. By combining comparative studies with an emphasis on implementation science, researchers can develop a more comprehensive understanding of how to optimise the delivery of Sleep Best-i and improve its effectiveness in addressing the complex needs of individuals who have experienced trauma. Ultimately, this research could inform the development of targeted interventions that meet the needs of diverse populations and contexts, and provide valuable insights into the potential of digital interventions to improve mental health outcomes.

9.12 Contribution to Knowledge

Despite the growing threat of wildfires globally, a significant knowledge gap persists regarding their consequences on sleep and trauma symptoms. This thesis, partially, addressed this critical knowledge gap by contributing novel findings and insights in this area. The systematic review and international survey collectively

advanced our understanding of sleep disturbances and trauma symptoms among wildfire-exposed populations, revealing new prevalence rates, alarming rates of insomnia, nightmares, and PTSD, and a significant fire-proximity correlation. Notably, the survey also provided new findings about the difference in prevalence rates of sleep and trauma symptoms among the three countries. The new findings can potentially inform policy decisions related to wildfire preparedness, response, and mitigation.

This research also developed a comprehensive, evidence-based treatment manual, incorporating CBT-I, ERRT, and psychoeducation about PTSD. The treatment manual is yet another resource for health professionals to inform treatment about insomnia, nightmares and PTSD symptoms. Sleep Best-i was found to be feasible in reducing symptoms of sleep disturbances and trauma symptoms. It challenges the assumption that mental health providers are the sole providers of treatments by offering a scalable, cost-effective, and immediately available solution to address the growing needs of wildfire-affected communities. Sleep Best-i can be used with survivors of other natural disasters as well as those who present with sleep and trauma symptoms.

9.13 References

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Appendix A

Ethics Approval for "the Prevalence of Sleep Disturbances and Trauma Symptoms in Survivors of Bushfires/Wildfires" and Final Report Submission for Project A21-124

Principal Researcher:	Professor Gerard Kennedy
Co-Researcher/s:	Ms Fadia Isaac Dr Samia R Toukhsati Dr Mirella Di Benedetto
School/Section:	**School of Science, Psychology and Sport**
Project Number:	**A21-124**
Project Title:	**The Prevalence of Sleep Disturbances and Trauma Symptoms in Survivors of Bushfires/Wildfires.**
For the period:	23/09/2021 **to** 01/04/2024

Quote the Project No: A21-124 in all correspondence regarding this application.

Approval with comment has been granted to undertake this project in accordance with the proposal submitted for the period listed above.

Comment: It is a condition of this approval that external permissions from each organisation are submitted to the Ethics Office prior to commencement of research at the organisation that has granted permission.

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:
23 September 2022
23 September 2023

Final project report:
1 May 2024
The combined annual/final report template is available at:
HREC Forms

Fiona Koop

Coordinator, Research Ethics
23 September 2021
Please note the standard conditions of approval on Page 2:

STANDARD CONDITIONS OF APPROVAL

1. Conduct the project strictly in accordance with the proposal submitted and granted ethics approval, including any amendments made to the proposal required by the HREC.

2. Advise (email: research.ethics@federation.edu.au) immediately of any complaints or other issues in relation to the project which may warrant review of the ethical approval of the project.

3. Where approval has been given subject to the submission of copies of documents such as letters of support or approvals from third parties, these are to be provided to the Ethics Office prior to research commencing at each relevant location.

Submission for approval of amendments to the approved project before implementing such changes. A combined amendment template covering the following is available on the HRE website: https://federation.edu.au/research/support-for-students-and-staff/ethics/human-ethics/human-ethics3

- Request for Amendments
- Request for Extension. Note: Extensions cannot be granted retrospectively.
- Changes to Personnel

4. Annual Progress reports on the anniversary of the approval date and a Final report within a month of completion of the project are to be submitted by the due date each year for the project to have continuing approval.

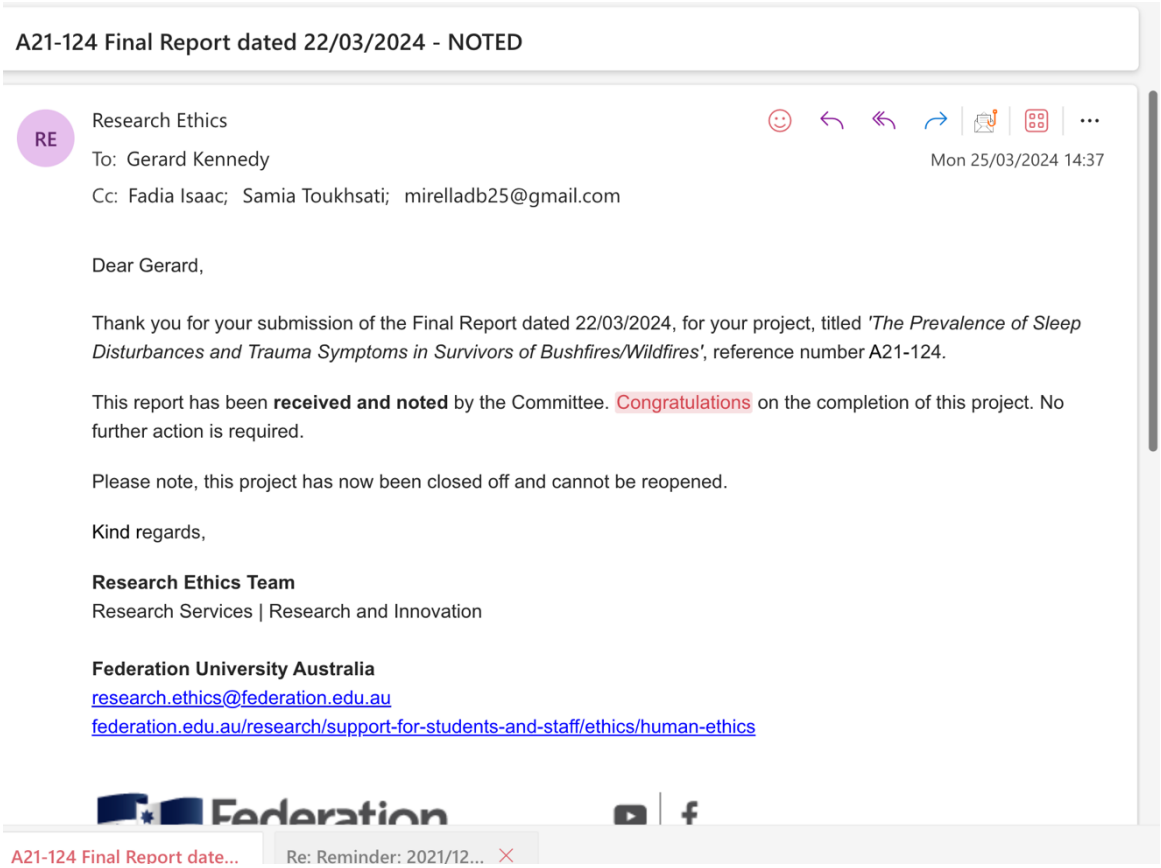
5. If, for any reason, the project does not proceed or is discontinued, advise the Committee by completing the Final report form.

6. Notify the Ethics Office of any changes in contact details including address, phone number and email address for any member of the research team.

7. The HREC may conduct random audits and / or require additional reports concerning the research project as part of the requirements for monitoring, as set out in the National statement on Ethical Conduct in Human Research.

Failure to comply with the *National Statement on Ethical Conduct in Human Research* 2007 (Updated 2018) and with the conditions of approval will result in suspension or withdrawal of approval.

Final Report Submission for Project A21-124



A21-124 Final Report dated 22/03/2024 - NOTED

RE

Research Ethics

To: Gerard Kennedy

Mon 25/03/2024 14:37

Cc: Fadia Isaac; Samia Toukhsati; mirelladb25@gmail.com

Dear Gerard,

Thank you for your submission of the Final Report dated 22/03/2024, for your project, titled *'The Prevalence of Sleep Disturbances and Trauma Symptoms in Survivors of Bushfires/Wildfires'*, reference number A21-124.

This report has been **received and noted** by the Committee. Congratulations on the completion of this project. No further action is required.

Please note, this project has now been closed off and cannot be reopened.

Kind regards,

Research Ethics Team
Research Services | Research and Innovation

Federation University Australia
research.ethics@federation.edu.au
federation.edu.au/research/support-for-students-and-staff/ethics/human-ethics

Federation

A21-124 Final Report date...

Re: Reminder: 2021/12...

Appendix B

Plain Language Statement for "the Prevalence of Sleep Disturbances and Trauma Symptoms in Survivors of Bushfires/Wildfires"

Federation University

Application for HREC Approval (Standard)

Human Research Ethics Committee

Appendix A

Plain Language Information Statement

School of Science, Psychology and Sport

PROJECT TITLE:	The prevalence of sleep disturbances and trauma symptoms in survivors of bushfires/wildfires
PRINCIPAL RESEARCHER:	Professor Gerard Kennedy
OTHER/STUDENT RESEARCHERS:	Fadia Isaac, Dr Samia R Toukhsati, Dr Mirella Di Benedetto

Dear participant,

You are invited to participate in a research project. Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you would like further information about this project, please contact the principal researcher via email g.kennedy@federation.edu.au.

What is the purpose of this project?

This research project aims to assess the prevalence of sleep disturbances such as insomnia and nightmares, and trauma symptoms in individuals who have experienced bushfires/wildfires in Australia, Canada and the USA in the last 10 years. This study is an online survey that entails potential participants to answer questions about their experience with bushfires/wildfires and the impact of bushfires/wildfires on their sleep. This study has been approved by the Federation University Human Research Ethics Committee (approval number: A21-124).

What does this study involve?

To be eligible to take part in this study, you need to be 18+ years of age, have been exposed to bushfires/wildfires in the last 10 years, and have sufficient knowledge of the English language. If you agree to participate in this research project you will be asked to complete online questionnaires that are likely to take 20-30 minutes of your time. More specifically, you will be asked to provide information about your demographics, previous experience with bushfires/wildfires, economic losses or human life losses, your experience with evacuation, mental health conditions prior to the fires, previous or current medications intake, the impact of smoke on your physical health, your experience with other stressful life events following the fires, the impact of COVID-19 on your mental health and sleep, questions about your mood, questions about your sleep difficulties, questions about symptoms of anxiety, questions about symptoms in response to stressful life experiences, quality of your sleep, severity of sleep disturbances and frequency and severity of bad dreams or nightmares.

Do I need to sign a consent form for this study?

No, your completion of the survey implies your informed consent in this project. Your participation is this study is voluntary and you are under no obligation to be involved. Your refusal to participate in this study requires no explanation from you.

What will happen if I decide to withdraw my consent?

You are free to withdraw your consent at any time during the online survey/study or following the completion of the survey/study. Please note that your information in this study is unidentifiable (you are not required to provide your name or address). As such, once you complete a section of the questionnaire and click "next", it is not possible to withdraw information/data that you have submitted. However, you are free to withdraw your consent or discontinue your participation at any time with no consequences to you. If you choose not to answer specific questions that you don't feel comfortable responding to, there will be no consequences to you.

What are the possible risks or disadvantages associated with participation?

Participating in this study may cause distress or discomfort to some people who experienced bushfires/wildfires. If you feel distressed while taking part in this project, participants in Australia are encouraged to contact their general practitioner, mental health provider, or contact Beyondblue on (1300 22 4636). Email and chat service is also available https://beyondblue.org.au/get-immediate-support. If you have thoughts of suicide, please contact Lifeline on (13 11 14) or Suicide Call Back Service (1300 659 467).

Participants in Canada are encouraged to contact their general practitioner, mental health provider, or Canada Suicide Prevention Service (CSPS) on 1-833-456-4566, or send a text to 45645 available from 4:00 pm to midnight, should you become distressed. You can also contact Hope for Wellness Helpline on 1-855-242-3310 or connect to online Hope for Wellness chat through hopeforwellness.ca.

Participants in the USA are advised to contact their general practitioner, mental health provider, or contact National Suicide Prevention Lifeline on 1-800-273-8255, or chat live by texting HELLO to 741741 should you become distressed as a result of undertaking this online survey. Participants in the USA please note that as of July 2022, **988** will become the national three-digit dialing code for the National Suicide Prevention Lifeline.

If you have any questions about this project, please contact Professor Gerard Kennedy on (61) 3 5327 6651 during business hours or via email at: g.kennedy@federation.edu.au. Prof Kennedy will discuss your questions with you confidentially and suggest appropriate follow-up, if necessary.

Methods of data collection, storage and dissemination?

Your participation in this study is anonymous and you will not be personally identified in any publications arising from the study. The site we are using for collecting data is Qualtrics. When the survey is open and running, data will be stored within Qualtrics. After the closing date of the survey, data will be exported from Qualtrics and deleted from the Qualtrics system. Data will then be retained in secure files on a computer system protected by a password known to the researchers of this project only. The information that you provide will not be shared with external organisations or other researchers. All information will be kept for 5 years before being destroyed.

Group data will be used by the researchers of this project to identify the prevalence of insomnia, nightmares and trauma symptoms in bushfire/wildfire survivors. No identifying personal information will be collected in the survey so no individual will ever be identified. Findings from the study will form a part of a researcher's PhD degree, and therefore findings will be presented in a thesis, may be published in scientific journals, as well as presented in conferences held nationally and internationally.

Can I review results, data, or publication arising from this research?

As a participant of this project, you have the opportunity to preview outcome results and any publications arising from this project. Please contact Professor Gerard Kennedy on g.kennedy@federation.edu.au should you wish to receive a summary of the project and outcomes or publications related to this study.

Can I amend previously provided data/answers to certain questions?

Participation in this study is anonymous. No identifying information will be collected such as your name and address. As such, we cannot amend previous answers to certain questions as collected data cannot be matched with individuals.

Whom should I contact if I have any questions?

If you have any questions about this study, please do not hesitate to contact Professor Gerard Kennedy on (+61) 3 5327 6651 during business hours or via email at: g.kennedy@federation.edu.au.

If you have any questions, or you would like further information regarding the project titled (The prevalence of sleep disturbances and trauma symptoms in survivors of bushfires), please contact the Principal Researcher, (Professor Gerard Kennedy on (+61) 3 5327 6651 during business hours or via email at: g.kennedy@federation.edu.au) of the School of *(*School of Science, Psychology and Sport, Federation University, Ballarat, Victoria, Australia*)*.
Should you (i.e. the participant) have any concerns about the ethical conduct of this research project, please contact the Federation University Coordinator Research Ethics, Research Services, Federation University Australia, P O Box 663 Mt Helen Vic 3353 Telephone: (+61) 3 5327 9765 Email: research.ethics@federation.edu.au CRICOS Provider Number 00103D

Appendix C

Ethics Approval for "Sleep Best-i: An Online Cognitive-Behavioural Intervention for the Treatment of Insomnia and Nightmares in Bushfire Survivors" and Final Report Submission for Project 2022/153

Fiona Koop

From: Research Ethics
To: Gerard Kennedy
Cc: Fadia Isaac; Samia Toukhsati; Britt Klein; Mirella Di Benedetto; Robert Teese
Subject: 2022-153 ethics application dated 23-08-2022 - Approved

Dear Gerard,

I am pleased to advise you that the Federation University Human Research Ethics Committee has approved your ethics application titled 'Sleep Best-i: An online cognitive-behavioural intervention for the treatment of insomnia and nightmares in bushfire survivors', reference 2022-153.
Approval period: 23 August 2022 to 23 August 2027

This approval is subject to the following conditions:

1. The project must be conducted strictly in accordance with the proposal approved by the {Committee name}, including any amendments made to the proposal required by the Committee.
2. The Chief investigator must advise the Committee via email to research.ethics@federation.edu.au immediately of any complaints or other issues in relation to the project which may warrant review of the ethical approval of the project.
3. Where approval has been given subject to the submission of copies of documents such as letters of support or approvals from third parties, these are to be provided to the Ethics Office prior to research commencing at each relevant location.
4. **Amendment requests** must be submitted to the Committee PRIOR to implementation of such changes. Amendments cannot be implemented prior to receipt of approval from the relevant ethics committee. Amendment requests may include:
   - Changes to project personnel
   - Project extension (note, extensions CANNOT be granted retrospectively)
   - Amendments to project procedures
5. **Annual and Final Reports** MUST be submitted by the following deadlines:
   - Annual Progress Reports – annually on the anniversary of the approval date. Amendment requests will not be accepted for projects with overdue annual reports.
   - Final Report – within one month of project completion, which may be prior to the expiry of ethics approval. Submission of a final report will close off the project.
6. It is incumbent on the research team to keep track of reporting requirements and submit reports on time. Reminders may not be sent by the Research Office and should not be relied upon.
7. If, for any reason, the project does not proceed or is discontinued, the Committee must be advised via the submission of a Final Report.
8. The Human Research Ethics Committee may conduct random audits and/or require additional reports concerning the research project as part of the requirements for monitoring, as set out in the National statement on Ethical Conduct in Human Research.
9. The Ethics Team must be notified of any changes in to contact details for any member of the research team. This may include, but is not limited to address, phone number and/or email address
10. Failure to comply with the National Statement on Ethical Conduct in Human Research 2007 and all updates, and/or with the conditions of approval, will result in suspension or withdrawal of approval.

If you require any further information, if something is not clear or you would like to provide feedback, please contact the Ethics Team via email at research.ethics@federation.edu.au or call +61 3 5327 9765.
Regards,
Research Ethics
Ethics and Integrity Office
Research Services | Research and Innovation

1

Federation University Australia
Office F218 | Building F | Mt Helen Campus
Telephone +61 3 5327 9765
research.ethics@federation.edu.au

Federation University

Final Report Submission for Project 2022/153

2022/153 Final Report dated 09/10/2024 - NOTED

RE

Research Ethics

To: Britt Klein

Cc: Fadia Isaac

Thu 10/10/2024 13:42

Dear Britt,

Thank you for your submission of the Final Report dated 09/10/2024, for your project, titled *'Sleep Best-i: An online cognitive-behavioural intervention for the treatment of insomnia and nightmares in bushfire survivors'*, reference number 2022/153.

This report has been **received and noted** by the Committee. Congratulations on the completion of this project. No further action is required.

Please note, this project has now been closed off and cannot be reopened.

Kind regards,

Research Ethics Team
Research Services | Research and Innovation

Federation University Australia
research.ethics@federation.edu.au
federation.edu.au/research/support-for-students-and-staff/ethics/human-ethics

Federation University

Appendix D

Plain Language Statement for "Sleep Best-i: An Online Cognitive-Behavioural Intervention for the Treatment of Insomnia and Nightmares in Bushfire Survivors"

Application for HREC Approval (Standard)
Human Research Ethics Committee

Plain Language Information Statement/pilot study

Institute of Health and Wellbeing

PROJECT TITLE:	Sleep Best-i: An online cognitive-behavioural intervention for the treatment of insomnia and nightmares in bushfire survivors
PRINCIPAL RESEARCHER:	Professor Gerard Kennedy
OTHER/STUDENT RESEARCHERS:	Fadia Isaac, Dr Samia R Toukhsati, Professor Britt Klein, Dr Mirella Di Benedetto

Dear participant,
You are invited to participate in this research project. Please read this sheet carefully so you are confident that you understand the contents before deciding whether to participate. If you would like further information about this project, please contact the principal researcher via email: g.kennedy@federation.edu.au.

What is the purpose of this project?
This research project aims to assess the efficacy of a digital mental health intervention program (Sleep Best-i) for the treatment of insomnia and nightmares in wildfire/bushfire survivors.

What does this study involve?
To be eligible to take part in this study, you need to be 18+ years of age, have been exposed to wildfires/bushfires in the past, have sufficient knowledge of the English language, have access to a computer, iPad or a smart phone and have access to the internet.

Potential participants will answer online questions that are likely to take 5-10 minutes in duration. The questions include demographic information, questions about wildfires/bushfires, current medications, mental health history, questions that assess sleeping difficulties, trauma symptoms and questions about nightmares. Eligible participants will have to sign a consent form. Those signing the consent form will complete other online questions that will take 5 minutes to complete. The online questions assess symptoms of depression, anxiety and sleep quality. Participants will also be offered the opportunity to attend a clinical interview with a clinical psychologist to establish diagnosis of sleep disorders ***should they wish***. The clinical interview, 15 minutes in duration, will ask questions about sleep difficulties to establish diagnosis of sleep disorders, trauma symptoms, and questions about medications. The clinical psychologist running the clinical interviews, has 13 years of experience and has received training in diagnosing and treating sleep and trauma symptoms. Eligible participants will be assigned to either an intervention group or a waitlist group. The intervention group will receive treatment immediately and the waitlist group will start receiving treatment after 4 weeks.

The intervention group will fill out a sleep diary, 5 minutes to complete, once a week during the treatment. The sleep diary includes questions about time going to bed, hours spent in

bed, and quality of sleep. A Fitbit Inspire 2 will be posted to participants (Australian participants only) to measure sleep objectively. Participants will be asked to wear their Fitbit throughout the study. Participants will be given 6 modules of Sleep Best-i (each 17 minutes in duration) to implement weekly for 4 weeks as part of their treatment. Participants will also be given one relaxation module to use as part of their online intervention. Those who complete the treatment and provide data, will keep the Fitbit Inspire 2 ((Australian participants only) as a thank you for their contribution in the study. All participants who complete the study will receive a $100 Coles e-voucher (Australian participants), and a $100 Amazon voucher (participants from the USA and Canada). Automated emails will be sent at week 2, week 3 and week 4 to address any concerns or answer questions, and get feedback on the intervention (15 minutes to complete). At the end of week 4 and week 12, participants will complete self-administered questionnaires (20 minutes in duration). The waitlist group will start the digital mental health intervention/Sleep Best-i following a four-week wait period. Potential participants will get access to all materials associated with this study via a platform called HealthZone at Federation University Australia.

This study has been approved by the Federation University Human Research Ethics Committee (approval number: 2022-153).

Do I need to sign a consent form for this study?
Yes, a written consent is required for participation in the study. However, participation in this study is voluntary and there is no obligation to be involved, and no explanation is needed for refusal to participate.

What will happen if I decide to withdraw my consent?
Participants are free to withdraw their consent at any time during the recruitment phase, during the treatment phase or when the study has concluded. There will be no consequences to participants if they do not wish to answer any questions that they don't feel comfortable in responding to. Please also note that withdrawing a consent after the data has been combined, grouped and processed, it will not be possible to withdraw participants' non-identifiable data, however, participants can still withdraw their consent.

What are the possible risks or disadvantages associated with participation?
Participating in this study may trigger pervious trauma or it may lead to reliving of events related to the experience of wildfires/bushfires. Furthermore, the materials presented in the modules may also cause distress or discomfort to some people. If you feel distressed while taking part in this project, participants in Australia are encouraged to contact their contact their general practitioner, mental health provider, or contact Beyondblue on (1300 22 4636). Email and chat service is also available https://beyondblue.org.au/get-immediate-support. They can also speak with a registered nurse by calling the healthdirect hotline on (1800 022 222) from anywhere in Australia. The hotline is open 24 hours, 7 days a week. If you have thoughts of suicide, please contact Lifeline on (13 11 14) or Suicide Call Back Service on (1300 659 467).

Participants in Canada are encouraged to contact their general practitioner, mental health provider, or Canada Suicide Prevention Service (CSPS) on 1-833-456-4566, or send a text to 45645 available from 4:00 pm to midnight, should you become distressed. You can also contact Hope for Wellness Helpline on 1-855-242-3310 or connect to online Hope for Wellness chat through hopeforwellness.ca.

Participants in the USA are advised to contact their general practitioner, mental health provider, or contact Suicide & Crisis Lifeline on 988, or chat live by texting HELLO to 741741 should you become distressed as a result of participating in this study.

If you have any questions about this project, please contact Professor Gerard Kennedy on (61) 3 5327 6651 during business hours or via email at: g.kennedy@federation.edu.au. Prof Kennedy will discuss your questions with you confidentially and suggest appropriate follow-up, if necessary.

What are the possible benefits associated with participation?
The cognitive and behavioural components used in Sleep Best-i are well researched and highly effective in reducing the symptoms of insomnia, nightmares, and trauma. Participants in Australia will keep the Fitbit Inspire 2, and receive a $100 Coles e-voucher upon completion of the study. Participants in the USA and Canada will receive a $100 Amazon voucher upon completion of the study.

Methods of data collection, storage and d nination?
Even though, personal information such as name, age, email address and a mobile number will be collected, participants will not be personally identified in any publications arising from the study. Collected data will be retained in secure files on a computer system protected by a password known to the researchers of this project only. Data will be stored separately from any listing that includes personal or other identifying information.

The site we are using for collecting data is Qualtrics. When the study is open and running, data will be stored within Qualtrics. After the closing date of the study, data will be exported from Qualtrics and deleted from the Qualtrics system. Data will then be retained in secure files on a computer system protected by a password known to the researchers of this project only. All data will be kept for 5 years before being destroyed permanently.

Group data will be used by the researchers of this project to assess the effectiveness of the intervention for the treatment of insomnia and nightmares. Findings from the study will form a part of a researcher's PhD degree, and therefore findings will be presented in a thesis, may be published in scientific journals, as well as presented in conferences held nationally and internationally. No identifying personal information will be revealed in any publications arising from this study.

Please note that in the event of a small number of participants, there is a slight risk that some data may be identifiable, which could have anonymity implications. In addition, the confidentiality of information provided is subject to legal limitations (e.g., subpoena, freedom of information claim, or mandatory reporting in some professions).

Can I review results, data, or publication arising from this research?
As a participant of this project, you have the opportunity to preview outcome results and any publications arising from this project. Please contact Professor Gerard Kennedy on

Application for HREC Approval (Standard)
Human Research Ethics Committee

g.kennedy@federation.edu.au should you wish to receive a summary of the project and outcomes or publications related to this study.

Can I amend previously provided data/answers to certain questions?
Participants can amend previously provided data to questions when the study is still open and running. However, when the study's data have been combined and grouped, it will not be possible to amend answers because it will not be possible to change non-identifiable data.

Whom should I contact if I have any questions?
Questions about this study should be directed to Professor Gerard Kennedy on (+61) 3 5327 6651 during business hours or via email at: g.kennedy@federation.edu.au.

What should I do next if I want to take part in this study?
To take part in this study, please answer the online questions to follow this plain language statement. Once your eligibility/or not for this study is established by the researchers, you will receive an email to confirm if you can participate or not in the study.

If you have any questions, or you would like further information regarding the project titled (Sleep Best-i: An online cognitive-behavioural intervention for the treatment of insomnia and nightmares in bushfire survivors), please contact Professor Gerard Kennedy on (+61) 3 5327 6651 during business hours or via email at: g.kennedy@federation.edu.au. Institute of Health and Wellbeing, Federation University, Ballarat, Victoria, Australia.
Should you (i.e., the participant) have any concerns about the ethical conduct of this research project, please contact the Federation University Coordinator Research Ethics, Research Services, Federation University Australia, P O Box 663 Mt Helen Vic 3353 Telephone: (+61) 3 5327 9765 Email: research.ethics@federation.edu.au CRICOS Provider Number 00103D

Appendix E

Permission to use "Cognitive Behavioral Therapy-Based Treatments for Insomnia and Nightmares in Adults with Trauma Symptoms: A Systematic Review

no-reply@email.copyright.com

To: Fadia Isaac

Sun 23/10/22 5:02 PM

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Thank you for your order!

Dear Fadia Isaac,

Thank you for placing your order through Copyright Clearance Center's RightsLink® service.

Order Summary

Licensee:	Federation University
Order Date:	Oct 22, 2023
Order Number:	5654041312463
Publication:	Current Psychology
Title:	Cognitive behavioral therapy-based treatments for insomnia and nightmares in adults with trauma symptoms: a systematic review
Type of Use:	Thesis/Dissertation
Order Total:	0.00 USD

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To:Fadia Isaac

Tue 24/10/2023 21:20

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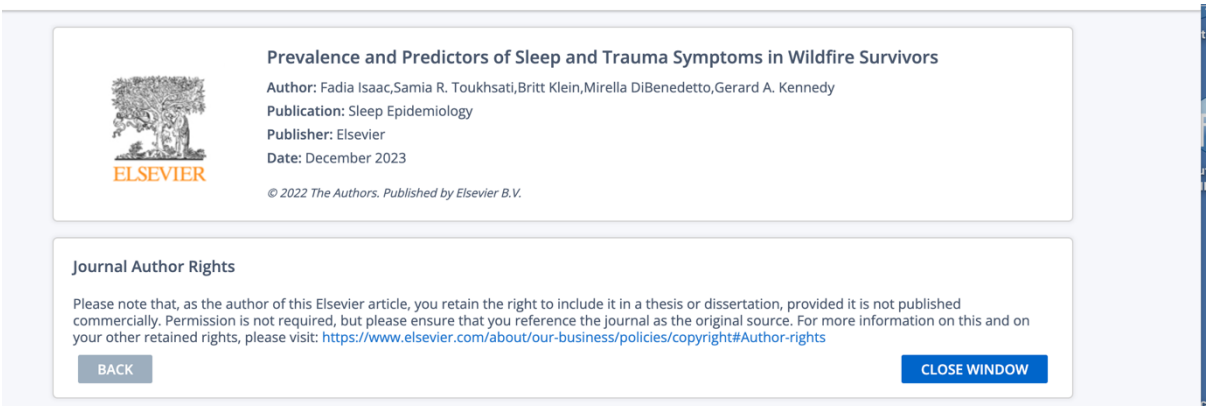
Kind Regards,
André
André Buller
Permissions Assistant
SpringerNature
The Campus, 4 Crinan Street, London N1 9XW, United Kingdom
T: [0]+442070146466
E andre.buller@springernature.com
http://www.nature.com
http://www.springernature.com

Appendix F

Permission to use “Prevalence and Predictors of Sleep and Trauma Symptoms in Wildfires Survivors



Prevalence and Predictors of Sleep and Trauma Symptoms in Wildfire Survivors

Author: Fadia Isaac,Samia R. Toukhsati,Britt Klein,Mirella DiBenedetto,Gerard A. Kennedy
Publication: Sleep Epidemiology
Publisher: Elsevier
Date: December 2023

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BACK CLOSE WINDOW

Appendix G

Permission to use "Assessment of the Effectiveness of Online and Face-to-Face Cognitive Behavioural Therapy for Insomnia/Nightmares in Adults Exposed to Trauma Using Self-Report and Objective Measures: Preliminary Findings"

Trends in Telemedicine & E-health <telemedicine@crimsonpublishers.com>

To:You

Fri 23/10/27 12:01 AM

Dear Dr. Fadia Isaac,

Thank you for your reply.

Let me inform you that, regarding your below mail, we have had a discussion with higher authorities and they have granted us permission to share this article.

Have a nice day!

Clarke Nicholas
Trends in Telemedicine & E-health

Appendix H

Permission to use "A Systematic Review of the Impact of Wildfires on Sleep Disturbances", and "Differences in Anxiety, Insomnia, and Trauma Symptoms in Wildfire Survivors from Australia, Canada and United States of America"

From: noreply@mdpi.com <noreply@mdpi.com>
Sent: Tuesday, 17 September 2024 13:33
To: support@mdpi.com
Subject: MDPI Contact Form: Copyright inquiry

Dear all,

The following message has been sent to you from the mdpi.com contact form.

Received: 17 Sep 2024
Creator: Fadia
Email: fisaac@students.federation.edu.au
Query: Other (general queries)

To: Journal of Environmental Research and Public health

Dear editor

I hope this email finds you well. I am writing to request permission to reuse my own articles, previously published in Journal of Environmental Research and Public health , in my upcoming thesis. The articles in question are:

• Isaac, F., Toukhsati, S. R., Di Benedetto, M., & Kennedy, G. A. (2021). A systematic review of the impact of wildfires on sleep disturbances. International Journal of Environmental Research and Public Health, 18(19), 10152. 10.3390/ijerph181910152
• Isaac, F., Toukhsati, S. R., Klein, B., Di Benedetto, D., & Kennedy, G. (2024). Differences in anxiety, insomnia, and trauma symptoms in wildfire survivors from Australia, Canada and United States of America. International Journal of Environmental Research and Public Health, 21(1), 38. 10.3390/ijerph21010038
• [Article Title 2], published in [Journal Volume and Issue], [Year]
I am the primary author of these articles and would like to include them in my thesis, [A Multi-Component Cognitive Behavioural Based-Treatment for Trauma and Sleep Disturbances in Wildfire Survivors], which I am currently completing at Federation University/Australia. I believe that including these articles will enhance the quality and coherence of my thesis.

I would like to request permission to reuse these articles in their entirety, with modifications to only the "reference style". I will ensure that the original publication is properly cited and credited in my thesis.

Could you please let me know if this is acceptable and if there are any conditions or requirements that I need to meet?

Thank you for considering my request.
Best regards,
Fadia

MDPI Contact Form: Copyright inquiry

S support@mdpi.com
To: Fadia Isaac

Reply Reply all Forward
Wed 18/09/2024 00:27

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Kind regards,

Megan Moeschlin
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Data Protection Notes
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Reply Forward

Appendix I

Psychiatry Research Communications Author Policy

Overview | Author rights | Institution rights | Government rights | Find out more

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Appendix J

Advertisement for "the Prevalence of Sleep Disturbances and Trauma Symptoms in Survivors of Bushfires/Wildfires"

We are looking for participants who can take part in an online survey.

To participant, please click on this link:

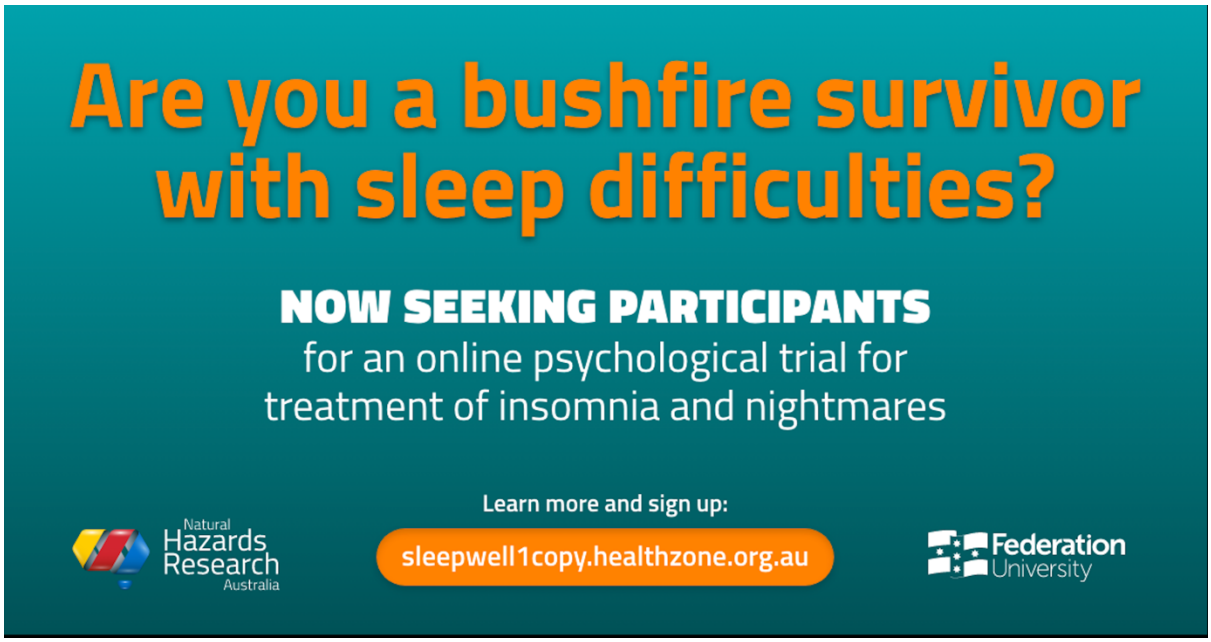
https://federation.syd1.qualtrics.com/jfe/form/SV_02Qkro6hL1gtOp8.

If you have any questions about this research, please contact Professor Gerard Kennedy on: g.kennedy@federation.edu.au.

We thank you for taking the time to be part of this study

Appendix K

Advertisement for "Sleep Best-i: An Online Cognitive-Behavioural Intervention for the Treatment of Insomnia and Nightmares in Bushfire Survivors"



Federation UNIVERSITY • AUSTRALIA

Natural Hazards Research Australia

Have you experienced bushfires in the past? Do you have sleep difficulties?

We are looking for wildfire/bushfire survivors, 18 years or over, who can take part in an online psychological intervention (Sleep Best-i) for the treatment of insomnia and nightmares (ethics approval #: 2022-153).

To learn more about the study, copy and paste the link below into your internet browser. Feel free to share the link with your friends and network.

https://sleepwell1copy.healthzone.org.au/

Click on step 1 & 2 to read the plain language statement and sign up to answer the pre-trial questions.

Participants will receive a $100 Coles or Amazon vouchers (Australian dollar) upon completion of the study.

If you have any questions about this research, please contact Professor Gerard Kennedy on: g.kennedy@federation.edu.au.

Appendix L

Transcript of a Relaxation Therapy Session (Morin & Espie, 2003: pp 149-151)

"The exercises on this tape are designed to help you relax. Relaxation is a skill, which you can learn. It is just like any other skill, so don't be surprised if you find it takes practice because that is how we learn skills. So do practice. Practice a couple of times a day, especially as you start to learn. Of course, you will want to use the relaxation when you go to bed, to help you relax and go to sleep, but you will find it most useful if you have already learned what to do. It is best to practice at a time when you know you won't be disturbed. The tape will last between ten and fifteen minutes so you will need at least that length of time set aside. When you do your relaxation exercises in your bed, you will be able to listen to the tape there too. But after a while you will have learned what to do and you will be able to just follow the exercises in your own mind. The exercises themselves begin now. Settle yourself down. Lie down with your hands and arms by your sides; have your eyes closed. That's good. We will start by just thinking about your breathing. Your breathing can help you relax; the more deep and relaxed it is the better you will feel and the more in control you will feel. So begin by taking some slow regular breaths. Do that now. Breathe in fully, fill up your lungs fully; breathe in, hold your breath for a few seconds now, and let go, breathe out…Do that again, another deep breath, filling your lungs fully when you breathe in, hold it…and relax, breathe out. Continue that in your own time, noticing that each time you breathe in the muscles in your chest tighten up, and as you breathe out there is a sense of letting go. You can think the word 'relax', each time you breath out. This will remind you that breathing out helps

you relax. It will also help you to use this word to tell yourself to relax whenever you need to. You will find that your body will begin to respond. Breathing slowly, comfortably, regularly, and deeply; thinking the word ‘relax’ every time you breath out; enjoying just lying still and having these moments to relax, concentrating on the exercises. Now I’d like you to turn your attention to your arms and hands. At the moment just lying at your sides. I’d like you to create some tension in your hands and arms by pressing your fingers into the palms of your hands and making fists. Do that with both hands now. Feel the tension in your hands, feel the tension in your fingers and your wrists, feel the tension in your forearms. Notice what it is like. Keep it going…and now relax. Let those hands flop. Let them do whatever they want to do; just let them relax. Breathing slowly and deeply, you will find that your fingers will just straighten out and flop, and your hands and arms will feel more relaxed. Allow them to sink into the couch or into the bed, just allow your arms to be heavy. Breathing slowly and deeply, thinking the word ‘relax’ each time you breathe out, and finding that your hands and arms just relax more and more and more. Your arms and your hands so heavy and rested. It’s almost as if you couldn’t be bothered moving them. Just because you have let go of the energy and tension that was in the muscles there. Breathing slowly and deeply, both your hands, both your arms, heavy and rested. Let go of the energy and tension that was in the muscles there, breathing slowly and deeply. Both your hands, both your arms, heavy and rested and relaxed.

I’d like you to turn your attention now to your neck and shoulders. Again we’re going to get your neck and shoulders into a state of relaxation following some tension we’re going to introduce. I’d like you to do that by pulling your shoulders up towards your ears. Now, do that; pull your shoulders up towards your ears.

Feel the tension across the back of your neck, across the top of your back and in your shoulders. Feel the tension, keep it going not so much that it's sore, but keep it constant. Feel it, and now let go…relax; go back to breathing slowly and deeply. Let that tension drain away, let it go. Breathe deeply, and as you do so, notice that the tension, almost like a stream, drains away from your neck, across your shoulders, down the upper part of your arms, down the lower part of your arms and out through your fingertips. Draining out and leaving a sense of warmth and relaxation deep in your muscles. Breathing slowly and deeply and allowing that to take place. Just let the tension go. If it doesn't seem to go, don't force it, it will go itself. Be confident about that. Just breathe slowly and deeply and allow yourself to be relaxed; remembering to think the word 'relax', each time you breathe out. Using that word 'relax' to focus on the sense of relaxation that you get, using the word 'relax' to remind you of the success your are having in relaxing your body. I'd like you to concentrate now on your face, and on your jaw, and on your forehead. I'd like you to create some tension in these parts of your body by doing two things together at the same time. These things are to screw up your eyes really tightly and bite your teeth together. Do these things together now. Bite your teeth together; feel the tension in your jaw. Screw up your eyes ;feel the tension all around your eyes, in your forehead, in your cheeks, throughout your face, wherever there is tension. Now keep it going…and relax; breathing in through your nose and out through your mouth, slowly and deeply. Notice how your forehead smooths out and then your eyelids and your cheeks. Allow your jaw to hang slightly open. Allow your whole head to feel heavy and to sink into the pillow; breathing slowly and deeply. Allow there to be a spread of relaxation across the surface of your face and into all those muscles in your face. Allow your eyelids to feel heavy and

comfortable, your jaw and your whole head; breathing slowly and deeply, enjoying the relaxation which you feel in your body. Relax each time you breathe out. Relax just that little bit more each time you breathe out".

Concentrating now on your legs and feet, I want you to create some tension here by doing two things at the same time; and these things are to press the backs of your legs downwards and to pull your toes back towards your head. Do these things together now. Create the tension in your legs, press the backs of your legs downwards and pull your toes back towards your head. Feel the tension in your feet, in your toes, in your ankles, in the muscles in your legs. Feel what it is like. Don't overdo it; just notice what it is like…and relax. Breathing slowly and deeply once more; just allow your feet to flop any old way. Allow the muscles to give up their energy, give up their tension. Let it go, breathing slowly and deeply. Notice how your feet just want to flop to the side. Notice how your legs feel heavy as if you couldn't be bothered moving them. Heavy and comfortable and rested and relaxed. Just that little bit more relaxed each time you breathe out. Be thinking about your whole body now; supported by the bed, sinking into it, but supported by it. You've let go the tension throughout your body. Your body feels rested, comfortable. Enjoy each deep breath you take. Just use these few moments now to think about any part of your body that doesn't feel quite so rested and allow the tension to go. It will go. Breathe slowly and deeply; thinking the word 'relax' each time you breathe out. Just let any remaining tension drain away; from your hands, your arms, your neck and your back. Heavy and rested, comfortable and relaxed. From your face and your eyes, from your forehead; letting the muscles give up their energy. Like a stream of relaxation flowing over your whole body. Let

your legs and feet feel relaxed; sinking into the bed. Breathing slowly and deeply. In a few moments, this tape will finish; but you can continue to relax. You may wish to repeat

some of the exercises yourself and that is fine. You may wish to enjoy just continuing as your are. You may wish to think on your visualization scene or build pictures in your mind that will help you to relax further. It's up to you, but continue to relax".

Appendix M

Sleep Best-i: A Treatment Manual for the Treatment of Insomnia, Nightmares and PTSD in Wildfire Survivors

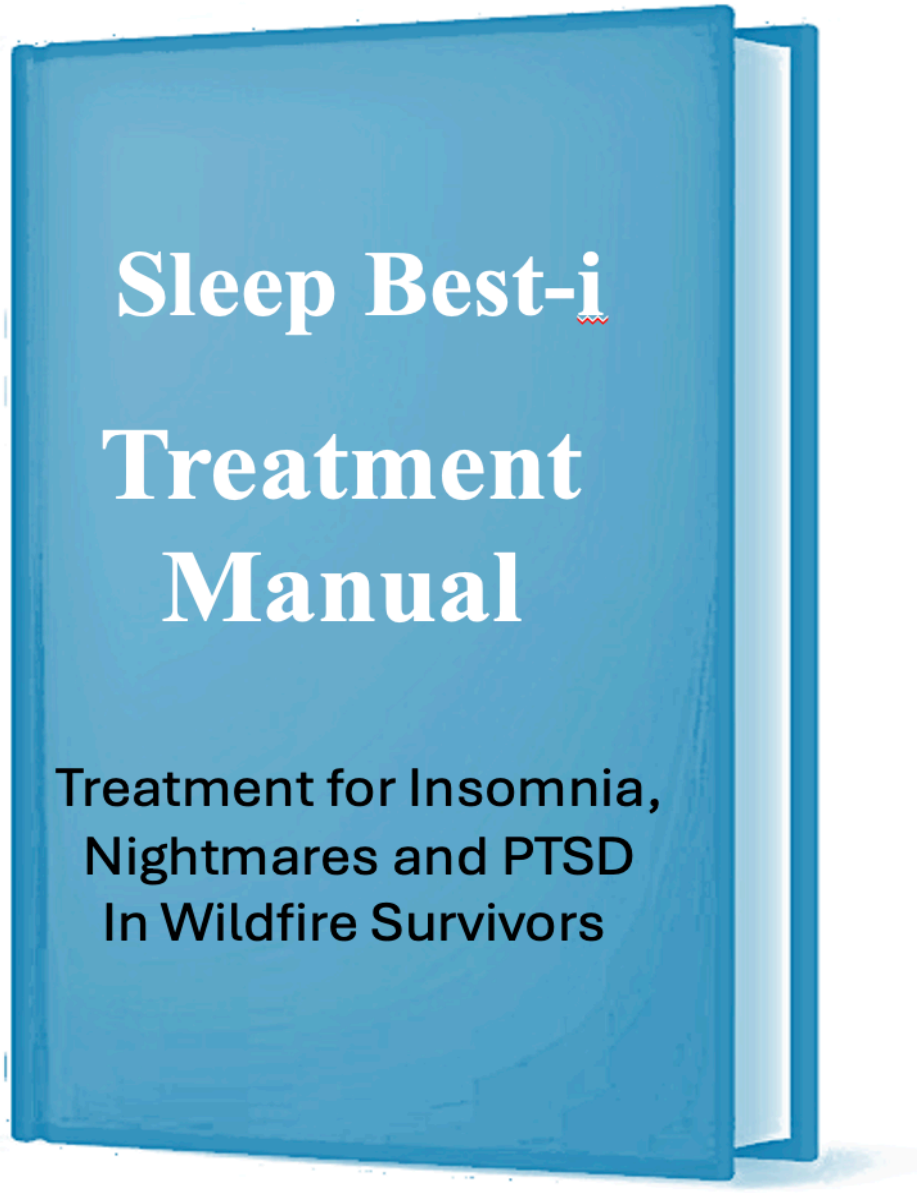


Image credit: Fadia Isaac

Introduction

The intervention, Sleep Best-i, incorporates three paradigms to provide the most comprehensive and complete treatment for those suffering from insomnia and nightmares. The three paradigms include cognitive, physiological and behavioural components (Davis & Wright, 2007). An example of cognitive reaction to sleep difficulties is holding negative thoughts such as: “I will never have a good night sleep”, “I will never be able to sleep well again”, “I will fail my studies because of my insomnia”, “I will be sacked from my job because I cannot sleep” (Davis & Wright, 2007). Physiological reaction to sleep difficulties include feeling fully alert before bedtime, inability to relax or feel calm knowing that bed time is near, feeling panicky when waking up from a nightmare (e.g. sweating, heart racing, inability to get back to sleep, difficulty breathing), and feeling lethargic during the day as a result of lack of sleep (i.e., confusion, concentration difficulties, irritability, and mood changes) (Davis & Wright, 2007). Behavioural reactions, on the other hand, entail changes in actions to cope with sleep difficulties including drinking alcohol, coffee or energy drinks, watching TV or reading in bed (Davis & Wright, 2007). Sleep Best-i also offers a recorded clip of a progressive muscle relaxation exercise (Morin & Espie, 2003: pp 149-151, see Appendix M for the transcript). The YouTube recording for the progressive muscle relaxation is found here (https://www.youtube.com/watch?v=iN_aSJk3iTY). The relaxation exercise aims to teach participants how to relax the body and calm the thoughts. Subsequent sections will explore each module.

Module 1: Psychoeducation About Sleep and Insomnia

Psychoeducation about sleep is an important part of any sleep intervention, simply because many people are not aware that sometimes their thoughts or behaviours play a major part in causing and maintaining sleep difficulties. Psychoeducation provides an insight into what is hindering an individual's ability in achieving a good night sleep. The YouTube clip for this module is found here (https://youtu.be/4R6u4uP5De4). This module covers the following sections:

- What is Sleep?
- Stages of Sleep
- Why is Sleep Important?
- Circadian Rhythm
- Homeostasis
- What is Insomnia?
- The Fight-Flight Response
- How Does the Fight-Flight Response Contribute to Sleep Problems?

What is Sleep?

Sleep is a vital biological need marked by a lack of response to stimuli, absence of memory and low arousal (Ogilvie, 2001). Almost all living creatures sleep. The average person will spend nearly one third of their life sleeping. Babies sleep approximately 17 hours a day (Suni & Vyas, 2024), while older adults need between 6-8 hours of sleep a day (American Academy of Sleep Medicine, 2014). However, everyone is different, some people may need more than 8 hours to function, while others may feel refreshed after 5 hours of sleep. As people age, sleep quality tends to decline, with more time spent in light sleep (stages 1 and 2) and less time in deep sleep, leading to more frequent awakenings (Morin & Espie, 2003).

Stages of Sleep

There are four stages of sleep. Stage 1 is five minutes in duration, and it is considered an interim between sleep and wakefulness states (Morin & Espie, 2003). Stage 2 of sleep is about 10-15 minutes in duration, and it marks the experience of sleep. Stage 3 and 4 are considered deep sleep stages, and they last between 20-40 minutes in the first sleep cycle (Morin & Espie, 2003). Once the individual reaches stage 4, the brain waves revert back to stages 3 and 2, finally allowing for rapid eye movement or (REM) sleep to occur (Carskadon & Dement, 2000; Pacheco & Singh, 2022). REM sleep is marked by rapid eye movements under the eye lids, loss of muscle tone and high activity in the brain. Emotional processing, consolidation of new memories and dreaming occur mostly during REM sleep. REM sleep accounts for 25% of the total amount of sleep in a given night, and the remaining 75% is spent in non-rapid eye movement (NREM) sleep (Morin & Espie, 2003: Pacheco & Singh, 2022). Each sleep cycle is 90 minutes in duration. In a given night, an individual has 3-5 sleep cycles. Some sleep problems are related to how much time an individual spends in each sleep stage. For example, some people may spend less time in deep sleep and more time in light sleep leading to dissatisfaction with the quality of sleep.

Why is Sleep Important?

No single theory can comprehensively explain and answer the question as to why we sleep. Adaptive theories stipulate that we sleep to protect ourselves from danger during periods of inactivity (Ezenwanne, 2011). Other theories suggest that we sleep to restore and revitalise various internal/physiological functions by eliminating build-up of toxins inside the brain and body during the waking hours (Ezenwanne, 2011). Other functions of sleep include preserving energy, strengthening immunity, and regulating weight and body temperature (Ezenwanne, 2011). Research shows that lack of sleep alters the glucose

metabolism and related hormones leading to lower leptin levels and higher ghrelin levels (Sharma & Kavuru, 2010). More specifically, chronic partial sleep deprivation is related to an increased risk of developing diabetes and obesity (Sharma & Kavuru, 2010).

Circadian Rhythm

The circadian rhythm is an internal system that regulates sleep, and it functions as a biological clock controlling wakefulness and sleep according to environmental cues over a 24-hour cycle (Blume et al., 2019). Within the hypothalamus is a small brain structure called the suprachiasmatic nucleus (SCN). The SCN acts as a biological clock, controlling wakefulness and sleep in response to environmental signals (Blume et al., 2019). Some of the most important environmental cues is the light-dark cycle, mealtimes, and social and work activities. During the waking hours, the retinas send signals to SCN activating hormones responsible for sleep drive, appetite, and body temperature (Blume et al., 2019; Suni & Rehman, 2024).

Homeostasis

Homeostasis regulates sleep by maintaining internal stability while adjusting to environmental conditions. For example, prolonged sleep deprivation and body temperature, controlled by circadian factors, dictate the desire to sleep (Morin & Espie, 2003; Pacheco & Singh, 2022; Suni & Rehman, 2024). As the body temperature drops, melatonin levels increase to promote sleep. The body temperature reaches its lowest point in the early morning hours between 3 to 5 AM and it starts to rise around wake-up time, reaching its peak in the evening. Sleep is most likely to occur when the body temperature is low (Lack et al., 2008; Morin & Espie, 2003).

What is Insomnia?

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) defines insomnia as a disorder that is characterised by dissatisfaction with quality and

quantity of sleep despite available opportunity for sleep (APA, 2013). Insomnia further refers to difficulties in initiating, maintaining sleep, or waking up early in the morning without being able to go back to sleep (APA, 2013). The disorder takes into account the severity and frequency of symptoms, and daytime sleepiness. Insomnia is the most prevalent of all sleep disorders and it is present in about 10-20% of the general population (APA, 2013). Sufferers of insomnia report anxiety about not being able to sleep which leads to hyperarousal at bedtime. Some people also report experiencing helplessness, stress and worry about the consequences of lack of sleep (Riedel & Lichstein, 2000). If insomnia symptoms persist beyond four weeks, it can evolve into chronic insomnia, and may become unresponsive to treatment (APA, 2013).

Insomnia may also lead to consequences such as depression, hypertension, low mood, irritability, tiredness, sleepiness, road accidents, low energy, poor quality of life, impaired social and work relations, diabetes, dementia, stroke, and migraines (APA, 2013; Cunnington et al., 2013; Morgan et al., 2015; Nadorff et al., 2011; Ohayon & Smirne, 2002; Roth & Ancoli-Isreal, 1999; Simon & VonKorff, 1997; Uchmanowicz et al., 2019).

Many theories attempt to provide explanation on how and why some people go on to develop insomnia. One of the most researched theories is Spielman's 3P behavioural model of insomnia which we turn to next (Spielman et al., 1987).

Several factors can make an individual susceptible to developing insomnia: (1) family genetic makeup, family's history of insomnia, vulnerability to anxiety, and personality characteristics (Perlis et al., 2010; Spielman et al., 1987); (2) illness, drugs, shift work, death of a loved one or major disruptions to important relationships; (3) and engaging in behaviours to compensate for sleep loss such as watching TV, reading in the

bedroom, and poor sleep hygiene (Spielman et al., 1987). A combination of the aforementioned factors can cause insomnia disorder.

The Fight-Flight Response (FFR)

The fight, flight response (FFR) is an involuntary physiological change that takes place in threatening situations. It is an evolutionary behaviour that served our ancestors well and kept them safe and away from danger in a dangerous environment. In our current society, the FFR response gets triggered whether the danger is real or not. An example of that would be delivering a presentation, having a job interview, having to confront a friend about an issue or being cut off by a vehicle while driving (West, 2021). During stressful situations, the body's autonomic nervous system (ANS) is activated, causing an increase in heart and breathing rates. This escalation allows more blood to flow to the larger muscles, preparing the body to confront danger or flee, leading to trembling and/or choking sensations (West, 2021). Additionally, pupils dilate to let more light into the eyes, enhancing vision and potentially causing tunnel vision and sharper sight (Guy-Evans, 2023). The FFR starts in the amygdala or the fear centre. The amygdala is a small part hidden deeply within the brain and it controls fear. When they body gets activated by the FFR, the brain sends signals to the hypothalamus stimulating the ANS (Guy-Evans, 2023). ANS consists of sympathetic and parasympathetic nervous systems. The sympathetic system is the part responsible for FFR, whereby signals are sent to the adrenal gland to release adrenaline and noradrenaline hormones (Guy-Evans, 2023). Symptoms noted during the FFR include faster heart rate to assist more blood flow to the larger muscles in the body, faster breathing to allow more oxygen into the larger muscles in the body, hands and feet may get cold due to the loss of blood flow into extremities, nausea, racing thoughts to help with rapid decision making, light-headedness

or dizziness, tension in the jaws and griding of teeth, feeling angry, feeling fidgety, and numbness in fingers and toes (Guy-Evans, 2023).

How Does the FFR Contribute to Sleep Problems?

When someone is out of danger (or the fight-flight response is over), the medial prefrontal cortex (mPFC) communicates with the amygdala to allow for recovery (Dong et al., 2012; Kessler, 2010). For most individuals the system resumes functioning as per normal following stressful situations, however for some, a failure in communication between the mPFC and the amygdala occurs, and the amygdala continues to be activated leading to the development of trauma symptoms (Liberzon & Sripada, 2007; Shin et al., 2004). Furthermore, a hyper-aroused amygdala provokes psychological reactions such as changes in thoughts (i.e., for example thinking “I will always feel stressed and anxious). Additionally, a hyper-aroused amygdala will also lead to strong emotions and behaviours such as frustration, anger, agitation, and violence even in the absence of external threat/stress (Sripada et al., 2013). When dysfunctional thoughts, beliefs and emotions are paired together, they lead to disturbed sleep and eventually to insomnia.

Module 2 (Part 1): Cognitive Restructuring and Sleep Hygiene

This module will help participants in recognising their negative automatic thoughts related to their sleep, understand how cognitions, emotions and behaviours are connected and how they influence each other. They will also learn how to collect evidence for and against a specific automatic unhelpful thought and develop a more realistic perspective on their faulty and negative thoughts (Bélanger et al., 2006). The YouTube clip for this module can be found here (https://www.youtube.com/watch?v=8ujFi-sgjZ4). This module will also explore the following:

- Types of Unhelpful Thoughts
- Thoughts, Emotions and Behaviour
- Challenging Unhelpful Thoughts
- How to Deal With Worrisome Thoughts
- Safety Behaviours Related to Sleep
- Stay Away From Judgment
- Selective Attention and Monitoring
- Sleep Hygiene

Types of Unhelpful Thoughts

Five factors contribute to faulty thoughts in people who suffer from insomnia: Worry or cognitive arousal, misunderstanding of sleep and daytime consequences, selective attention and monitoring, faulty beliefs about sleep, and compensating and unhelpful safety behaviours (Morin & Espie, 2003). The treatment applies to difficulty in initiating sleep and/or resuming sleep if woken up. Cognitive therapy uses the process of re-appraising, re-attribution, attention shifting, de-catastrophising, and hypothesis testing/experimental work with faulty thoughts (Morin & Bélanger, 2011).

When people are unable to get to sleep, they lie in bed and worry about multiple topics. Research suggests that worry triggers FFR leading to physiological arousal and distress. This combination of physiological arousal, worry and stress lead to anxiety, making it difficult to fall asleep or stay asleep (Espie, 2002).

Thoughts, Emotions and Behaviour

Let's explore how thoughts, feelings and behaviours are related. Let's look at the following example (Morin & Bélanger, 2011). You are studying at night for an upcoming exam, a thought crosses your mind "I must get some sleep otherwise I will fail." Thinking this way will lead to feelings of agitation, frustration, and anxiety. The feelings will lead to changes in your behaviour such as forcing yourself to go to bed too early. Few hours later, you are still awake at 3 am, then another negative thought crosses your mind "I will fail my exam for sure." Again, thinking this way, will lead to more anxiety and even more frustration. The outcome behaviour will then be sleeping in longer the following morning to make up for the lost sleep.

Situation	Thoughts	Feelings	Behaviour
At night-time studying for an upcoming exam	"I must get some sleep otherwise I will fail"	Agitation, frustration and anxiety	Forcing self to sleep very early
3am in the morning, still awake	"I will fail my exam for sure"	More anxiety and more frustration	Sleeping in longer the following morning to make up for the lost time

Using this model, can you think of a recent incident where you couldn't sleep? What were you thinking when you couldn't get to sleep? how did the thought/s make you feel? What did you do after that? (Morin & Bélanger, 2011).

Challenging Unhelpful Thoughts

Most people will experience negative or unhelpful thoughts from time to time. Sometimes holding such thoughts can cause disruption to personal and professional life. We will use a method called cognitive restructuring. We use cognitive restructuring to challenge unhelpful thoughts and rebuild them in a more balanced and accurate way (Morin & Bélanger, 2011). Let's look at how cognitive restructuring works through listening to the following conversation between a therapist and a client/Sam.

> Therapist: ok Sam, so one of the thoughts you have been having when in bed is "If I don't sleep, I will get sacked from my job." This tells me that you have been worried about your sleep pattern which potentially can make you lose your current job. Did I understand this correctly?
>
> Sam: yes, this is my main concern.
>
> Therapist: let's explore this in more details. Can you tell me if your manager has spoken to you about your job performance?
>
> Sam: maybe not my manager, but this is more a concern for me.
>
> Therapist: ok then. Let me ask you another question: are you able to complete your job tasks when you have had a poor night sleep?
>
> Sam: I guess, most of the time.
>
> Therapist: can you remember a time where you were able to do well at work despite sleeping poorly the night before?
>
> Sam: yes, in fact last week, I had a terrible sleep, yet I was able to get through the day and wondered how I was able to achieve that.
>
> Therapist: excellent, now, I want you to tell me if you have had a great night sleep, yet you were unable to complete all the urgent tasks.

Sam: yes, this happened few times as well. I would say two weeks ago, this happened to me despite sleeping so well.

Therapist: this then tells me that it is not only your sleep that affects your performance at work. Am I right in saying that?

Sam: you are right, I never thought about it like this before, this is quite interesting.

Therapist: then it seems to me that you worry before bedtime, are unable to sleep and you worry so much about your sleep affecting your work performance, when in fact other factors can also be responsible for your work performance.

Sam: this makes sense to me. I think I need to be less judgmental about my sleep and more patient with myself. Everything seems a lot worse when I wake up in the middle of the night and think about not being able to go back to sleep. I should refrain from judgments and be more kind to myself (Morin & Bélanger, 2011).

We encourage you to use the same method to challenge your unhelpful thoughts about sleep. When doing cognitive restructuring on your own thoughts, it is important to ask yourself the following questions suggested by Morin and Bélanger (2011):

1. Can you identify any evidence in your daily life to affirm your negative/unhelpful thought about sleep?
2. Can you identify any evidence that are against/reject the negative/unhelpful thought?
3. What are the chances of your thought taking place in real life?
4. What is the worst outcome that could happen if your negative thought takes place in real life?
5. If that happens, do you believe you can live through it?

6. Are there any other ways of looking at this thought?
7. What is the most likely realistic outcome as result of your thought? (Morin & Bélanger, 2011).

How to Deal With Worrisome Thoughts

While thought restructuring can be very helpful, at times people find that their negative thoughts can be so repetitive. The more they try not to think about their thoughts, their thoughts seem to persist. If I ask you now to stop thinking of a pink elephant, chances are, the harder you try, the more difficult it would be to empty your mind. It is the same when you try to stop your negative thoughts (Morin & Espie, 2003). It is ok to let the thoughts come, don't fight with them, don't try to make them stop, at the same time direct your attention to something interesting such as reading a book, watching a comedy show or listening to light relaxing music (Morin & Espie, 2003).

Majority of people who cannot sleep, usually engage in a "why question" (i.e., why am I unable to sleep, why are my thoughts negative, why is my sleep not getting better). These questions are unlikely to help, they usually do not have simple and straight forward answers and are likely to cause you anxiety and frustration (Harvey & Payne, 2002; Nelson & Harvey, 2003; Watkins & Baracia, 2002).

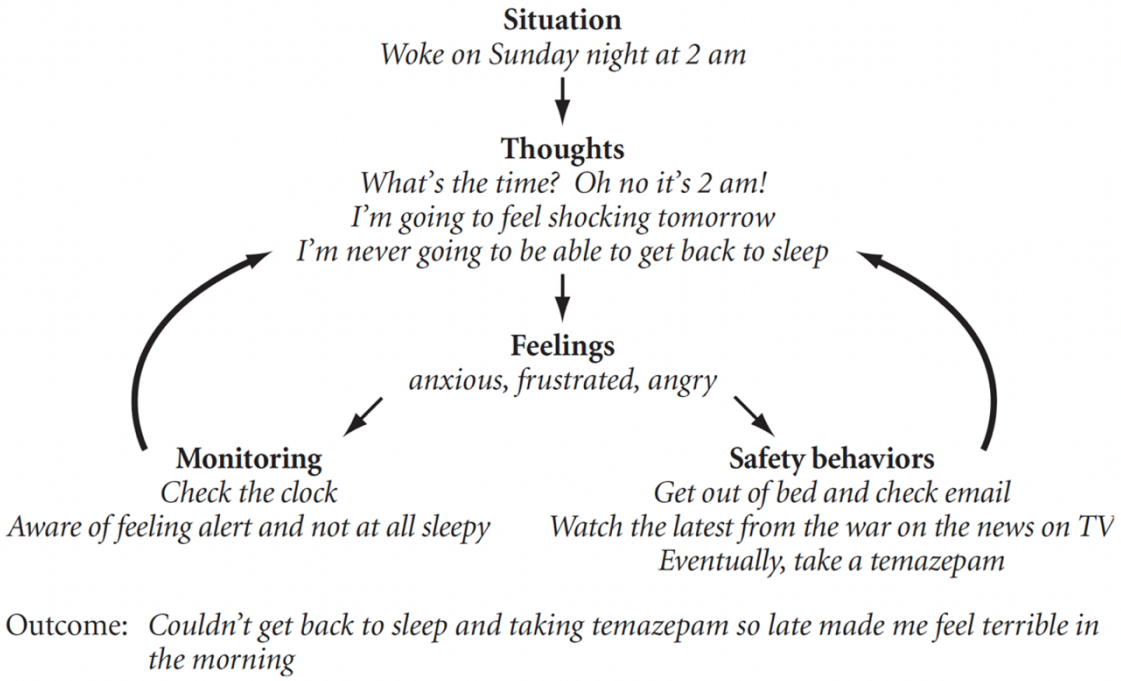
Safety Behaviours Related to Sleep

Negative thoughts and beliefs fuel worry (Morin, 1993). For example, if you believe you have to have 10 hours of an uninterrupted sleep to be able to carry out tasks during the day, chances are that you will worry when this does not take place. In fact, it would be impossible for majority of people to get 10 hours of sleep (Morin & Bélanger, 2011). When worry takes place, people are likely to feel anxious, frustrated and angry, this will then lead to engagement in safety behaviours (Salkovskis, 1991). Drinking alcohol, smoking and taking sleeping medications are some methods to ease anxiety and

help with sleep onset. A major challenge associated with safety behaviours is that whilst they may promote sleep initially, their effectiveness wears off with time, and people may end up with more persistent patterns of unhealthy sleep (Salkovskis, 1991) (refer to Figure 8.1).

Figure 1

An Example of Personalized Version of the Cognitive Model for the Night



Note. Figure adapted from "A cognitive theory and therapy for chronic insomnia" by A. G. Harvey, 2005, *Journal of Cognitive Psychotherapy, 19*(1), 41-59. DOI: 10.1891/jcop.19.1.41.66332

Stay Away From Judgment

Majority of people will need anything between 15-20 minutes after waking up where they may feel sleepy and tired (Morin & Espie, 2003). This phenomenon is called "sleep inertia." Sleep Inertia is a transitional period between sleeping and being awake. This period is not a reflection of how well you slept for that night, so stay away from judging the quality of your sleep in the first half an hour when you wake up. Get two

diaries, one for sleep and another one for your daily functioning (how tired you feel, how functional and productive you were and your satisfaction for the day) and compare the two over time, this will give you some data to inspect about your sleep and how well you function during the day (Harvey, 2005).

Selective Attention and Monitoring

Monitoring thoughts and the environment is an observed phenomenon in those who cannot sleep. To give one example "when my sleep is interrupted at night, I need to check the clock, otherwise I won't be able to sleep" (Morin & Espie, 2003).

We would like for you to run the following experiment: Night 1, check the clock if and when you wake up in the middle of the night and record how you feel, you can do that by writing down your feelings or you can use Subjective Units of Distress Scale or (SUDS, Davis, 2009). SUDS rating is a way of communicating how you feel. Feelings such as anxiety, anger, fear, or other emotions can be measured using the SUDS unit (refer to Figure 8.2). Rate the emotion from 0 to 100, where 0 reflects the absence of a negative emotion and 100 reflects the highest level of a given negative emotion (Morin & Espie, 2003). Night 2, try to turn the clock around and record what you feel when you wake up in the middle of the night (again either write down your feelings or use the SUDS). Now compare the two nights. You will probably notice that its more difficult to get back to sleep when you check the time or when your feelings on the SUDS are higher. Do you monitor other things in your environment??

Figure 2

Subjective Units of Distress Scale

0----------25----------50----------75----------100

Sleep Hygiene

Sleep hygiene refers to habits and behaviours that help the individual to have a good night's sleep. Some sleeping difficulties are often caused by poor sleep habits reinforced over time (Suni & Rosen, 2024). You can improve your sleep quality by applying the following simple steps suggested by Morin and Espie (2003, pp. 48-58).

- Turn off your TV, iPad, and your mobile an hour before bedtime. The blue light emitted from electronic devices are similar to daylight. Your brain will interpret the blue light as daylight/daytime which will lead to suppression in your melatonin causing delayed sleep. Furthermore, watching media news can trigger certain emotions which may cause a delay of your sleep and an overactivation of your brain (Morin & Espie, 2003). Your bedroom should only be used for sleeping and intimacy (Edinger, 2018; Suni & Rosen, 2024).
- Caffeine is a stimulant and can disturb your sleep. Avoid caffeine 8 hours before sleep. Caffeine is found in tea, coffee, chocolate, soda and energy drinks. Your last coffee should be at 1pm and you may benefit from cutting caffeine all together for some time (Morin & Espie, 2003; Suni & Rosen, 2024).
- Some smokers claim that nicotine before bedtime can relax them and can promote sleep. Just like caffeine, nicotine is a stimulant. Whilst the initial relaxing effects may occur, the build-up of the nicotine in the system produces an effect similar to caffeine. Avoid smoking during the night and bedtime and don't smoke to get yourself back to sleep after waking up (Morin & Espie, 2003).
- Avoid alcohol after dinner. While, alcohol may promote sleep initially, when it is metabolised in the body, it can disrupt sleep (Morin & Espie, 2003).

- During the day engage in regular exercise. Walk for half an hour, if possible, go to the gym, or even go swimming. Exercising assists in regulating your sleep. Getting some sunshine during the day will help with regulating your circadian rhythm and promote sleep at night-time. Avoid exercising close to bedtime as this may make falling asleep harder (Morin & Espie, 2003).
- Eat healthy and regularly. Three meals a day are likely to promote good health, and this will lead to better night sleep. Avoid heavy or spicy food close to bedtime and if you feel hungry, you can eat a light snack such as a bowl of cereal, cheese, or a warm glass of milk (Morin & Espie, 2003).
- Hot baths with Epsom salt for about 20 minutes can promote sleep. Have your hot baths two hours before bedtime (Morin & Espie, 2003).
- Your bedroom should be quiet, dark and of a pleasant temperature. An extremely cold or hot bedroom can disrupt your sleep and can make sleeping difficult (18^0). Outside noises can be masked with neutral noises such as a fan running or a relaxing music. You can also use earplugs. You can promote darkness by pulling the curtains down and having black-out shades (Morin & Espie, 2003).
- Stay away from napping during the day. The sleep you have during the day takes away from your sleep at night which can lead to restless and lighter sleep at night. If you must take a nap, take your nap before 3 pm and limit your naps to 15 minutes only (Morin & Espie, 2003).
- Each day, dedicate 10-15 minutes where you can think, worry and plan in a controlled manner. You can also journal your feelings for each day. Do this at a time well away from your bedtime (Edinger, 2018).
- Replace any thoughts about sleep or not sleeping with statement in your own words like “resting in bed is good” or “I like to rest in bed”. You are more likely

to fall asleep if you are in bed, in the dark and not worried or annoyed (Edinger, 2018).

- Set a time early in the evening, an hour before your bedtime, where you can write your schedule for the next day, write down your commitments in a diary. You can also journal your feelings for each day before going to bed, this will help with processing your emotions, and allow you to clear your mind. Bedtime is not a time to worry or find solutions to problems. If you start this, you probably will have fewer intrusive thoughts when trying to sleep (Edinger, 2018).

Module 2 (Part 2): Sleep Scheduling and Stimulus Control

The behavioural component of CBT-I in this manual is based on the work of Germain and Buysse (2011), Edinger and Carney (2014) and Edinger (2018).

In part 1 of module 2, we explored the cognitive component or cognitive restructuring of CBT-I. In part 2, we will examine the behavioural component of CBT-I. Sleep scheduling and stimulus control are the main principles behind behavioural therapy for insomnia (Edinger, 2018). Sleep scheduling aims to specify a regular sleeping and waking up time with as little variation as possible between the two. You may find that sleep scheduling can lead to sleep deprivation which in turn can lead to homeostasis drive and sleep consolidation (Germain & Buysse, 2011). Stimulus control aims to restrict the bedroom or the bed to sleep only. It also incorporates sleep hygiene, which we visited in Part 1 of this module. The YouTube video clip for this module can be found here (https://www.youtube.com/watch?v=Y7obiP7Eeu4). This module will explore the following:

- Sleep Scheduling
- Stimulus Control

Sleep Scheduling and Stimulus Control

Research shows that sleep scheduling and stimulus control show significant improvements in sleep duration, sleep latency, daytime functioning and sleep efficiency (Harris et al., 2012). The offered treatment in this section will require from you to make great changes in your sleep routine so you can gain better results. You need to set what time to go to bed and what time to wake up according to how much sleep you need.

So how much sleep do you think you need? Typically, there is no specific amount that will work for everyone, everyone is unique, and your body will differ to others in its

need to sleep (Edinger, 2018). Adults need between 6-8 hours of sleep; however, some people may need 5 hours while others may need 10 hours to feel refreshed (Edinger, 2018). It is important in this treatment to let go of any preconceived ideas of how much sleep you need and it's important to start listening and learning how much sleep your body needs (Edinger, 2018).

Behavioural interventions for insomnia work on two major systems in the body including the homeostasis and circadian drives (Germain & Buysse, 2011). The homeostasis system refers to an increased desire for sleep when the body has been awake for an extended period of time (Morin & Espie, 2003). The circadian system is the internal or the biological clock and it is regulated by external cues (Blume et al., 2019). Sleep is usually promoted during darkness by the release of melatonin and the drop of body temperature (Morin & Espie, 2003; Pacheco & Singh, 2022; Suni & Rehman, 2024). When the process of sleep gets delayed due to shift work or other factors, sleep become less efficient, lighter, more disrupted and of a poor quality (Åkerstedt & Wright, 2009). The aim of sleep scheduling and stimulus control is to regulate and correct sleep so that it is in line with both homeostasis and circadian processes by changing sleep and waking behaviours.

Please note that compensating for sleep deprivation by taking daily naps or going to bed earlier in the night are very unlikely to help and can work against your desire to establish a good and efficient sleep (Edinger & Carney, 2014). So, even though you may think that you would not be able to function during the day, facts are, you will be able to carry through and your body will be more prepared to sleep the following night. Your body is more likely to sleep when it has been awake for 16 hours than when it has been awake for only 2 hours (Edinger & Carney, 2014).

It is important to collect data about the patient's baseline sleep using sleep logs for two weeks prior to starting the CBT-I treatment (Edinger, 2018). Obtaining this data will assist in calculating individualised time in bed (TIB) for each person. Edinger (2018) recommends utilising a "TIB prescription" when implementing the sleep restriction method. TIB is calculated by adding 30 minutes to the total sleep time (TST). This additional time accounts for the duration required to fall asleep and for brief awakenings during the night. The patient's cooperation and input are highly encouraged when determining a bedtime and wake-up time.

In this manual, 6-8 hours of sleep was used as a guideline for the amount of sleep an adult requires (Suni & Singh, 2024). It is crucial to consider bedtime and wake up time during the decision-making process (Edinger, 2018). Following the initial application of the TIB prescription, wherein patients achieve satisfactory sleep and daytime functionality during the first week of treatment, adjustments to the prescribed treatment may not be necessary. However, if patients report daytime fatigue, they may increase their TIB by 15 minutes during the second and third weeks. Conversely, if patients experience prolonged wakefulness in bed, they may decrease their TIB by 15 minutes. Flexibility in treatment is essential to accommodate individual needs (Edinger, 2018)

The recorded YouTube video clip in the module represents a role-play between a clinical psychologist and a client focusing on sleep scheduling and stimulus control. The below scenario incorporates the six rules outlined by Edinger (2018) in his treatment manual. These rules include establishing a consistent wake-up time, refraining from engaging in activities other than sleep while in bed, avoiding prolonged wakefulness in bed, avoiding worries and future planning while in bed, abstaining from daytime naps, and going to bed only when feeling sleepy.

Therapist: welcome back Sam. During our last session, you mentioned that you have trouble initiating sleep. You also mentioned that sometimes you wake up in the middle of the night and are unable to get back to sleep. Did I get this right?

Sam: yes, this is right. I have been having issues with my sleep for nearly 2 years.

Therapist: two years is rather a long time. Sam, I will be asking you few questions about your daily routine so we can work on your sleeping difficulties. Is this ok with you?

Sam: yes, this is ok.

Therapist: tell me Sam, what time do you usually wake up in the morning and what do you do after waking up?

Sam: I have to be up at 6 am, even though most of the time it is very hard to wake up because I don't get enough sleep. After waking up, it takes me about an hour to get ready for work, I have breakfast, have a shower and leave home at 7 am so I can be at work by 8 am.

Therapist: ok, this is good. So, what is it like for you at work especially that you don't get enough sleep?

Sam: it can be very difficult at times to stay focused and function at my best. I do feel sleepy during the day, but I keep going by getting up and walking away from my desk for a few minutes. This helps at times and other times it doesn't. I finish work at 5 pm and get home at 5:30. I will take a nap for an hour, then get up and cook. At around 8 or 8:30 pm, I sit in front of my computer for an hour to do some work. By then the time will be around 9:30 or 10 pm. I don't feel sleepy, so I will be playing games on the computer until 1:30 am or I will hit the

gym for couple of hours. Then, I try to go to bed, but cannot fall asleep. Most nights I can be up until 3 am.

Therapist: you sleep at 3 am, and wake up at 6 am, so you sometimes get only 3 hours of sleep!!.

Sam: this is roughly the amount of hours I sleep most nights.

Therapist: And how many hours of sleep do you think your body needs to function well during the day?

Sam: I really don't know, because I have had sleep difficulties for two years, I feel like I don't know my body well.

Therapist: I see, it would be difficult given how long you have had the difficulties for. Ok, in this case, we can work on this together. You see most adults need anything between 6-8 hours of sleep each night to be able to function during their day.

Sam: I see.

Therapist: one of the methods that we use in sleep psychology that are highly effectiveness is called sleep scheduling. Sleep scheduling aims to limit the number of hours in bed to those actually spent sleeping with an extra 30 minutes to allow for a normal time to fall asleep.

Sam: mmm, this is interesting. This will be difficult to follow.

Therapist: it can be, but it works very well for people who stick to it and apply it. In saying that, for you Sam to be able to achieve a good night sleep we will have to work on introducing a new bedtime and wake up time. You will need to commit to the wake-up time regardless of whether you had a good sleep or not. Think of it as you are teaching your brain new rules, it's almost hitting the power button to get your computer to restart and get rid of any viruses. By sticking to a

standard wake-up time, you are likely to avoid unnecessary interruption to your sleep from day to day. Committing to the same time, you will notice that you get sleepy at around the same time and wake up around the same time. It is also best to follow your sleep schedule on the weekend, so that you are not undoing all the learning that your brain has done during the week. We can become more flexible with some of the rules if we feel like your sleep efficiency is getting better.

Given what you told me about your wake-up time and using the 7 hours rule, you will need to be in bed by10:30 or 11 pm. Your wake-up time is at 6 am so this will give you the 7 hours we are aiming for. You will need to give up your nap time at 5:30 pm. Napping so close to your sleep time ruins your sleep scheduling because your body feels rested and it does not need to sleep. Also, you need to wind down at least an hour or two before bedtime. This means staying away from activities that may stimulate your brain about 8:30 or 9:00 pm. Activities such as computer games, cleaning your space, or exercising need to happen earlier in the evening. For example, some people will watch a comedy, listen to music or even read a book before bed as this help them relax.

Sam: I see. So, what happens if I cannot sleep or wake up in the middle of the night.

Therapist: That's a very good question Sam. I always tell people to get out of bed if they toss and turn for 30 minuets in bed. You will need to leave the bedroom, make your way to another room and do something that will not stimulate your brain so much. So, you can read a book in a dim light, listen to music, or even do a relaxation mindfulness exercise. Give yourself half an hour of engaging in the light activity then head back to bed. Repeat the process again if you failed to sleep after half an hour. You may find yourself doing this

multiple times a night when you first start, but as you progress with your sleep scheduling you will find that your sleep will become more established. You may need to consider starting your sleep scheduling say on the morning of a Saturday if you don't work on weekends. At least even if you are sleep deprived during the weekend, you don't have to work. If napping is a must and cannot be avoided, I would say limit your naps to 15 minutes and perhaps have those before 3 pm if possible.

It is also important to know that resting can be equally as important as sleeping. So, sometimes when you cannot sleep you can say to yourself "resting is good, resting is important even if I don't sleep."

Sam: ok, I think I can do that.

Therapist: excellent, do you have any questions?

Module 3: Trauma, PTSD and Flashbacks

This module offers psychoeducation about PTSD and flashbacks. The YouTube video for this module can be found here (https://www.youtube.com/watch?v=aA_AAigtikI). This module will explore the following:

- What is Trauma?
- What is PTSD?
- What are Flashbacks?
- Signs of Flashbacks
- Behavioural Methods for Flashbacks

What is Trauma?

Trauma is a frightening event that causes the individual an emotional reaction overwhelming their ability to cope with the consequences of the event (APA, 2013). Such events can be personal such as physical attacks, rape, automobile accidents or the loss of a loved one, or it can affect entire communities such as wars and natural disasters (APA, 2013). The exposure to events does not need to be direct to cause traumatic response, people who witness events happening to others through the media can be equally and severally as affected (APA, 2013). The experience of the event is subjective, and it needs to be evaluated for the reaction and the symptoms it causes rather than the event experienced.

What is PTSD?

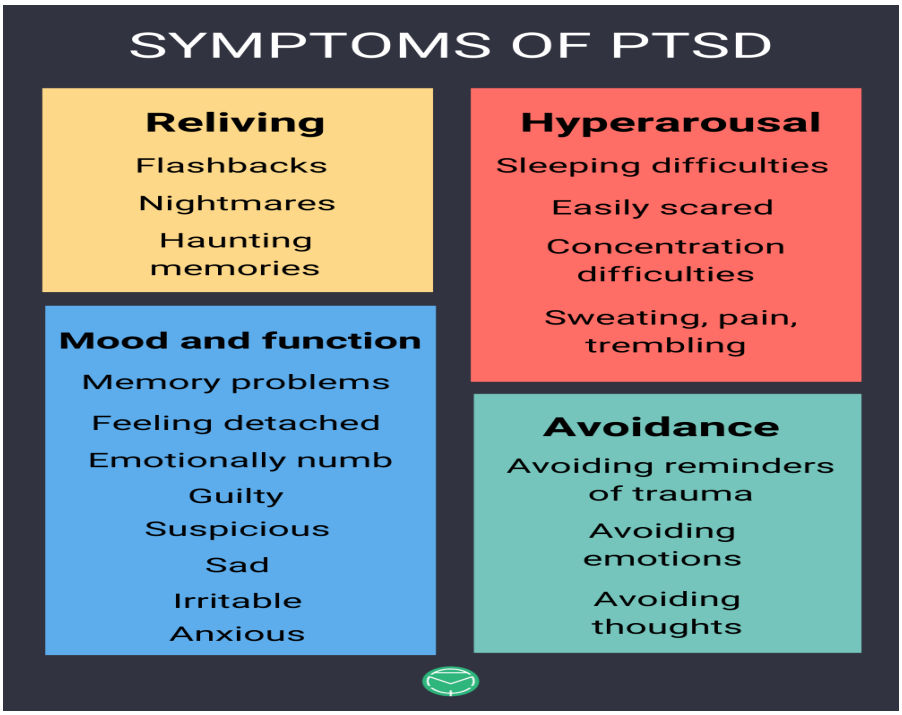
Post-Traumatic Stress Disorder (PTSD) occurs in people who experience and/or witness, either directly or indirectly traumatic events such as accidents, natural disasters and personal assaults (APA, 2013). It is estimated that 8.7% of adults will meet criteria for PTSD at some point in their lifetime (APA, 2013), with a substantially higher rates for

those who are veterans, frontline and emergency workers (Brooks & Greenberg, 2024; Obuobi-Donkor et al., 2022).

PTSD symptoms consist of four clusters including, hyperarousal, avoidance, reliving of events and mood changes (see Figure 8.3). In the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), sleep disturbances including recurrent trauma-related nightmares and difficulties falling or staying asleep are core features of PTSD, and their presentation is a prerequisite for a clinical diagnosis of PTSD (APA, 2013). Insomnia and nightmares fall under the reliving and hyperarousal clusters. The presence of insomnia and nightmares can lead to the development of PTSD and other symptoms (Babson & Feldner, 2010; Germain, 2013).

Figure 3

The Four Clusters of PTSD Symptoms



Note. Figure image adapted from "The four clusters of PTSD symptoms" by The Wright Initiative, 2024, from https://thewrightinitiative.com/misc/c-ptsd-physical-symptoms.html

What are Flashbacks?

Flashbacks are repetitive and intrusive thoughts, dreams, or mental images of a traumatic event (Hall, 2024; Raypole, 2021). They can lead to significant psychological and emotional distress such as experiencing fear, anger, sadness, dread, frustration, emotional detachment, disassociation, tremors, and sweating (Walker, 2005). Flashbacks are a replay of traumatic events that have taken place in the past and can reactivate the FFR (Hall, 2024; Raypole, 2021; Walker, 2005). They can occur abruptly and are challenging to deal with. They make the person believe that they are re-living the traumatic event all over again, they are unpredictable in nature and can cause a great amount of distress for the person (Brewin, 2015; Tull, 2020; Walker, 2005).

The brain is a powerful organ, it stores information attaching emotions to the content and the context of events such as where was the person at a given time, with whom was the person and what happened (Tyng et al., 2017). Under normal circumstances, experiencing emotions and context of the event work harmoniously together. However, during a flashback, the emotional content will override the context of events, leading to a vivid experience of sensations masking the person's ability to distinguish whether the trauma happened in the past or it is taking place right now (Bourne et al., 2013; Hall, 2024). Flashbacks can be transient, meaning the person can still maintain a sense of being here, or they can be severe where they may take the person right back to the trauma (Walker, 2005). For example, a survivor of a car accident when triggered will start to smell certain smells, hear certain noises associated with the actual accident and may start to feel like they are suffocating and cannot breathe. While flashbacks can be disturbing, it's the body's opportunity to process and validate your experience (Walker, 2005). They offer an opportunity for processing unmet needs from the past.

Flashbacks can be internal or external. Internal flashbacks are sensations and feelings associated with the person such as thoughts of not being able to escape, feelings of loneliness, disassociation, nervousness or racing of the heart (Walker, 2005; Tanasugarn, 2020). External flashbacks on the other hand are concerned with other people such as conversations or places where the trauma took place (Tanasugarn, 2020). Flashbacks can be triggered by either internal or external cues. It is important to know your triggers.

Signs of Flashbacks

Some of the symptoms of flashbacks include feeling nervous and overwhelmed, anger, disassociation, detachment from others, tremors, heart beating fast, avoidance of people, places or activities, muscle tension, stomach cramps and sweating (Walker, 2005).

Behavioural methods for coping with flashbacks

In this section we will look at slow or controlled breathing. Slow breathing tells the brain that the danger is over, in other words we are calming the FFR down when we breathe.

Slow Breathing (Jewell & Hoshaw, 2021)

- Sit or stand upright and close your eyes.
- Relax your body and breathe in through your nose until you can't take in anymore air.
- Exhale until all air has left your body.
- Keeping your eyes closed, fully inhale again.
- Keep the air in your lungs for a few seconds, then let it all out.
- Count that as breath one.
- Inhale fully again.
- Hold for a few seconds, then let it all out.

- Count that as breath two.
- Repeat a full inhale, hold, and then exhale.
- Count that as breath three.
- Repeat these steps until you've reached 10.
- Do this 5-10 minutes three to four times a day to get the full benefits of the slow controlled breathing (Jewell & Hoshaw, 2021).
- Use soothing images or objects to remind yourself that you are here and you are safe. Keep a reassuring image of a person, an item, or a favourite place in your pocket or on your phone as your wallpaper (Raypole, 2021). You can also choose to have a small object in your pocket such as a ring or a necklace. Looking at the images or touching the item will be your cue to remind yourself that you are safe and that you're here (Raypole, 2021).
- Creating personal phrases that are meaningful to you such as "I am no longer in danger", "I am safe and no one or nothing can hurt me", "that person or event no longer has any control over me", "it's just another flashback and it will pass", is such a powerful technique to repel flashback (Hall, 2024; Moore, 2022; Walker, 2005).
- Once a flashback takes place, try to work out what caused the flashback/s. What were the first signs that a flashback was imminent? what was your emotional state at the time? where were you? what did your environment look like? can you specify any triggers (people or places or conversations?) (Hall, 2024; Moore, 2022). It is important to know what triggers your flashbacks, so you are better equipped to avoid them if possible or deal with them effectively (Moore, 2022; Youngren et al., 2020). Some people report that their surroundings may begin to look fuzzy, or they may feel as though they're separating from or losing touch with

their surroundings, or other people, or even losing touch with themselves before a flashback takes place (Tull, 2020). Catching a flashback early will help you in managing it better (Tull, 2020). Keep a log of the flashbacks, it is important to know if they change in nature, frequency and timing (Hall, 2024).

- Ground yourself by paying attention to your five senses. Let's begin with your sight, identify five objects, describe them out loud, what is the object? what is the shape of the object? what is the colour of the object? (Hall, 2024; Moore, 2022; Raypole, 2021). Sounds, identify 3 sounds you hear in the room you're in, what is the sound? can you describe the sound? say it out loud? can you describe the pitch or the rhythm of the sound? (Tull, 2020). Smell, identify 2 smells you notice, what is the smell? is it a sweet smell? is it sour? is it minty or lemony? is it a strong or a weak smell? (Raypole, 2021). It also helps to sniff a strong peppermint or a coffee when having a flashback (Raypole, 2021). Smelling something strong like peppermint can stop a flashback, and can bring you right back to the present moment (Tull, 2020). Taste, bite into a lemon, tasting the strong sour flavour will bring you back to the present moment and out of a flashback. Touch, place your hands on your thighs, make sure you notice how your touch feels against your thighs, can you describe the touch? is it cold, hot, soft or rough? other methods of touching include holding on to an ice cube, the cold sensation will force you to stay in the present moment (Lebow & Casabianca, 2022). Warp a rubber band around your wrist, every time you feel like a flashback is imminent or is taking place, snap the rubber band against your skin, the sheer pain inflicted on the skin will force you out of a flashback.
- If you believe that you may be at risk of a flashback simply by being in certain situation, have a person to support you. Knowing that there is someone who cares

right next to you can help you in both preventing and coping with flashbacks (Moore, 2022).

- It is also helpful to identify feelings or themes associated with flashbacks. Write the feelings or the themes down in a journal (Raypole, 2021). Writing down the feelings or the themes will help with processing certain emotions so you can slowly process the trauma (Raypole, 2021).
- Keep it in perspective. When you experienced the actual trauma, it was in the past (position A). Right now, you are somewhere else in life (position B) (Raypole, 2021).
- Make a personalised “keep it in perspective” card. For example, “this year is 2022, I am 30 years old, I live with my partner at (write your address)” (Raypole, 2021). You may not be where you want to be in life right now, but you are not where you were when the trauma took place (Raypole, 2021). Have this card stored in your phone or have a printout with you.
- Progressive muscle relaxation. When a flashback is present, all the focus is on your thoughts, so it’s vital to bring your awareness to your body, move or stretch your body (Raypole, 2021).
- Self-soothing. Wrap a blanket tightly around the upper part of your body, close your eyes and sit upright holding this position for a minute or two. Doing so will help you feel stronger and allows for your back to support your body frame (Moore, 2022).
- Remember, it is just a flashback. Remind yourself that it is normal, and it is a healthy response to an emotional memory, you’re here, you are not in danger, and you are safe (Walker, 2005).

- Take your time. The slower you go, the faster you move. This is a well-known fact in trauma work. It is understandable that you want to feel better in a short time, notice the urgency and pace yourself. Healing is a steady, slow and a gradual process (Moore, 2022).

Module 4: Nightmares

This module provides psychoeducation about nightmares. It's based on the cognitive behavioural approach for the treatment of trauma related nightmares proposed by Davis (2009) using exposure, relaxation and rescripting of the nightmare (ERRT). The YouTube link for this module can be found here (https://youtu.be/6N7aCc1_dKE). This module will cover the following:

- What is Nightmare Disorder?
- How do Nightmares Develop?
- The Vicious Cycle of Nightmares
- What to do When You Wake up From a Nightmare?
- Rescripting the Nightmare
- Role-Play of a Rescripted Nightmare

What is Nightmare Disorder?

Nightmare disorder is defined as repeated stressful dreams that cause clinically significant distress or difficulties in occupational and personal activities (APA, 2013). It is estimated that about 5% of the general population report having one nightmare per week (Li et al., 2010). Nightmares can lead to a range of negative emotions for the individual including fear, sadness, confusion and anger (Gieselmann et al., 2018; Phelps et al., 2008; Robert & Zadra, 2014; Solms, 2000). Nightmares are more prevalent in individuals affected by trauma than those from the general public. They can cause an increase in heart rate and sweating which are in line with the physiological symptoms observed in PTSD and panic attacks (Davis, 2009).

How do Nightmares Develop?

Following the experience of trauma, memories are not stored correctly in the brain. So, in order for the brain to make sense of the memories, affected people start to experience flashbacks during the day and nightmares at night (Chi, 2023; Davis, 2009). When the person wakes up from the nightmare with significant distress, the brain does not have the opportunity to correct or change the nightmare by not allowing it to continue, and therefore the nightmare continues (Davis, 2009). Over time, the nightmare is kept separate from other emotions and it becomes independent from other symptoms of trauma, and therefore the nightmare does not change (Davis, 2009). Nightmares also change to include more recent stressors and people that were not present in the initial trauma. Everyone is different in how they experience nightmares. Some people will be more likely to have nightmares than others.

The Vicious Cycle of Nightmares

Regardless of the origins of nightmares following trauma, they can perpetuate a vicious cycle. Upon awakening from a nightmare, individuals may experience symptoms such as racing of the heart, shortness of breath, panic, trembling, distress, and fear leading to increased distress (Davis et al., 2009). This heightened distress often prevents them from returning to sleep, fuelled by the fear of re-experiencing the nightmare, leading to sleep deprivation. Sleep deprivation, in turn, results in diminished daily functioning, including lack of concentration, poor memory, and agitation (Davis et al., 2009). Daytime fatigue may trigger the trauma, elevating arousal levels and increasing the frequency of nightmares at night. Moreover, sleep deprivation exacerbates anxiety the following evening, fostering a heightened fear of bedtime, thus perpetuating the cycle of nightmares (Davis et al., 2009). Negative thoughts, such as feeling powerless, further increase arousal

levels. Therefore, individuals may attempt to alleviate their distress by resorting to alcohol, smoking, or watching TV to promote sleep, inadvertently exacerbating the nightmares (Davis et al., 2009).

What to do When you Wake up From a Nightmare

- Use your five senses to ground yourself.
- Use your vision and try to name three objects you can see, describe the object, the shape, the size, and the colour.
- Use your hearing and describe a sound, its volume, pitch, and rhythm.
- Use your sense of taste, describe the taste, is it bitter, sour or sweet.
- Note a smell and describe if it is sweet, sour, strong or weak.
- Touching an object and describe the sensation, texture and the temperature against your touch.
- Take the whole environment at once, observe it, notice it, and sit with it (Davis, 2009).
- Have a statement card ready and keep it in your bedroom, the card content can have a personal statement such as “my name is Sam, I am in my bed, and I feel safe and protected.”
- Leave the bedroom if you don’t feel sleepy.
- Engage in a light activity such as reading a book in a dim light, listen to music or practice mindfulness.
- Go back to bed when you feel sleepy (Davis, 2009).

Rescripting the Nightmare Using Exposure, Relaxation, and Rescripting Therapy (ERRT)

Rescripting the nightmare is a treatment approach suitable for individuals experiencing frequent nightmares (Davis, 2009). Even if you don't regularly have

nightmares, this treatment may still prove beneficial, hence the goal of the treatment is to lessen the intensity and occurrence of nightmares. Whether your nightmare reflects the trauma or centres around a particular theme, it's common for nightmares to evolve over time to include new elements that were not present in the initial trauma (Davis, 2009).

An important aspect of nightmares is the development of "fear of sleep" due to the anticipation of experiencing them (Davis et al., 2009). This fear can cause considerable distress, leading individuals to avoid thinking about their nightmares. Confronting the emotions and situations avoided due to nightmares is likely to facilitate healing and recovery (Davis, 2009). Therefore, facing your nightmares is an important step in initiating the process of recovery.

How to Write Your Nightmare?

Davis (2009) outlines the following steps when rescripting a nightmare:

- Select a suitable time for writing your nightmare.
- Dedicate approximately 20-30 minutes to writing your dream.
- Include all the details you can recall about the nightmare.
- Write the nightmare in present tense, describing it as if it is happening to you now and include as much details as possible.
- Engage all five senses—vision, hearing, touch, smell, and taste—by describing what you experience in the dream.
- Incorporate the emotions you feel during the nightmare, such as anger, frustration, sadness, fear, or horror.
- Identify recurring themes in your nightmare, such as feelings of anger, lack of safety, distrust of others, or loss of control.
- It is important to identify the themes and work on them.
- Recognising the themes is an important step in processing unresolved emotions.

- Note, it is normal to experience unpleasant feelings when writing your nightmare. You can take breaks to relax and gather your thoughts as needed.
- Remind yourself that it's just a nightmare and that you are safe. Nothing from the nightmare can harm you.
- Expect to feel anxious after writing the nightmare, as confronting traumatic experiences can be unsettling. With time and continued confrontation, you will likely become more comfortable with the nightmare, reducing its power in creating fear.

After completing the writing of your nightmare, it's time to modify it and rewrite it into a less distressing dream. Note, you have the freedom to alter any part of the nightmare—its beginning, middle, or end (Davis et al., 2009). Aim to rescript the dream to closely resemble the original nightmare, allowing your brain to connect the two and facilitate the changes. For instance, if your nightmare involves a stranger attacking you, you might choose to write the dream exactly as it is until the point of the attack, and then modify it to allow for your escape or self-defence. While rewriting the nightmare, you have the discretion to decide how you want to change it, but it's crucial to pinpoint the "stuck point" during the process (Davis, 2009).

Your "stuck point" is the moment you wake up from your nightmare. To address the theme of fear in your dream, transform it so that you feel empowered in the rewritten version. You have the freedom to include trusted individuals, beloved pets, or comforting objects that evoke feelings of safety and strength (Davis et al., 2009). When identifying themes, prioritise those that are both common and distressing. Begin by working on the least distressing themes before moving on to more challenging ones. Consider altering both the middle and end of the dream, converting negative elements into harmless or positive ones (Davis, 2009).

Your revised dream can be as imaginative and unconventional as you like, without limitations on creativity. Make as many alterations as necessary until you feel comfortable and confident with the new narrative. Once you have finalised the dream, practice rehearsing the new script by not only reading it aloud but also visualising the imagery of the revised dream (Davis, 2009).

Congratulations on completing this difficult part of the treatment. You are taking some control over your nightmares.

Role Play of a Rescripted Nightmare

The recorded video clip in the module presents a role-play between a clinical psychologist and a client focusing on rescripting a nightmare to facilitate learning. The utilised scenario resembles a scenario used by Davis (2009) with some variations.

> Therapist: Ok Hazel, so you have been having different nightmares with the same theme for some time now. During our last session we spoke about taking 20-30 minutes to write down your nightmare. So, I have asked you to consider the following when writing your dream: Write your dream in present tense, write it as it is happening to you now and put as much details as possible, include your five senses, vision, hearing, touch, smell and taste. It is also important to include emotions arising in the nightmare such as anger, frustration, sadness, fear, horror or any other emotion. We also spoke about identifying themes related to your dream. Were you able to identify any themes from your nightmares?
>
> Hazel: yes, I identified one theme, and it is “fear.”
>
> Therapist: good. I see that you have brought a writing pad with you today.
>
> Hazel: yes, I actually wrote my nightmare and wanted to share it with you.
>
> Therapist: That would be wonderful, if you don’t mind sharing, then I am ready to listen.

Hazel: I am lying in my bed. I can feel someone standing at the end of the bed. I open my eyes and I can see him very clearly. I can hear him laughing and looking at me. My heart is racing, and I feel terrified. I am looking at the bedroom door and working out whether I can make it to the door in time before he comes near me. I turn my vision into his direction, and he is coming close towards me. I feel the walls closing on me as he comes closer and closer. He is taking his time in coming towards me. This gives me a minute to think. I suddenly feel him standing right next to me. He is standing there in front of me, glaring at me while smiling at the same time. He tells me "you cannot escape."

Therapist: how do you feel reading this to me?

Hazel: I feel ok, I thought it would be worse, but I am glad that I have written it, so, I feel like I have some control over it.

Therapist: this is great Hazel. I am glad to hear that you feel this way. I am just wondering if you were also able to write your nightmare into a harmless dream/changing some of the content or the "stuck point" we spoke about last time.

Hazel: I tried, and I had to make some changes here and there. I also found myself going back to it few times and changing the "stuck point" until I was satisfied with the final version.

Therapist: this is such a big achievement. It is not easy sitting with some of the difficult emotions you spoke about in previous sessions. Congratulations on getting this far with your treatment.

Hazel: yeah, I feel good about it. I am ready to share the new content with you.

Therapist: yes, please go ahead.

Hazel: I am lying in my bed. I can feel someone standing at the end of the bed. I open my eyes and I can see him very clearly. I can hear him laughing and looking at me. My heart is racing, and I feel terrified. I am looking at the bedroom door and working out whether I can make it to the door in time before he comes near me. I turn my vision into his direction, and he is coming closer towards me. I feel the walls closing on me as he comes closer and closer. He is taking his time in coming towards me. This gives me a minute to think. I suddenly feel him standing right next to me. He is standing there in front of me, glaring at me while smiling at the same time. He tells me "you cannot escape." I find myself responding to him "oh, you are so mistaken." Suddenly, my dog, Carlos, appears next to me, I also see my parents holding me and giving me a hug. I hear my mom saying, "it's alright, Hazel, don't be afraid, we love you." I then stand and look around me and I see Carols on one side and my parents on the other side standing next to me. I turn my vision towards him and he disappears into thin air, he evaporates, like I cannot see him anymore. I feel safe, protected, loved and I feel so powerful, surrounded by my beloved dog and my parents.

Therapist: that is such a powerful ending to a dream Hazel. How do you feel about it?

Hazel: I feel so good about it, it is like I am not so scared of the nightmare anymore and also I am not afraid of going to sleep anymore.

Therapist: you can work on the other themes from a nightmare in the same manner and you can use different objects, people or even phrases to change the content of the nightmare into a harmless dream. I would like for you to practice the new harmless dream two-three times a day if possible and perhaps not just

reading it out loud but actually sitting and imagining that you are having the harmless dream. Try to attach images to the content to make it even more meaningful to you. Do you believe you can do that.

Hazel: Yes, I can.

Module 5: Relapse Prevention

This module is based on the treatment manual proposed by Lynch et al. (2015). The YouTube video clip can be found here (https://youtu.be/OrA7_pbyw_o). This module will cover the following:

- What is Relapse?
- What is Recovery?
- What is Resiliency?
- Recognising Relapse Signs
- What to do if You Relapse?
- What is Post-Trauma Growth?
- Acceptance

What is Relapse?

Relapse is the process of reverting back to old habits. For example, when you stopped drinking coffee at night before sleep for a year, then one day you decided to go back to dirking coffee before bedtime, this is called a relapse. Note that relapse is a normal part of your progress and the more relapses you have, the more determined you become to make changes. It is important to know what worked well for you in the past, and remember to use those skills again.

What is Recovery?

Recovery is your willpower to go back to using the learned skills after having a relapse instead of continuing with the old habits (Lynch et al., 2015).

What is Resiliency?

Resiliency is the ability to bounce back after facing difficulties. Resiliency also refers to learning new skills and changing your thinking and behaviour to match the new learned skills (Lynch et al., 2015).

Recognising Relapse Signs

If you suspect you may be experiencing a relapse, consider the following: (1) inquire with a family member, friend, or colleague if they observe a return to old habits; (2) monitor feelings of daytime fatigue; (3) be mindful of a reuse of sleep medications; (4) recognise an increase in the frequency and intensity of negative thoughts; (5) note heightened levels of anger, anxiety, or heart rate; (6) be aware of turning to substances like alcohol, nicotine, or excessive TV watching to induce sleep; (7) observe changes in emotional state, including heightened agitation, sweating, or avoidance behaviours; (8) be attentive to challenges in relationships; (9) note decreased tolerance for pain, stress, or interaction with others; (10) and monitor the use of safety behaviours (Lynch et al., 2015).

What to do if You Relapse?

We suggest you do some of the following if you think you maybe having a relapse: (1) consider revisiting the modules of this program; (2) see your GP; (3) revisit some of the personal statements and self-assurance methods; (4) talk to a therapist; (5) try implementing sleep restriction, stimulus control, cognitive restructuring, or dream rescripting; (6) and consider using the mindfulness exercise you have learned during this online intervention (Lynch et al., 2015).

What is Post-Trauma Growth?

Post-trauma growth is the ability to grow despite the pain you have experienced. It is a positive change where you see yourself with more wisdom, and more appreciation for

life. A post-trauma growth can motivate you to make changes in your life and opening yourself to new opportunities that you have not considered prior to the trauma (Lynch et al., 2015).

Acceptance

Acceptance is your ability to sit with what you cannot change. Focus on your available choices rather than trying to change what has happened. Being present in the moment and staying away from judging the outcome can also be helpful. Acknowledging your difficulties and taking pride of what you have achieved can also be very rewarding (Lynch et al., 2015).

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Appendix N

Acknowledgment Letter from Natural Hazards Research Australia

naturalhazards.com.au

Natural Hazards Research Australia
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Monday, 7 August 23

Fadia Isaac,
9 Wilkinson St
Mernda VIC 3754

Dear Fadia,

Subject: Early Career Researchers Competition

Congratulations on winning the 2023 Cooperative Research Australia Early Career Researchers Competition. At Natural Hazards Research Australia we were thrilled to hear of your achievement at the recent Collaborate Innovate conference in Adelaide.

The win is a fantastic achievement as the calibre of entries is high. Your success demonstrates your excellent communication skills and highlights your ability to communicate clearly to a non-specialist audience. This is a critical skill to possess and will only help you gain further support for your research.

Natural Hazards Research Australia is exceptionally proud of your achievement in securing first place.

We are glad to have you on board as a Natural Hazards Research Australia postgraduate scholar. You have proven to be a highly capable, professional and dedicated PhD candidate. We look forward to supporting your research career further and seeing you grow as a researcher.

Yours sincerely,

Andrew Gissing

Chief Executive Officer

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Appendix O
Screenshots of Published Chapters

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Contents lists available at ScienceDirect

Sleep Epidemiology

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Prevalence and Predictors of Sleep and Trauma Symptoms in Wildfire Survivors

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A B S T R A C T

Objective: This study aimed to establish the prevalence and to identify predictors of insomnia, nightmares and post-traumatic stress disorder (PTSD) in wildfire survivors.
Method: A total of 126 (23 males, 102 females, and 1 nonbinary individual, *M*age = 52 years, *SD* = 14.4) wildfire survivors from Australia, Canada and the USA took part in an online survey. Participants completed a demographic questionnaire and self-report measures including: The Insomnia Severity Index (ISI), PTSD Checklist for DSM-5 (PCL-5), and Disturbing Dream and Nightmare Severity Index (DDNSI).
Results: Results showed that 49.2% of the sample reported clinical insomnia on the ISI, 28.7% reported nightmares on the DDNSI, and 77.88% reported PTSD symptoms on the PCL-5. Fear for life of others (*Pearson's r* = .40, .21, .31), and the impact of smoke (*Pearson's r*, .47, .25,.41) significantly correlated with insomnia, nightmares and PTSD symptoms, respectively. Hierarchical regression showed that smoke was a significant predictor of insomnia (β = .17, p <.05, *95% CI*, 0.15 – 1.49), and insomnia predicted both of PTSD (β = .27, p <.05, *95% CI*, 0.26 – 1.05), and nightmares (β = .19, p = .04, *95% CI*, 1.01 – 1.45) scores.
Conclusion: Insomnia, nightmares and PTSD are highly prevalent in wildfire survivors. Smoke, one of the trauma-related factors, was found to be as a significant predictor of insomnia; and insomnia was a significant predictor of both PTSD and nightmares. Future longitudinal studies are needed to establish which disorder emerges first as a result of smoke.

1. Introduction

Climate change has set the stage for increased frequency and severity of various natural disasters including floods and fires. Particularly, the rise in global temperature and resulting droughts has contributed to the increase in wildfires, leading to a global crisis [1]. Wildfires have been predicted to increase by 57% by the end of this century [2], as they are now impacting many parts of the world that were previously immune to their destructive nature, including parts of Russia, the Amazon and even the Arctic region [1,3]. Parts of Australia, Canada and the United States of America (USA), are prone to wildfires and climate change has further increased their vulnerability [4–7].

Repercussions of wildfires

The repercussions of wildfires extend from financial losses, to human hardship with loss of life and injury, and psychological traumatisation of survivors [7]. Many survivors report difficulties initiating sleep, maintaining sleep, waking up too early in the morning with inability to return to sleep, which are typical symptoms of insomnia [8,9]. Some survivors report regularly experiencing highly stressful, well remembered dreams that result in awakening from sleep and difficulty returning to sleep which is consistent with nightmare disorder [8,10]. Survivors may also report constant re-living of the traumatic event, hyperarousal, negative affect symptoms, and avoidance of remembering the traumatic event. This cluster of symptoms is referred to as post-traumatic stress disorder (PTSD) [8]. The co-occurrence of insomnia, nightmares, and PTSD potentially complicate psychological treatment, leading to increased depression, anxiety, stress, reduced daily functioning, and poor quality of life. Studies show that the presence of sleep disturbances in those who experience trauma, exacerbates and maintains PTSD, and hinders recovery [11–14].

The relationship between sleep disturbances and PTSD symptoms

The literature is inconclusive on whether sleep disturbances lead to the development of PTSD or whether PTSD leads to sleep disturbances. Whilst some researchers suggest a bi-directional relationship between the two [11,15], experimental animal designs, current theoretical models, and intervention studies suggest that sleep disturbances possibly precede the development of PTSD [12,16–22]. Historically, insomnia and nightmares occurring in the context of PTSD disorder, have always been

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Wings to the Research

Review Article

Assessment of the Effectiveness of Online and Face-to-Face Cognitive Behavioural Therapy for Insomnia/ Nightmares in Adults Exposed to Trauma Using Self-Report and Objective Measures: Preliminary Findings

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Abstract

Online therapies are gaining rapid attention since the COVID-19 pandemic. The ever-evolving way of living during the pandemic changed our health system and the way therapies are delivered and received. Online Cognitive Behavioural Therapy (CBT) has been shown to be as effective as face-to-face therapies in treating insomnia and/or nightmares in adults presenting with trauma symptoms. This review assessed the efficacy of online CBT for the treatment of insomnia in comparison to face-to-face CBT using self-report and objective measures of sleep such as actigraphy. A literature search on the following databases was carried out: PubMed, MEDLINE, PsychINFO, Scopus, CINAHL, EMBASE, Cochrane Library, EBSCO and Taylor & Francis between January 1990 and January of 2022. Two studies met the inclusion criteria. Findings from this review showed that both online and face-to-face CBT were effective treatments of insomnia, with face-to-face outperforming online CBT in adults with trauma symptoms using sleep diaries. However, findings from actigraphy were not consistent with self-report measures. Further studies that assess and compare online and face-to-face psychological treatments for the treatment of insomnia/nightmares in those presenting with trauma symptoms are needed.

Keywords: Insomnia; Nightmares; Trauma; CBT; Objective; Self-report; Measures

Abbreviations: CBT-I: Cognitive Behavioural Therapy for Insomnia; PSG: Polysomnography; RCT: Randomised Controlled Trials; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines; PICO: Population, Intervention, Comparison, Outcome; PCBT-I=Professional Cognitive Behavioural Therapy for Insomnia; VCBT-I=Video Cognitive Behavioural Therapy for Insomnia; ISI=Insomnia Severity Index; ESS=The Epworth Sleepiness Scale; DBAS=The Dysfunctional Beliefs and Attitudes about Sleep

Introduction

Sleep disorders including insomnia and nightmares are the most predominant sleep complaints reported by people exposed to trauma [1]. Research shows that both insomnia and nightmares continue to be prevalent even after successful treatment of trauma (77% and 52% respectively) [2,3]. Notably, the presence of sleep difficulties act as antecedents to the development of certain psychiatric conditions including Post-Traumatic Stress Disorder [PTSD] [4-6]. Moreover, treating sleep disturbances in those presenting with trauma, leads to reduction of symptoms for both sleep disorders and related trauma symptoms [6-10]. Therefore, it follows that the focus of future research should be on treating sleep disturbances in

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Systematic Review

A Systematic Review of the Impact of Wildfires on Sleep Disturbances

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Abstract: Wildfires present a serious risk to humans as well as to the environment. Wildfires cause loss of lives, economic losses, expose people to personal as well as collective trauma, and compromise the mental health of survivors. Sleep disturbances are highly prevalent following a traumatic event; however, their prevalence is not well established amongst those confronted by natural disasters such as wildfires. The aim of this systematic review is to synthesise the empirical findings pertaining to wildfires and the prevalence of sleep disturbances in the general community affected by this natural disaster. We searched EBSCO, PsychINFO, Medline, SpringerLink, CINAHL Complete, EMBASE, PubMed, Scopus and Cochrane Library between January 2012 and March 2021. Five studies met the inclusion criteria. Findings from this systematic review suggest that sleep disturbances, assessed one to ten months following the fires, are highly prevalent in wildfire survivors, with insomnia (ranging between 63–72.5%) and nightmares (ranging between 33.3–46.5%), being the most prevalent sleep disturbances reported in this cohort. Results also highlight the significant associations between sleep disturbances and post-traumatic symptoms following the trauma of wildfires. There is a possible link between sleep disturbance prevalence, severity of, and proximity to fires.

Keywords: bushfires; sleep disturbances; trauma; psychopathology; bushfire survivors

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1. Introduction

Climate change is posing serious threats to humans and the environment and may be increasing the frequency and intensity of droughts, floods, tornadoes, hurricanes, wildfires, and other extreme weather events. Such weather-related events cause human fatalities, loss of property, massive disruption to infrastructure, economic losses, displacement of those impacted, and negative physical and mental health sequalae [1–3].

Wildfires are natural phenomena that deleteriously affect most continents around the world including: Australia, Europe, Asia, and North and South America [4–7]. In Australia, approximately 20 million hectares were burnt and more than 3000 homes were destroyed in the 2019 summer fires [8]. In the USA, wildfires pose a similar risk to the economy with an annual average loss of $2677 million (USD) [9]. Wildfires also result in injury and the loss of many human lives. Data extracted from the Emergency Event Database shows that fires contributed to the loss of 3753 lives between the year 1901 and 2014, and a further six million peoples' lives were negatively affected between 1984 and 2013 globally as a result of fires [9].

In addition to injury, loss of lives and economic losses, trauma resulting from wildfires causes disruption to community cohesion and people's sense of belonging, safety, and wellbeing [10]. Collective trauma takes place when a traumatic event damages the ties that bind community members together and shatters the social fabric of society [11,12]. Hirschberger refers to collective trauma as a loss of identity, affirming that the collective

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Article

Differences in Anxiety, Insomnia, and Trauma Symptoms in Wildfire Survivors from Australia, Canada, and the United States of America

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Abstract: Many survivors of wildfires report elevated levels of psychological distress following the trauma of wildfires. However, there is only limited research on the effects of wildfires on mental health. This study examined differences in anxiety, depression, insomnia, sleep quality, nightmares, and post-traumatic stress disorder (PTSD) symptoms following wildfires in Australia, Canada, and the United States of America (USA). One hundred and twenty-six participants from Australia, Canada, and the USA completed an online survey. The sample included 102 (81%) women, 23 (18.3%) men, and one non-binary (0.8%) individual. Participants were aged between 20 and 92 years (*M* age = 52 years, *SD* = 14.4). They completed a demographic questionnaire, the Disturbing Dream and Nightmare Severity Index (DDNSI), Generalized Anxiety Disorder Questionnaire (GAD-7), the Insomnia Severity Index (ISI), Patient Health Questionnaire (PHQ-9), the Pittsburgh Sleep Quality Index (PSQI), and PTSD Checklist (PCL-5). Results showed that participants from the USA scored significantly higher on the GAD-7 ($p = 0.009$), ISI ($p = 0.003$), and PCL-5 ($p = 0.021$) than participants from Australia and Canada. The current findings suggest a need for more international collaboration to reduce the severity of mental health conditions in Australia, Canada, and the USA.

Keywords: depression; anxiety; PTSD; nightmares; insomnia; sleep quality; wildfires; survivors; USA; Canada; Australia

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1. Introduction

Wildfires are vital events for many ecosystems in preserving species that respond to fires, stimulating seed germination and growth of native vegetation, helping to eliminate competition from invasive weeds, and eradicating diseases and insects that cause harm to older plants and vegetation [1–3]. However, when wildfires spread rapidly with great intensity and force, they annihilate forests, wildlife, and entire communities. This decade has witnessed unparalleled numbers of wildfires affecting the globe including; the Arctic, the United States of America (USA), Canada, parts of Europe, and Australia [4–6].

In Australia, the 2019–2020 Black Summer fires resulted in the burning of more than 24 million hectares of land, destroyed 3000 homes, and killed 33 people [7,8]. Similarly, in 2018, British Columbia/Canada was hit by the worst wave of wildfires in the region's recorded history, leading to the destruction of 1.35 million hectares of land, destroying 2211 properties, and USD 615 million was spent to fight the fires [5]. Furthermore, The August Complex Fires in the USA in 2020 were labeled the largest wildfires that the

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Cognitive behavioral therapy-based treatments for insomnia and nightmares in adults with trauma symptoms: a systematic review

Fadia Isaac[1] · Samia R. Toukhsati[1] · Mirella DiBenedetto[2] · Gerard A. Kennedy[1,3,4]

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Introduction

Post-Traumatic Stress Disorder (PTSD) is one of the most frequently reported psychopathological conditions following trauma. PTSD occurs in people who experience and/or witness, either directly or vicariously traumatic events such as accidents, natural disasters and personal assaults (APA, 2013). Depending on the country of residence and social background, the lifetime prevalence of PTSD ranges from 1.3 to 12.2%, (Karam et al., 2014). PTSD leads to several negative physical, psychological and social sequelae. These include but are not limited to physical pain, gastrointestinal and cardio-respiratory issues, anxiety, depression, premature death, onset of Type 2 diabetes, drug and alcohol use, reduced occupational capacity and loss of important personal relationships (Pacella et al., 2013; Pietrzak et al., 2011; Schlenger et al., 2015; Shalev et al., 2017; Vogt et al., 2016).

Insomnia and nightmares are the most prevalent sleep disturbances reported by people with PTSD (Buysse et al., 2006; Pruiksma et al., 2016). Studies show that 70% to 91% of people with PTSD have difficulty initiating sleep, staying asleep, and may experience chronic nightmares (Neylan et al., 1998; Ohayon & Shapiro, 2000). Notably, insomnia and nightmares are the most frequently reported residual health problems following a successful resolution of PTSD treatment with psychological interventions (Pruiksma et al., 2016).

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In a sample of 108 US military veterans receiving psychological treatment for PTSD, insomnia and nightmares were highly prevalent at baseline (92% and 69%, respectively), and remained high following psychological treatment (77% and 52%, respectively) (Pruiksma et al., 2016). A recent clinical trial by Taylor and colleagues (Taylor et al., 2020) showed that both insomnia and nightmares remained in the clinically significant range following a prolonged exposure therapy treatment for PTSD even among those who achieved remission of PTSD.

Theoretical framework

Youngren and colleagues (Youngren et al., 2020) proposed a Nightmare Cognitive Arousal Processing (Night-CAP) model that explains how the presence of sleep difficulties predict the development of PTSD. More specifically, pre-sleep cognitive arousal, worry and rumination, and sleep latency predict the occurrence of post-traumatic nightmares. When levels of sleep latency and pre-sleep cognitive arousal are high, an individual is at an increased risk of developing/experiencing post-traumatic nightmares (Youngren et al., 2020). The Night-CAP model suggests that rumination provides the right opportunity for longer period of rehearsing of negative cognitions about the actual trauma priming the content of nightmares that replay during sleep.

Similarly, the longer an individual spends in waking-state wanting to fall asleep the more pressure to fall asleep leading to rapid eye movement (REM-sleep stage) rebound and more prompt entry into REM sleep. Dreams are more likely to take place during REM; providing a rationale as to why sleep latency leads to more post-trauma nightmares (Youngren et al., 2020). The presence of trauma related nightmares, pre-sleep cognitive hyperarousal and sleep latency will increase vulnerability to the development of PTSD (Agorastos, et al., 2014; Youngren et al., 2020).

Even though the Night-CAP model provides a framework of how an individual is at increased risk of

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Pre-existing depression, anxiety and trauma as risk factors for the development of post-traumatic stress disorder symptoms following wildfires

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ABSTRACT

The trauma of wildfires leads to one of the most challenging and treatment resistant mental health conditions-namely-post-traumatic stress disorder (PTSD). Research addressing the contribution of pre-existing mental health conditions to the development of PTSD symptoms following traumatization by wildfires is limited. This study examined whether people with pre-existing diagnoses of anxiety, depression, PTSD, insomnia and nightmares, by a mental health professional, are more likely to develop symptoms of PTSD than those with no previous diagnosis following the trauma of wildfires. A total of 126 wildfire survivors from Australia, Canada and the United States of America completed an online survey. An independent sample *t-tests* revealed that pre-existing diagnosed conditions of depression, an anxiety disorder and PTSD significantly increased the likelihood of developing PTSD symptoms following traumatization by wildfires ($t = -2.51$, $p = 0.014$, 95% CI [-18.91 to −2.20], $t = -2.61$, $p = 0.01$, 95% CI [-18.91 to −2.57], $t = -2.57$, $p = 0.012$, 95% CI [-22.36 to −2.87] respectively). Practitioners working in communities subjected to wildfires need to run a thorough screening of their patients' pre-existing mental health conditions to provide the right treatment and referral pathways to those affected by the trauma of wildfires.

1. Introduction

There has been a tenfold increase in natural disasters since 1960, with a further predicted and inevitable increase over the next two decades (The Royal Commission, 2020; Vision of Humanity, 2020). Wildfires severely and negatively impact infrastructure, agriculture, forestry and wildlife, and have deleterious effects on people's lives (The Royal Commission, 2020). More specifically, the impact of fires on mental health is palpable, with many survivors reporting multiple mental health conditions following wildfires such as depression, anxiety, alcohol and substance use, sleep difficulties, and post-traumatic stress disorder (PTSD) (Bryant et al., 2014; Isaac et al., 2023; To et al., 2021).

The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) defines PTSD as any event that involves exposure to and/or witnessing a life-threatening event where a person's life and/or their physical integrity is severely threatened leading to physical and/or psychological injuries (APA, 2013). Reactions during traumatic events include but are not limited to extreme fear, horror and feeling of helplessness. A diagnosis of PTSD is warranted if the following symptoms are present: (1) re-experiencing or reliving the traumatic event; (2) deliberate avoidance of cues or stimuli associated with the traumatic event and emotional numbness; and (3) prominent arousal state. The symptoms must be present for at least one month and must lead to significant disruptions in daily functioning (APA, 2013).

Post-traumatic stress disorder is highly prevalent in wildfire

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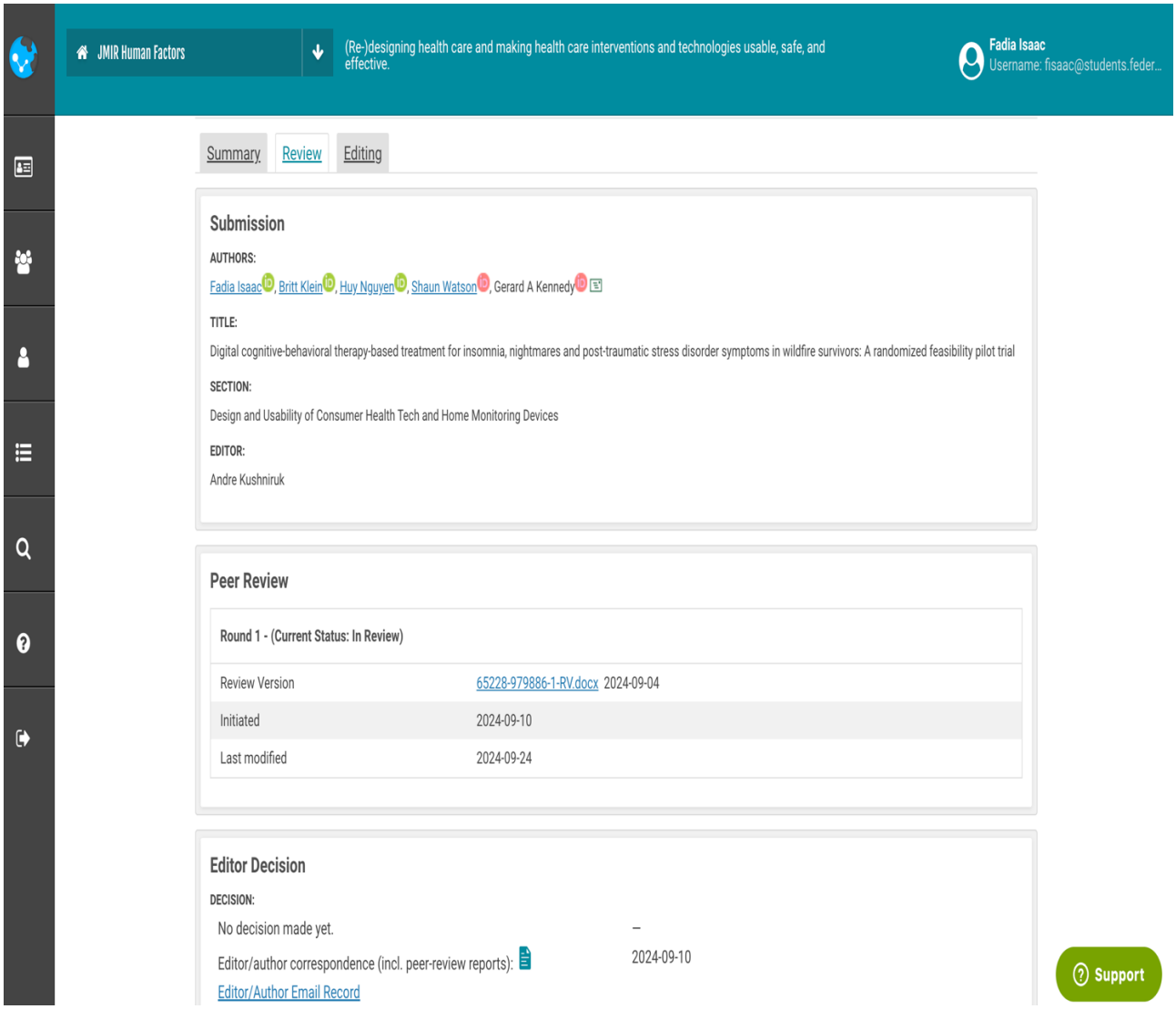
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Appendix P

Links to Sleep Best-i's Modules

Module 1
https://youtu.be/4R6u4uP5De4

Module 2-part 1

https://www.youtube.com/watch?v=8ujFi-sgjZ4

Module 2-part 2

https://www.youtube.com/watch?v=Y7obiP7Eeu4

Module 3

https://www.youtube.com/watch?v=aA_AAigtikI

Module 4

https://youtu.be/6N7aCc1_dKE

Module 5

https://youtu.be/OrA7_pbyw_o

Mindfulness

https://www.youtube.com/watch?v=iN_aSJk3iTY