Positive Psychological Traits Predict and Facilitate Good Sleep Quality and Quantity

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Thesis Submitted for the Degree of Doctor of Philosophy

January 2023

Declaration

This thesis conforms to a “papers style” format in which the middle chapters consist of discrete articles written in a style that is appropriate for publication in peer-reviewed journals in the field. The first and final chapters present synthetic overviews and discussions of the field and the research undertaken.

Chapter 2 presents a cross-sectional study written in a style suitable for submission to *The Journal of Health Psychology*. (*Note:* The cross-sectional study presented in Chapter 2 was later combined with an earlier cross-sectional study conducted as part of a dissertation project by the author of this thesis and comprises Study 2 of the two-part paper, entitled: “Tout. A. F., Jessop, D. C., & Miles, E. (2023b). Investigating the combined and unique contributions of positive psychological traits to sleep and exploring emotion regulation as a common mediator”. The two-part paper is written in a style suitable for submission to *Psychology and Health* and is available in Appendix B; Tout et al., 2023b).

The author contributions for the cross-sectional study presented in Chapter 2 of this thesis are as follows: Amber Tout was responsible for all of the data collection, data analysis and writing up of the manuscript. Donna Jessop and Eleanor Miles were responsible for providing feedback on study design and corrections to the manuscript. Amber Tout and Donna Jessop were jointly responsible for the initial conception of the research.

Chapter 3 presents a prospective study written in a style suitable for submission to *Health Psychology*.

The author contributions for the prospective study in Chapter 3 are as follows: Amber Tout was responsible for all of the data collection, data analysis and writing up of the manuscript. Donna Jessop and Eleanor Miles were responsible for providing feedback on study design and corrections to the manuscript. Amber Tout and Donna Jessop were jointly responsible for the initial conception of the research.

Chapter 4 (and Appendix A) presents a systematic scoping review and meta-analysis written in a style suitable for submission to *The Annals of Behavioural Medicine.*

The author contributions for the systematic scoping review and meta-analysis presented in Chapter 4 (and Appendix A) are as follows: Amber Tout was responsible for all of the data collection, data analysis and writing up of the manuscript. Donna Jessop and Eleanor Miles were responsible for providing feedback on study design and corrections to the manuscript. Amber Tout was responsible for the initial conception of the research.

Chapter 5 presents an intervention study written in a style suitable for submission to *The Journal of Health Psychology.*

The author contributions for the intervention study presented in Chapter 5 are as follows: Amber Tout was responsible for all of the data collection, data analysis and writing up of the manuscript. Donna Jessop and Eleanor Miles were responsible for providing feedback on study design and corrections to the manuscript. Amber Tout was responsible for the initial conception of the research.

I hereby declare that this thesis has not been, and will not be, submitted in whole or in part to another University for the award of any other degree. However, Appendix B (Tout et al., 2023b, Study 1 only) incorporates material submitted as part of required coursework for the degree of: *MSc Cognitive Neuroscience*, awarded to the author of this thesis (Amber Tout) by the *University of Sussex* in 2019.

Signature…………………………………

Acknowledgements

Firstly, I would like to express my deepest and most heartfelt gratitude to my supervisors, Drs Donna Jessop and Eleanor Miles. I am exceptionally thankful to you both for your unwavering support and encouragement, as well as the sheer amount of time and effort you have dedicated to providing me with expert advice and feedback throughout this project. I would also like to thank you both for the compassion you have shown me at a personal level – without you, I would not have had the confidence or the calmness of mind to complete such a huge undertaking given all the social, political, economic and personal disasters that have occurred during this time.

I would also like to thank the many colleagues, friends and family members who have helped to support me throughout my PhD. You have provided me with the confidence to believe in the importance of my work as well as the motivation to keep going. Your questions, insights and suggestions have been invaluable. Thank you for sticking by me despite the fact I have been glued to my laptop for the last three years, I hope to emerge very soon.

Last, but not least, I would like to acknowledge the humble Buddhist philosophers who recognised the importance of all this centuries ago – thankfully, the Western world is finally catching on.

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SUMMARY

Sleep is essential to the maintenance of good health and wellbeing; however, surprisingly little is known about the positive antecedents of this crucial health-related behaviour. By adopting a positive psychological approach to sleep, this thesis aims to consolidate, integrate and extend the current literature by determining the collective and relative contributions of four positive psychological traits (mindfulness, self-compassion, gratitude and optimism) to overall sleep quality and quantity, cross-sectionally and prospectively. Within both cross-sectional and prospective studies, this thesis also explores the role of emotion regulation as a potential common mediator of the relationships between each of the aforementioned positive traits and sleep, in an attempt to determine whether these relationships can be situated within a broader, common framework. Based on the finding that optimism consistently emerged as a significant linear predictor of sleep in its own right, this thesis lastly presents the results of an experimental study that explored whether a brief optimism intervention might improve overall sleep quality and quantity within a student sample. Taken together, findings not only highlight the importance of considering positive traits when it comes to explaining variation in sleep outcomes and facilitating future sleep quality and quantity, but also provide interesting implications for theory and echo recent calls for new and integrative positive psychological approaches to sleep medicine.

If sleep does not serve an absolutely vital function, then it is the greatest mistake evolution ever made.

– Allan Rechtschaffen, 1978

Sleep scientists, for all their advances, remain in the awkward position of not knowing why we sleep. An analogous situation in the sciences is difficult to find.

– Marcos Frank, Reviews in the Neurosciences, 2006

Scientists have discovered a revolutionary new treatment that makes you live longer. It enhances your memory and makes you more creative. It makes you look more attractive. It keeps you slim and lowers food cravings. It protects you from cancer and dementia. It wards off colds and the flu. It lowers your risk of heart attacks and stroke, not to mention diabetes. You'll even feel happier, less depressed, and less anxious. Are you interested?

– Matthew Walker, Why We Sleep, 2017

CHAPTER 1 – INTRODUCTION

1.1 Sleep

1.1.1 The Importance of Sleep

The importance of sleep cannot be overstated; however, it is only within recent decades that research has stopped viewing sleep as a mere cure for sleepiness and has instead recognised sleep as a vital biological state, essential to the maintenance of good physical health and psychological functioning (Grandner, 2017a; 2019; Walker, 2021). Indeed, despite being hallmarked by long periods of behavioural inactivity, sleep involves a highly complex interaction of neurological systems and physiological processes (see McNamara, 2019, for a review), without which, periods of wakefulness would become highly compromised and dysregulated.

While research is yet to elucidate all functions, sleep is known to remove the accumulation of metabolic waste products associated with neurodegeneration from the brain (Boespflug & Iliff, 2018; Mander et al., 2016); facilitate learning and memory by helping to sort, refine and strengthen neural connections, while forming creative new links between previously dissociated ideas (MacDonald & Cote, 2021); and 'decouple' memories from their associated emotional tone, thus enabling events to be recalled without the same level of emotional intensity that may have occurred upon their initial encoding (Ben Simon et al., 2020; Walker & van Der Helm, 2009). As well as helping to regulate and restore emotional balance, sleep is also essential for the regulation of our hormonal systems, and therefore supports reproductive health (Lateef & Akintubosun, 2020), metabolism, appetite and blood-sugar regulation (Morselli et al., 2012), immunity (Irwin, 2015) and the stress response (van Dalfsen et al., 2018).

Perhaps the clearest way to exemplify the importance of good quality and quantity sleep, however, comes from an observation of the consequences that occur when we do not get enough of it. Indeed, compared to individuals who get the recommended 7–9 hours of sleep per night, those who get less than 7 hours are at an increased risk of a variety of negative physical and mental health outcomes, including premature mortality (see Cappuccio et al., 2010a; Chattu et al., 2019, Grandner, 2019 and Krause et al., 2017, for reviews). When it comes to cardiovascular and cardiometabolic health, for instance, poor sleep has been linked to increased risk of coronary heart disease (Yang et al., 2015), stroke (Koo et al., 2018), inflammation (Patel et al., 2009), hypertension (Meng et al., 2013), insulin resistance (Knutson et al., 2007), diabetes (Barone et al., 2011; Cappuccio et al., 2010b; Lee et al., 2017) and obesity (Grandner, 2017b; Li et al., 2017). Even short-term sleep loss can have striking effects on cardiovascular health, as observed during Daylight Savings Time, wherein the hour of lost sleep in the spring sees an associated 24% increase in hospital admissions for heart attacks the following week, while the added hour in autumn sees a comparable 21% reduction (Sandhu et al., 2014). Poor sleep also compromises immune function and reduces the effectiveness of vaccines, thus leaving us more susceptible to viruses (Besedovsky et al., 2019; Irwin, 2015); increases the risk of cancer, with The International Agency for Research into Cancer listing night shift work as a probable carcinogen (Ward et al., 2019); and contributes to the onset of neurodegenerative diseases such as Alzheimer's Disease and other dementias (Mander et al., 2016; Xu et al., 2020).

When it comes to cognitive functioning, poor sleep can have effects akin to that of alcohol intoxication, wherein vigilant attention is blunted, working-memory is compromised, and problem-solving abilities suffer (Tubbs & Grandner, 2021; Wild et al., 2018). In a global study of 10,000 participants, Wild et al., (2018) explored associations between natural sleep duration and cognitive ability through a series of 12 standardised tests, finding that individuals who slept for 4-hours per night exhibited cognitive deficits equivalent to that of aging eight years. Social and emotional functioning are also compromised by poor sleep (Beattie et al., 2015), with sleep loss hindering our ability to recognise facial expressions and social cues (van Der Helm et al., 2010). More serious and prolonged sleep deprivation can even make us more aggressive, impulsive and violent (Kamphuis et al., 2012). Effects on mental health outcomes can also be severe, with disturbances in sleep quality and quantity known to precipitate, contribute to and/or manifest as a symptom of all psychiatric illnesses and mood disorders, including: anxiety and depression (Chapman et al., 2013; Ferre Navarrete et al., 2017; Rumble et al., 2015), schizophrenia, bi-polar disorder, borderline personality disorder and post-partum depression (Faulkner & Bee, 2016), post-traumatic stress disorder (McLay et al, 2010), and even, suicidality (Betts et al., 2013; Littlewood et al., 2016; Koyawala et al., 2015).

Insufficient quality and quantity sleep can also have a negative impact on other health-related behaviours, such as diet and exercise (Wickham et al., 2020), and makes us more inclined to select and overindulge in unhealthy foods (Lundahl & Nelson, 2015), while decreasing our desire and ability to engage in high-quality exercise (Holfeld & Ruthig, 2014). Unsurprisingly, the direct and indirect consequences of poor sleep also put a huge level of strain on the economy in terms of associated health costs, hours of lost work and accidents in the workplace (Chattu et al., 2019; Hafner et al., 2017; Rosekind, 2005; Rosekind et al., 2010). In the United

Kingdom, for instance, insufficient sleep is estimated to account for almost 1.7 million hours of lost work per year, with an associated cost of $50 billion (1.89% of Gross Domestic Product; GDP; Hafner, 2017). Similarly high and relatively proportionate figures are also observed in the United States, Japan, Germany and Canada, with the United States losing an estimated 9.9 million hours of work and $411 billion in costs annually (2.28% of GDP; Hafner, 2017). Poor sleep is equally problematic for those still in education and has been associated with poorer health and academic performance as well as increased risk of mood disorders, suicidal ideation and drowsy driving-related accidents, with early school start times doing nothing to accommodate the needs of the developing brain (Owens et al., 2014; Owen & Weiss, 2017).

1.1.2 The Sleep Loss Epidemic

With the importance of good sleep becoming increasingly evident, reports of declining sleep quality and quantity across nations and age-groups present a significant concern for public health (Chattu et al., 2019; Keyes, 2015; Kocevska et al., 2021; Tubbs & Grandner, 2021). Indeed, when it comes to sleep duration, findings from around the globe suggest that approximately one third of adults do not get the recommended 7–9 hours of sleep per night (Beck et al., 2013; Liu et al., 2016; Soldatos et al., 2005; Steptoe et al., 2006; Wild et al., 2018). The situation may be even more problematic for those in younger age brackets, where sleep duration has declined over the last twenty years (Keyes et al., 2015), and one half of teenagers currently report getting less than their recommended 8–10 hours of sleep per night (Kocevska et al., 2021; Matricciani et al., 2012; Owens et al., 2014). Thus, it is not surprising that some researchers have now declared sleep loss to be a "public health epidemic" (Chattu et al., 2019).

In addition to reports of declining sleep duration, the prevalence of sleep disturbances and insomnia – the subjective inability to get to sleep and/or stay asleep despite the adequate opportunity to do so (Edinger et al., 2021a) – have also increased. It is currently estimated that around 35–50% of the population in the United States experience short-term insomnia, while 5-15% suffer from more chronic forms (Edinger et al., 2021a; 2021b; Ohayon, 2002). Similarly high rates of sleep disturbance and insomnia symptomology have also been observed in European samples (Beck et al., 2013; Siversten et al., 2019; Ohayon, 2002; Morin et al., 2006a), with one Norwegian study finding a 10% increase in the prevalence of sleep problems between the years 2010 and 2018 (Siversten et al., 2019). Reports of sleep disturbance are also apparent in non-Western societies; for instance, a recent meta-analysis concluded that 20% of Chinese university students report dissatisfaction with their sleep quality, while 26% report sleep disturbances and 24% suffer from insomnia symptoms (Li et al., 2018).

Alongside declining sleep duration and increasing reports of sleep disturbances and insomnia, levels of excessive daytime sleepiness and fatigue are also high, with many individuals unable to maintain their desired levels of wakefulness throughout the day (Jaussent et al., 2014; Young, 2004). Thus, not only does insufficient sleep quality and quantity pose a direct risk to the physical health and psychological functioning of the individual, but the cognitive deficits associated with excessive daytime sleepiness also pose a risk to the safety of those around them (Wild et al., 2018); drowsy driving, for instance, has been estimated to increase the risk of car accidents by as much as 34% (Moradi et al., 2019).

1.1.3 Current Sleep Interventions and Their Associated Limitations

Given the importance of good sleep and the high levels of insufficient sleep quality and quantity currently afflicting society, the need for simple, inexpensive and self-administrable solutions to sleep problems is clear. However, current intervention options for sleep remain few in number and are subject to a host of limitations. The following provides a brief discussion of the most commonly used treatments in general practice and their associated limits.

1.1.3a Pharmacological Treatments

As previously stated, sleep is a highly complex process, involving multiple brain regions and a finely tuned pattern of neurotransmitter (in)activity, the full extent of which is yet to be realised (see McNamara, 2019, for a review). Thus, it is not surprising that, currently, no known pharmacological treatment successfully induces and/or mimics the profile of naturalistic sleep (Cacho & Lum, 2021; Walker, 2017). While providing some form of sedation and inducing the behavioural signs of sleep, there is increasing evidence to suggest that sedative medications alter normal sleep architecture and patterns of (in)activity in the brain – the long-term effects of which remain unclear (Pagel & Parnes, 2001). Sleep medications may therefore disrupt the usual function(s) of sleep and prevent the associated benefits to health and wellbeing.

Indeed, rather than promoting memory, alertness and good physical health, the prolonged use of sedative sleep medications (such as benzodiazepines and

‘Z-drugs’) has been linked to increased risk of excessive daytime sleepiness, falls, fractures, driving accidents, cognitive decline, dementia, cancer, and even death (Glass et al., 2005; Pottie et al., 2018; Schroeck et al., 2016). Long-term reliance on sleep medications can also result in issues of tolerance, dependency and addiction, making their use difficult to terminate, while doing very little to increase an individual’s self-efficacy for sleep in the meantime (Glass et al., 2005; Pottie et al., 2018; Schroeck et al., 2016). Side effects can also be problematic, and range from drowsiness, dizziness and difficulty concentrating, to gastrointestinal issues, psychiatric problems and further sleep disorders (Fitzgerald & Vietri, 2015; Glass et al., 2005; Pottie et al., 2018; Schroeck et al., 2016). In some cases, sleep medications can reduce an individual’s quality of life to a greater extent than the sleep problem(s) they were intended to treat, particularly in the case of older adults where the costs are suggested to outweigh the benefits entirely (Fitzgerald & Vietri, 2015; Glass et al., 2005).

In light of the above, it is not surprising that clinical practice guidelines have now suggested deprescribing certain sleep medications altogether and recommend non-pharmacological forms of treatment such as cognitive behavioural therapy for insomnia (CBT-I) in the first instance (Edinger et al., 2021b; Qaseem et al., 2016). Despite this, sleep medications remain one of the most frequently used methods of treating sleep problems in general practice, with their continued use facilitated by the strains of an under-resourced healthcare system, insufficient sleep education for general practitioners, and the desire for a quick fix (Everitt et al., 2014).

1.1.3b Cognitive Behavioural Therapy for Insomnia (CBT-I)

Cognitive behavioural therapy for insomnia (CBT-I) is the leading non-pharmacological intervention for sleep problems, with increasing evidence in support of its effectiveness (Maurer & Dedhia, 2021). Recommended as the first line of treatment by the American Academy of Sleep Medicine, the Australian Sleep Association and the British Association of Pharmacology (Edinger et al., 2021a; 2021b), CBT-I aims to identify and treat the underlying cause(s) of insomnia by addressing the dysfunctional thoughts and behaviours that interfere with healthy sleep, breaking down associations between the bed and worry, and employing sleep restriction techniques in an effort to increase sleep drive (Maurer & Dedhia, 2021). Meta-analyses have provided evidence for the effectiveness of CBT-I, wherein sleep outcomes have been demonstrated to improve by around 64%–70% and the time taken to fall asleep is reduced by approximately 30-minutes (Morin et al., 2006b; Trauer et al., 2015). CBT-I has also proven to be equivalent to sleep medications in the short-term, and shows superior effects in the long-term, with benefits persisting up to 12-months (Schroeck et al., 2016).

However, while CBT-I can be effective and increase an individual's self-efficacy for sleep without the harmful side effects of sedative medications, the significant amount of time and effort required (4–10 sessions with a specialist) can make it unsuitable for some individuals (Koffel et al., 2018). Although, it should be noted that some studies have found single sessions of CBT-I to be effective in some instances (Ellis, Cushing & Germain, 2005). CBT-I can also be difficult to access due to a lack of available specialists, as well as a lack of sleep knowledge and confidence on the part of general practitioners, who are more likely to prescribe medications and sleep hygiene advice as a result (Everitt et al., 2014; Koffel et al., 2018; Thomas et al., 2016); however, the increasing availability of digital technologies is starting to address certain accessibility issues (Wickwire, 2019). Additionally, individuals with subclinical sleep problems may not require such intensive options, and often struggle to cope alone due to a lack of alternative non-pharmacological solutions and the desire to avoid medications (Koffel et al., 2018).

1.1.3c Sleep Hygiene

Sleep hygiene refers to a series of recommended behavioural changes that can help to cultivate a supportive sleep environment (see Patel, 2021, for a review). Common sleep hygiene suggestions include the avoidance of sleep-impairing substances such as alcohol, tobacco and caffeine; ensuring the bedroom is kept cool, dark and quiet; engaging in passive and/or relaxing activities before bed (i.e., reading, television, yoga) while avoiding stimulating activities and stress (i.e., emails, social media, messages); and keeping a regular sleep schedule (Irish et al., 2015; Owens et al., 2014; Patel, 2021; Stepanski & Wyatt, 2003).

While these tips may help to support healthy sleeping conditions, sleep hygiene is not successful as a standalone treatment and is not recommended as a single-component therapy for sleep problems (Edinger et al., 2021b). Despite this, general practitioners are likely to hand out sleep hygiene information to individuals presenting with sleep problems in the first instance (Everitt et al., 2014; Maurer & Dedhia, 2021). Unfortunately, by the time an individual seeks advice from a medical practitioner, they are likely to have attempted such lifestyle changes already, meaning the reiterated emphasis on sleep hygiene could be unhelpful and run the risk of implying that continued sleep problems are the result of an individual's own behaviour(s) and/or inadequate attempts to follow advice (Smith, 2022). The term 'hygiene' is also unhelpful in itself and introduces a false sense of morality to sleep problems – i.e., clean vs. dirty sleep/ers (Smith, 2022). Strict instructions to reduce and avoid multiple substances and behaviours are also not in-keeping with the realities of life and can leave an individual feeling as if their sleep problems are impacting their usual waking activities and sense of enjoyment (Irish et al., 2015). Indeed, while emphasising the reduction of multiple sleep-impairing factors, avoiding stress is not always within the control of the individual, and sleep hygiene advice could therefore be considered vague and unhelpful when it comes to equipping individuals with the psychological means to cope (Irish et al., 2015).

1.1.4 The Need for New Approaches to Current Sleep Problems

In light of the above, it is clear that current sleep intervention options remain limited, especially for those with subclinical sleep problems who may wish to avoid sleep medications, may not require intensive treatments like CBT-I, and may already be employing general sleep hygiene practices. As a result, further research is needed to seek and identify novel, sleep-promoting solutions that can be made widely available to the general population while avoiding the limitations of current treatments. Encouragingly, calls for new and integrative approaches to sleep medicine have started to identify new targets for intervention (see Cacho & Lim, 2021, for a review), with positive psychological approaches suggested to be one particularly promising avenue for future exploration (Wickwire, 2021).

Unlike other treatments, positive psychological approaches to intervention could provide a relatively easy, inexpensive and self-efficacious means to improve sleep in the general population, by helping to increase positive emotions, foster resilience and buffer the impact of negative emotions and cognitions on sleep (Wickwire, 2021). Despite this, positive sleep research remains in its infancy due to a focus on the alleviation of disorder and the avoidance of negative, sleep-impairing substances, as opposed to the identification of positive sleep antecedents and attempts to promote them (Wickwire, 2021). The following section therefore begins by outlining an outdated disease model of health and emphasises the need to apply positive approaches to sleep research, before going on to introduce four positive psychological traits (mindfulness, self-compassion, gratitude, optimism) that have been linked to better sleep outcomes in the literature to date. Here, it is important to note that while positive approaches may help to tackle subclinical sleep complaints and symptoms of insomnia by reducing sleep-impairing cognitive-emotional processes, sleep disorders with other causal underpinnings (i.e., blocked airway passages in the case of obstructive sleep apnoea) are likely to require alternative treatments as appropriate (i.e., continuous positive airway pressure machines). Thus, references to poor sleep quality and quantity throughout this thesis should be understood as references to subclinical sleep complaints and symptoms of insomnia.

1.2 Towards a Positive Psychology of Sleep

1.2.1 The Need for Positive Psychological Approaches to Health

Current approaches to health research have been dominated by a medical model that defines human health as the absence of illness, disorder and disease (Seligman & Csikszentmihalyi, 2000). Indeed, despite the World Health Organisation recognising health as "…a state of complete positive physical, mental and social wellbeing and not merely the absence of disease or infirmity." (WHO, 1948), after World War II, research refocused on naming, diagnosing and treating disorders; identifying and reducing the negative effects of environmental stressors; and repairing damaged brains, bodies and behaviours (Seligman & Csikszentmihalyi, 2000). While this approach has undoubtedly helped to diagnose *disorder* and alleviate aspects of physical and mental *illness*, the importance of *good* subjective wellbeing, *positive* individual traits, and factors relating to the cultivation of *happy* and *healthy* societies has remained comparatively overlooked until more recently (Seligman & Csikszentmihalyi, 2000; Schmidt et al., 2011; Rusk & Waters, 2013).

To demonstrate the neglect of positive factors in health research, a content analysis conducted across three leading health psychology journals reported that between the year of their conception and 2008, only 3% of all articles had an explicit focus on a positive construct (i.e., wellbeing, positive affect, optimism) in relation to a health outcome, with most of those occurring in the context of reducing ill-health and problematic health behaviours (Schmidt et al, 2011). As a result, the authors emphasised the need for research to begin pushing "…beyond defining health and happiness as the absence of disorder and disability…" and begin exploring this "…entire pool of positive constructs…virtually untapped by research…" in an effort to "…determine which relate most significantly to optimising health." (Schmidt et al., 2011). Encouragingly, the paper did note that the number of studies investigating the positive antecedents of health *had* increased alongside the emergence of positive psychology, coined as a discipline by Martin Seligman in 1998 (Schmidt et al., 2011; Seligman & Csikszentmihalyi, 2000). Indeed, a subsequent content analysis of citeable PsycINFO documents found that 86% of all positive psychology-related articles were published after this date and comprised 4.4% of *all* documents in 2011 compared to 0.94% in 1992; although, similar to the findings of Schmidt et al., (2011), only 3.06% of those related to public health research in particular (Rusk & Walters, 2013).

Broadly speaking, positive psychology involves an effort to seek, identify and promote individual strengths, sources of resilience, and factors that enable individuals to flourish within themselves, their communities and the world (Seligman & Csikszentmihalyi, 2000). Positive psychology therefore provides an umbrella term for all lines of research that attempt to readdress previous imbalances in the literature and recognise the importance of promoting the good as well as alleviating the bad (Seligman & Csikszentmihalyi, 2000; Peterson, 2006; Rusk & Waters, 2013). Thus, with an emphasis on human flourishing, it is not surprising that the lens of positive psychology has more recently been applied to health research (Seligman, 2008), and finally, to sleep (Linley et al., 2009; Wickwire, 2021).

1.2.2 Putting the Positive in Sleep Research

Essential to the maintenance of overall health and wellbeing, good sleep is arguably key to human flourishing at both the individual and societal level (Linley et al., 2009; Wickwire, 2021). However, with the importance of good sleep only being recognised within the past few decades, and the emergence of positive psychology occurring in more recent years, current approaches to sleep medicine have tended to focus on the identification and treatment of sleep disorders and the reduction of negative, sleep-impairing factors (Baglioni et al., 2010; Linley et al., 2009; Steptoe et al., 2008; Wickwire, 2021).

Indeed, the recognition of sleep medicine as a discipline in 1999 only worked to increase the prevalence of insomnia diagnoses and the prescription of sedative drugs (Moloney et al., 2011), with current treatment options remaining focused on the alleviation of disorder and the avoidance of sleep-impairing factors as discussed previously. Thus, it is not surprising that empirical studies and reviews have provided ample evidence for links between *negative* affective states (such loneliness, grief, hostility, anger, depression, anxiety and stress) and *poor* sleep, while associations between *positive* psychological states and *good* sleep have remained limited until more recently (Baglioni et al., 2010; Linley et al., 2009; Steptoe et al., 2008; Wickwire, 2021).

Fortunately, the wealth of virtually untapped constructs within positive psychology has put researchers in an excellent position to begin exploring relationships between positive traits and sleep and start identifying those that could offer the best targets for new, positive psychological approaches to intervention. Unlike other treatments, interventions based on the promotion of positive traits could offer a relatively cheap, easy and self-administrable method of improving sleep in the general population, with the cultivation of individual strengths helping to increase positive emotions and personal resources while buffering negative, sleep-impairing emotions and cognitions (Wickwire, 2021). Accordingly, the need to identify those positive traits most relevant to optimising *good sleep health*, "…characterised by subjective satisfaction, appropriate timing, adequate duration, high efficiency and sustained alertness during waking hours”, is clear (Buysse, 2014). Indeed, determining how much variation in sleep outcomes positive traits might help us to understand, explain and predict could ultimately provide an answer to the much-overlooked question of: who sleeps well?

1.2.3 Positive Psychological Traits Linked to Good Sleep

Four positive psychological traits that have been linked to good sleep outcomes in the literature to date, comprise: *mindfulness* (Ong & Moore, 2020; Sala et al., 2020), *self-compassion* (Brown et al., 2021; Butz & Stahlberg, 2020), *gratitude* (Boggiss et al., 2020; Wood et al., 2009) and *optimism* (Hernandez et al., 2020; Lemola et al., 2011; 2013). Here, it is important to note that other positive traits may also be linked to good sleep; however, this thesis focuses on those constructs that have been shown to have the most well-established relationships with sleep in the literature thus far, with each of the aforementioned traits also having associated intervention(s) that could provide fruitful for the future of sleep medicine (Butz & Stahlberg, 2020; Malouff & Schutte, 2017; Ong & Moore, 2020; Wickwire, 2021).

Additionally, mindfulness (Garland et al., 2015a; 2015b; Roemer et al., 2015), self-compassion (Finlay-Jones, 2017; Inwood and Ferrari, 2018; Sirois et al., 2015; 2019), gratitude (Boggio et al., 2020; Lin, 2022; Wood et al., 2007; 2010) and optimism (Carver & Scheier, 2017; Zou & Yuan, 2021) are all considered to be adaptive psychological traits, inextricably linked with positive emotions and the expansion of personal regulation resources, which in turn afford an ‘upward spiral’ of benefits to health and wellbeing while ‘undoing’ the effects of negative states and emotions (Fredrickson, 2001; 2004; 2013; Fredrickson & Joiner, 2018; Garland et al., 2010). The following provides a brief overview of each positive psychological trait, as well as a discussion of the current evidence linking it to better sleep.

1.2.3a Mindfulness

Rooted in Buddhist philosophy and dating back to the fifth century BC, the concept of *mindfulness* – a translation of the Sanskrit word, *Sati* – has only emerged into Western consciousness in more recent years (see Bodhi, 2013 and Chiesa, 2013, for reviews). Coinciding with the conception of the academic journal *Mindfulness*, since 2010, the number of research publications on the topic has exponentially increased by 23.5% *per year*, with two-thirds of those articles published within the last five years (Baminiwatta & Solangaarachchi, 2021; Shapiro & Weisbaum, 2021).

Defined as a non-judgemental awareness and acceptance for the present moment experience, mindfulness involves noticing and approaching present moment thoughts, feelings and sensations with a sense of neutral curiosity and openness, rather than avoidance and overidentification (Bishop et al., 2004; Chiesa, 2013; Shapiro et al., 2006). Research has shown that higher levels of dispositional mindfulness are linked to a variety of beneficial health and wellbeing outcomes, including: decreased risk of psychopathological symptoms (e.g., depression, anxiety, eating disorders, borderline personality disorder, post-traumatic stress disorder); decreased reliance on maladaptive cognitive processes (e.g., rumination, pain catastrophising, neuroticism, impulsivity); more adaptive emotional processing (e.g., higher levels of emotional stability, emotional self-regulation and wellbeing; lower levels of stress and emotional reactivity); and increased engagement in positive health behaviours (e.g., healthy eating, physical activity, sleep; Karl & Fisher, 2022; Sala et al., 2020; Thomlinson et al., 2018).

When it comes to explaining links with psychological health, a recent systematic review and meta-analysis concluded that dispositional mindfulness was associated with reductions in maladaptive cognitive-emotional processes (such as rumination and catastrophising), which in turn accounted for decreased symptoms of anxiety, depression and psychological distress (Tomlinson et al, 2018). Meanwhile, enhanced self-regulation resources and increased levels of awareness may help to initiate the performance of positive health-related behaviours and lead to associated benefits for physical health outcomes (Howell et al., 2010; Sala et al., 2020). Indeed, the ability to detach from negative emotions and stressors is also suggested to reduce engagement in health risk behaviours (such as drinking, smoking, over/undereating) as a psychological means to cope (Sala et al., 2020).

In light of the abundance of research on mindfulness, it is not surprising that this positive trait has received the most empirical attention when it comes to sleep (Wickwire, 2021). Indeed, systematic reviews and meta-analyses have now consolidated and confirmed the presence of significant cross-sectional links between higher levels of dispositional mindfulness and better sleep quality and quantity (Sala et al., 2020), while longitudinal research has shown that dispositional mindfulness can also predict better sleep outcomes prospectively (Murphy et al., 2012; Pagnini et al., 2019). Adding further credence to the idea that mindfulness might play a causal role in impacting sleep, mindfulness-based interventions have been shown to promote good sleep outcomes (see Ong & Moore, 2020, and Shallcross et al., 2019, for reviews). Indeed, mindfulness-based practices (such as mindfulness meditations and relaxation techniques) have more recently been incorporated into CBT-I in an effort to cultivate awareness and encourage detachment from unhelpful sleep-related thoughts (Ong et al., 2008), with evidence that Mindfulness-Based Therapy for Insomnia (MBTI) could be an effective treatment for sleep problems in its own right (see Ong, 2017 and Ong & Manber, 2019, for reviews).

When it comes to sleep, mindfulness is suggested to increase objective awareness for the mental and physical states that arise in the face of sleep problems and enable adaptive attentional and emotional shifts away from unhelpful sleep-related thoughts, emotions and behaviours (Ong et al., 2012). Indeed, mindfulness-based practices may help individuals to detach from aversive thoughts and expectations about sleep and disengage from a preoccupation with trying to solve sleep problems, thus mitigating the associated levels of emotional reactivity and physiological arousal known to interfere with good sleep (Espie, 2007; Harvey, 2002; Harvey et al., 2011; Ong et al., 2012; Riemann et al., 2010). Supporting these ideas, research has shown that mindfulness relates to better sleep-related self-regulation (Howell et al., 2010), while reductions in anxiety and depression (Bogusch et al., 2016), stress (Simione et al., 2020), negative emotions (Ding et al., 2020) and maladaptive emotion regulation strategies (Zhang et al., 2019) have all been identified as underlying mediators of effect within cross-sectional studies.

1.2.3b Self-Compassion

Treating oneself kindly, recognising suffering as part of the common human experience, and maintaining presence in the face of difficult emotions, are all ideas that can be traced back to Eastern contemplative traditions, wherein a non-existent distinction between ‘self’ and ‘other’ makes self-compassion a prerequisite for compassion towards others (Strauss et al., 2016). Like mindfulness, however, self-compassion has only been conceptualised in the West more recently and reflects a movement away from social-comparison and approval-based evaluations of self (such as self-esteem), towards healthier, non-judgmental self-attitudes (Neff, 2003a).

As defined by Neff (2003a), self-compassion involves treating oneself with kindness versus self-criticism; recognising that suffering is part of the common human experience versus an isolating experience; and approaching negative thoughts and feelings with a sense of mindful acceptance versus overidentification. Since the advent of the self-compassion scale (Neff, 2003b), treating oneself kindly has been linked to a variety of benefits for psychological wellbeing (Finlay-Jones, 2017; Inwood and Ferrari, 2018), as well as improved physical health and the increased performance of positive health behaviours (Phillips et al., 2019; Sirois et al., 2015a; 2015b; Terry & Leary, 2011).

Current theory posits that self-compassion acts as an adaptive psychological resource and increases aspects of self-regulation needed for the initiation and maintenance of positive health behaviours (Terry & Leary, 2011; Sirois, 2015; Sirois et al., 2019). Indeed, by reducing unhelpful emotional states (e.g., self-blame, defensiveness) in the face of negative life events and stressors, self-compassion is thought to free-up the self-regulation resources needed for the performance of positive health behaviours, increase compliance with medical advice and facilitate engagement in self-care practices, which all help to promote good health and wellbeing (Terry & Leary, 2011; Sirois, 2015).

The first studies to explicitly investigate the link between self-compassion and sleep were conducted by a German research group, wherein significant medium-sized relationships between self-compassion and self-reported sleep quality were found across nine cross-sectional studies (r = .30, 95% CI[.24, .36]), while self-compassion meditations and writing exercises led to modest improvements in sleep outcomes across three intervention studies (g = .48, 95% CI[.15, .82]; Butz & Stahlberg, 2020). Due to the recent surge of interest in this area, Brown et al., (2021) subsequently conducted a consolidatory meta-analysis on the relationships between dispositional self-compassion and sleep in the wider literature, with the 15 publications that met their inclusion criteria for review producing an overall effect size of r = .32, 95% CI[.36, .28], further supporting the relevance of this positive trait and its potential application to future sleep intervention. While longitudinal relationships between self-compassion and sleep have remained unexplored in the published literature to date, the effectiveness of self-compassion interventions in promoting sleep outcomes helps to support the possibility of causal links (Butz & Stahlberg, 2020).

When it comes to explaining relationships between self-compassion and sleep, self-compassionate individuals may be more likely to prioritise their sleep, practice better sleep hygiene, avoid bedtime procrastination, and be mindful of sleepiness, thus leading to better sleep quality and quantity (Sirois et al., 2019). In the face of negative sleep-impairing emotions, individuals high in self-compassion are also more likely to draw upon adaptive emotion regulation strategies (such as cognitive reappraisal) and are less likely to engage in sleep-impairing maladaptive emotion regulation strategies (such as rumination, self-blame, worry and bedtime procrastination), which may also lead to benefits for sleep (Finlay-Jones, 2017; Inwood & Ferrari, 2018; Semenchuk et al., 2022; Sirois, 2015; Sirois et al., 2015a; 2015b; 2019). Supporting these ideas, the handful of cross-sectional studies that have explored underlying mechanisms of effect to date have implicated reductions in stress (Hu et al., 2018; Hwang et al., 2019), depression (Bian et al., 2020) and maladaptive emotion regulation strategies such as rumination and self-blame (Semenchuk et al., 2022; Butz & Stahlberg, 2018) as mediators of the self-compassion–sleep relationship.

1.2.3c Gratitude (see Tout, Jessop & Miles, 2023a in Appendix A of this thesis for a systematic review and meta-analysis)

Despite being a long-standing feature of many religious and spiritual traditions, like other positive traits, gratitude has remained relatively understudied until more recently (Emmons & Crumpler, 2000; McCullough et al., 2002; Wood et al., 2010). Defined as a sense of thankfulness for the good things in life, dispositional gratitude involves a life-orientation towards positive day-to-day outcomes, which may not necessarily be deserved, earned or expected (Emmons & McCullough, 2004; Watkins et al., 2004; Wood et al., 2010). Individuals who score highly on this positive trait are likely to experience feelings of gratitude more frequently, intensely, and in response to a wider variety of sources, such as the kind actions of another, a favourable life circumstance, the beauty of a natural sight and/or impersonal spiritual sources (Wood et al., 2010; Emmons & McCullough, 2004).

Within the last two decades, researchers have started to identify associations between higher levels of dispositional gratitude and better subjective wellbeing outcomes, including increased happiness, life satisfaction and positive affect, and lower levels of negative affect, anxiety, depression, stress, suicidal ideation and mental disorder (Portocarrero et al., 2020; Ding & Zhao, 2018). Writing about the things one is grateful for in life has also been shown to decrease anxiety, depression, stress, negative affect, inflammatory markers and physical symptoms (Boggiss et al., 2020; Cregg & Cheavens, 2021; Dickens, 2017; Komase et al., 2021); improve emotion regulation, glycaemic control and blood pressure (Boggio et al., 2020; Boggiss et al., 2020); and increase engagement in positive health behaviours, including sleep, exercise and healthy eating (Boggiss et al., 2020).

When it comes to explaining the links between gratitude and positive health and wellbeing outcomes, grateful individuals are thought to draw upon interpersonal relationships, engage in approach-based coping strategies and positively reappraise negative situations, which in turn help to buffer the effects of negative emotions and stressors (Boggio et al., 2020; Wood et al., 2007). Accordingly, gratitude can be considered an externally focused, present moment-orientated, adaptive psychological trait with upstream benefits to health and wellbeing – i.e., *not* just a positive emotional response to receiving a gift (Boggio et al., 2020; Fredrickson, 2004; Wood et al., 2010).

The first study to identify a link between higher levels of gratitude and sleep more specifically – although sleep outcomes were not the main focus – was an intervention study conducted by Emmons & McCullough (2003; Study 3), wherein listing the things one is grateful for in life led to improvements in self-reported sleep quality and feeling refreshed upon awakening. From this, studies began to explore the relationship between gratitude and sleep more explicitly, with Wood et al., (2009) finding that higher levels of gratitude were associated with better overall sleep quality and quantity. Indeed, initial calls for positive sleep research in the United Kingdom came from this seminal work (Linley et al., 2009). While the gratitude–sleep literature has not yet been subject to a published systematic review and meta-analysis, due to the growing number of studies in this area, one was conducted as part of this thesis and can be found summarised in Appendix A (Tout et al., 2023a). Notably, 18 out of 22 eligible studies provided evidence of an association between gratitude and sleep, with a meta-analysis of six methodologically comparable cross-sectional studies revealing significant positive relationships between higher levels of dispositional gratitude and better sleep quality (r = .26, 95%CI[.15, .37]; Tout et al., 2023a). While longitudinal investigation currently remains absent from the published literature, the effectiveness of gratitude interventions has helped to provide evidence for causal links, with seven out of 11 gratitude intervention studies identified in the review leading to improvements in sleep (Tout et al., 2023a). Indeed, a previous meta-analysis consolidating the effectiveness of gratitude interventions on physical health outcomes more widely similarly reported that 5 out of 8 sleep-focused intervention studies led to improvements in sleep outcomes (Boggiss et al., 2020). Accordingly, gratitude might be another promising candidate to consider in the development of future sleep interventions (Boggiss et al., 2020; Tout et al., 2023a).

When it comes to explaining why gratitude might benefit sleep, the systematic review by Tout et al., (2023a) identified three cross-sectional studies to date that had explored underlying mechanisms of effect, wherein reductions in depressive symptoms, anxiety, stress and negative pre-sleep cognitions (Alkozei et al., 2019; Hirsch et al., 2021; Wood et al., 2009), as well as increases in positive pre-sleep cognitions (Wood et al., 2009), were all found to be significant mediators. Thus, as with the other positive traits, gratitude may help to promote sleep via adaptive cognitive-emotional processes alongside reductions in negative sleep-impairing states and cognitions.

1.2.3d Optimism (see Tout, Jessop & Miles, 2023d in Chapter 4 of this thesis for a systematic scoping review and meta-analysis)

Dispositional optimism refers to the general expectation that more good things will happen in the future than bad – put simply, optimists *expect* the best (Carver et al., 2010; Carver & Scheier, 2009; 2014). Interestingly, this positive future life-orientation was once considered to be a form of cognitive delusion – a distorted sense of reality in-keeping with older definitions of mental illness (Taylor & Brown, 1994; Taylor et al., 2000). More recently, however, researchers have recognised that adaptive positive biases are a fundamental characteristic of human thought and relate to favourable outcomes for health and wellbeing (Taylor & Brown, 1994; Taylor et al., 2000). Here, it is important to note that *dispositional optimism* is empirically and conceptually distinct from *unrealistic optimism*, which may be associated with negative health and wellbeing outcomes; however, a full discussion of unrealistic optimism is beyond the scope of this thesis (see Shepperd et al., 2015, for a review). Dispositional optimism is associated with the motivation and confidence to pursue goals, the increased performance of proactive, goal-directed behaviours and the employment of adaptive emotion regulation strategies (Bouchard et al., 2017; Carver et al., 2001; 2010; Forgeard & Seligman, 2012; Scheier & Carver, 2014; 2018; Zou & Yuan, 2021) – indeed, if one does not believe a goal is achievable or have the confidence to engage in proactive steps towards it, then it is not likely to come about.

When it comes to health and wellbeing, higher levels of dispositional optimism have been repeatedly linked to better psychological functioning and improved physical health outcomes (Bouchard et al., 2017; Carver et al., 2010; Scheier & Carver, 2014), including decreased risk of cardiovascular disease, heart attack, stroke and cancer (DuBois et al., 2015; Rasmussen et al., 2009; Scheier & Carver, 2018). Indeed, optimists are more likely to seek out health-related information, medical advice and social support; demonstrate quicker recovery from illness, lower levels of stress and better adaptation to chronic conditions; and have an increased chance of survival and longevity in the face of life-threatening conditions (Carver et al., 2010; Carver & Scheier, 2014; Scheier & Carver, 2018). Thus, by adopting proactive behaviours (Carver et al., 2010), drawing upon approach-based coping strategies (Nes & Segerstrom, 2006), and engaging in adaptive cognitive emotion regulation processes (Zou & Yuan, 2021), optimists are thought to be better equipped to deal with the symptoms of ill-health and stress.

Within the last decade, higher levels of optimism have also been associated with better sleep. While the research in this area has yet to be subject to published empirical review, due to the rapidly expanding body of literature, a systematic review and meta-analysis was conducted as part of this thesis (see Chapter 4; Tout, Jessop & Miles, 2023d). In sum, 29 out of 32 eligible articles provided evidence of an association between higher levels of optimism and better sleep, with a meta-analysis revealing significant positive relationships between dispositional optimism and overall sleep quality and quantity across a set of six methodologically comparable cross-sectional studies (*r* = .30, 95% CI[21, .39]; Tout et al., 2023d). Unlike the other positive traits, however, while optimism interventions exist (Carrillo et al., 2019; Malouff & Schutte, 2017), the effects of an optimism intervention have not yet been examined in relation sleep outcomes, making it hard to draw conclusions of causality. Nevertheless, prospective studies have shown that optimism predicts subsequent improvements in sleep up to five-years later as well as reductions in insomnia symptoms, thus suggesting that optimism may indeed have a causal impact on this crucial health-related behaviour (Hernandez et al., 2020; Ren et al., 2019). Further helping to verify the relationships between optimism and *self-reported* sleep outcomes, optimism has also been linked to better objective sleep parameters, including sleep latency, efficiency and duration (Hernandez et al., 2020; Lemola et al., 2011; but see also Mezick et al., 2010 and Jackowska et al., 2016b, wherein relationships between optimism and objective sleep parameters were not observed).

When it comes to explaining the links between optimism and sleep, optimism has been suggested to foster positive emotions and encourage adaptive mood regulation processes, with an increased sense of hope versus worry providing a buffer against the daily hassles and stressors that ordinarily impair sleep (Lau et al., 2015; 2017; Hernandez et al., 2020; Tout et al., 2023d). Supporting the above ideas, research investigating mediators of the relationship between optimism and sleep more specifically have demonstrated that optimism has indirect effects on sleep via lower levels of depressive symptoms (Hernandez et al., 2020; Lau et al., 2015; 2017; Uchino et al., 2017; Weitzer et al., 2021), anxiety and stress (Lau et al., 2017), and higher levels of life satisfaction (Uchino et al., 2017) and happiness (Weitzer et al., 2021). Indeed, as with other health-related behaviours, when it comes to sleep problems, optimists may also adopt approach-based coping strategies and be less inclined to engage in maladaptive emotion regulation processes (Zou & Yuan, 2021).

1.2.4 How Might Positive Psychological Traits Benefits Sleep?

In light of the above evidence that mindfulness, self-compassion, gratitude and optimism all function as adaptive psychological resources and relate to reductions in negative affective states, the following section introduces *emotion regulation* as one potential meditating mechanism that could help to unite the relationships between each of these positive traits and sleep within a common positive psychology–sleep framework. Indeed, as well as having relationships with each of the aforementioned positive traits and sleep, the (in)ability to regulate one's emotions also relates to many previously implicated mediators by definition (i.e., anxiety, depressive mood, stress; Martin & Dahlen, 2005; Miklósi et al., 2014; Schäfer et al., 2017).

1.3 Emotion Regulation

1.3.1 Defining Emotion Regulation

Emotion regulation refers to the way in which an individual modulates their emotions in line with their goals, including when, where and how they experience and/or express them (Garnefski et al., 2001; Gratz & Roemer, 2004; Gross, 1998; 2014). Definitions such as this encompass a wide array of regulatory processes whether they be physiological (e.g., increased breathing rate when anxious or excited), behavioural (e.g., shouting when angry or overjoyed), social (e.g., seeking out friends when upset or happy) and/or cognitive (e.g., ruminating on events or cognitively reappraising them; Garnefski et al., 2001; Gross, 2014; Thompson et al., 2008).

While this broad conceptualisation of emotion regulation provides a helpful description of a complex process, this thesis hones in on *cognitive emotion regulation* (Garnefski et al., 2001; McRae, 2016). Cognitive emotion regulation strategies help individuals to manage and regulate their emotional responses to threatening and/or stressful events (Garnefski et al., 2001; McRae, 2016). Broadly speaking, these strategies can be considered adaptive (e.g., acceptance, positive reappraisal, putting into perspective, positive refocusing, refocus on planning) or maladaptive (e.g., rumination, catastrophising, self-blame and other blame) in nature due to their differential relationships with health and wellbeing outcomes (Garnefski et al., 2001; Garnesfski & Kraaj, 2006; 2007; 2018; McRae, 2016; Zou & Yuan, 2021). Indeed, while maladaptive strategies tend to upregulate negative emotions/ downregulate positive emotions and have been linked to negative outcomes such as depression, anxiety and psychological maladjustment, adaptive strategies tend to upregulate positive emotions/ downregulate negative emotions and have been linked to positive outcomes (as typically indicated by lower levels of the above symptoms; Garnefski et al., 2001; Garnefski & Kraaij, 2006; 2007; 2009; 2018; Gross & Jazaieri, 2014; Palmer et al., 2018; McRae, 2016).

1.3.2 Links Between Emotion Regulation and Sleep

When it comes to sleep, relationships with emotion regulation are thought to be bidirectional in nature due to shared neurobiological underpinnings (Fairholme & Manber, 2015; Gruber & Cassoff, 2014; Kahn et al., 2013; Palmer & Alfano, 2017;

Vandekerckhove & Wang, 2018). Indeed, as time without sleep goes by, emotional centres in the brain become increasingly active, while a reduced level of prefrontal activity makes the top-down regulation of emotions more demanding (Baum et al., 2014; Mauss et al., 2013; Yoo et al., 2007). Functionally, sleep is also thought to restore emotional balance and decouple memories from their associated emotional tone, thus enabling events to be recalled without the same level of emotional intensity upon awakening (Walker & van Der Helm, 2009). However, while this direction of effect has been relatively well-established, it is important to acknowledge that emotion regulation processes also have an influence on sleep outcomes (Kahn et al., 2013; Palmer & Alfano, 2017; Palmer et al., 2018; Vandekerckhove & Wang, 2018).

Indeed, (meta)cognitive and arousal-based models of insomnia suggest that sleep difficulties are characterised by a cognitive preoccupation with trying to solve sleep problems, with the inability to get to sleep often resulting in further stress, worry and emotional reactivity, which in turn, increases levels of sleep-impairing arousal (Espie, 2007; Harvey, 2002; Harvey et al., 2011; Ong et al., 2012; Reimann et al., 2010). Thus, it is not surprising that non-pharmacological treatments such as CBT-I and MBTI specifically aim to target and reduce the negative cognitive-emotional processes associated with poor sleep, often by promoting cognitive reappraisal and acceptance of sleep problems (Harvey, 2002; Ong et al., 2012; Maurer & Dedhia, 2021).

Further supporting the above, adaptive and maladaptive emotion regulation strategies have been differentially related to sleep outcomes (Cheng et al., 2020; Palmer & Alfano, 2017; Palmer et al., 2018). Rumination, for instance, has been repeatedly linked to poor sleep and insomnia (Carney et al., 2006; Palmer et al., 2018; Cheng et al., 2020; Thomsen et al., 2003), while cognitive reappraisal and problem-solving have been linked to better sleep (Maus et al., 2013; Palmer & Alfano, 2017; Palmer et al., 2018); although links with adaptive emotion regulation strategies do appear to be more varied (Palmer & Alfano, 2017; Palmer et al., 2018; Reddy et al., 2017).

1.3.3 Links Between Emotion Regulation and Positive Psychological Traits

Like sleep, mindfulness, self-compassion, gratitude and optimism have also all been linked to emotion regulation – specifically, each of these positive traits has been associated with the increased tendency to engage in adaptive forms of emotion regulation, alongside the decreased tendency to engage in maladaptive forms.

1.3.3a Mindfulness

As with sleep, links between mindfulness and emotion regulation have been established via both cross-sectional and intervention-based methods (see Roemer et al., 2015 and Guendelman et al., 2017, for a review), and are also thought to share neurobiological underpinnings (Wheeler et al., 2017). Defined as a non-judgmental sense of awareness and acceptance for the present moment experience, mindfulness is thought to free-up cognitive resources in the face of negative emotions and enable the flexible deployment of adaptive emotion regulation strategies such as cognitive reappraisal, while reducing engagement in rumination and worry (Garland et al., 2015a; 2015b; Ong et al., 2012; Roemer et al., 2015).

Indeed, lower levels of dispositional mindfulness have been associated with emotion regulation difficulties and rumination, while higher levels have been associated with the increased tendency to cognitively reappraise events (Luberto et al., 2014; Desrosiers et al., 2013). Emotion regulation has also been found to mediate the links between mindfulness and outcomes such as psychological distress, anxiety, depression and smoking cessation (Adams et al., 2014; Desrosiers et al., 2013; Roemer et al., 2009), with the cultivation of mindfulness leading to improvements in positive reappraisal, which in turn, help to account for reductions in stress (Huston et al., 2011; Garland et al., 2011). However, while mindfulness has been linked to both emotion regulation *and* sleep, and while (meta)cognitive models of insomnia have acknowledged that mindfulness aids the adaptive regulation of thoughts and emotions (Ong et al., 2012), research investigating the role of emotion regulation as an explicit mediator of the mindfulness–sleep relationship remains limited (Zhang et al., 2019).

1.3.3b Self-Compassion

Emotion regulation is similarly thought to be one key mechanism through which self-compassion promotes psychological wellbeing, physical health and engagement in positive health-related behaviours (Cha et al., 2022; Finlay-Jones et al., 2015; 2017; Guan et al., 2021; Inwood & Ferrari, 2018; Terry & Leary, 2011; Sirois, 2015; Sirois et al., 2015a; 2015b; 2019). Indeed, it has been suggested that self-regulation – and in particular, *emotion regulation* – accounts for the relationships between self-compassion and health-promoting behaviours observed previously (Sirois, 2015; Sirois et al., 2019). Specifically, treating oneself kindly in the face of negative events is thought to free-up the cognitive resources needed for adaptive emotional processing (Sirois, 2015; Sirois et al., 2015a; 2015b; 2019). Supporting this idea, self-compassion has been associated with higher levels of positive affect, cognitive reappraisal and better stress reactivity/recovery, alongside lower levels of negative affect, self-blame and rumination (Butz & Stahlberg, 2018; Finlay-Jones, 2017; Semenchuk et al., 2022; Sirois, 2015; Sirois et al., 2015a; 2015b; 2019).

When it comes to sleep outcomes, self-compassion has been linked to lower levels of bedtime procrastination (a sleep-delaying emotion regulation strategy that is used to improve mood in the short-term) via higher levels of cognitive reappraisal, which could theoretically lead to benefits for sleep (Sirois et al., 2019). Further supporting the idea that self-compassion might benefit sleep quality and quantity via emotion regulation, recent cross-sectional studies have demonstrated that reductions in rumination and self-blame mediate the links between self-compassion and good sleep outcomes (Butz & Stahlberg, 2018; Semenchuk et al., 2022).

1.3.3c Gratitude

While gratitude has been linked to adaptive forms of coping, positive emotions and positive pre-sleep cognitions (Boggio et al., 2020; Wood et al., 2009; 2010), this positive trait has only been empirically linked to emotion regulation within the last couple of years. In a recent cross-sectional study, for instance, dispositional gratitude was positively correlated with cognitive reappraisal and negatively correlated with the suppression of emotions (Lin, 2022). Cognitive reappraisal was also found to mediate the relationships between gratitude and sense of meaning in life, suggesting that the increased tendency to notice, acknowledge and reflect upon positive day-to-day outcomes might facilitate the reappraisal of negative events and buffer the impact of negative emotions on other outcomes (Lin, 2022).

Intervention studies have also shown that gratitude encourages the deployment of adaptive emotion regulation processes, with a study by Boggio et al., (2020) finding that writing about experiences of gratitude helped individuals to emotionally reappraise negative images compared to controls. Accordingly, the authors suggested that future research should consider the role of emotion regulation when it comes to explaining the influence of gratitude on health and wellbeing outcomes (Boggio et al., 2020). While the role of emotion regulation has not yet been explicitly investigated in relation to gratitude and sleep, cross-sectional work by Wood et al., (2009) has shown that higher levels of positive pre-sleep cognitions and lower levels of negative pre-sleep cognitions mediate the relationships with better sleep quality and quantity, lending support to the suggestion that gratitude might have an indirect benefit on sleep via differentially valanced cognitive-emotional processes.

1.3.3d Optimism

Like gratitude, the links between optimism and emotion regulation have been relatively lacking in explicit empirical investigation. Nevertheless, models of personality and coping suggest that differences in dispositional traits, such as optimism, can lead to differences in responses to emotional events (Segerstrom & Smith, 2019). Indeed, recent reviews suggest that optimists habitually engage in forms of implicit emotion regulation (thought to relate to unconscious self-regulation and the pursuit of goals) alongside explicit forms of emotion regulation (that take longer to develop and require a higher level of top-down control), resulting in a range of benefits to health and wellbeing (Zou & Yuan, 2021).

Supporting the links between this positive trait and emotion regulation, dispositional optimism has been shown to foster adaptive forms of cognitive coping, positive emotions and socio-emotional functioning, and has also been linked to the increased use of adaptive emotion regulation strategies such as cognitive reappraisal, versus the use of maladaptive emotion regulation strategies such as expressive suppression (Jenaabadi et al., 2015; Zou & Yuan, 2021). Nevertheless, when it comes to links between optimism and sleep outcomes more specifically, mediation via emotion regulation has yet to be explored.

1.3.4 Towards an Integrative Framework

In sum, mindfulness, self-compassion, gratitude and optimism have all been related to the increased tendency to engage in adaptive rather than maladaptive forms of emotion regulation. Similarly, more adaptive and less maladaptive forms of emotion regulation have been linked to better sleep. However, while mindfulness is thought to lend itself to better sleep via reductions in maladaptive cognitive-emotional processes (Garland et al., 2015a; 2015b; Ong et al., 2012; Zhang et al., 2019), and while recent cross-sectional studies have demonstrated that self-compassion might benefit sleep via associated reductions in rumination and self-blame (Butz & Stahlberg, 2018; Semenchuk et al., 2021), research to date has not explored the possibility that emotion regulation might mediate the relationships between *each* of the aforementioned positive traits and sleep quality and quantity, and thus determined whether these relationships can be situated within a common, positive psychology–sleep framework.

1.4 – Overview of Research Aims

Overall, research to date has linked higher levels of mindfulness, self-compassion, gratitude and optimism to better sleep quality and quantity cross-sectionally (Brown et al., 2021; Butz & Stahlberg, 2020; Sala et al., 2020; Tout et al., 2023a; 2023d), while longitudinal studies have further demonstrated that higher levels of dispositional mindfulness and optimism can predict positive changes in future sleep outcomes (Hernandez et al., 2020; Murphy et al., 2012; Pagnini et al., 2019; Ren et al., 2019). In addition, the effectiveness of mindfulness, self-compassion and gratitude-based interventions in promoting sleep outcomes further supports the possibility of causal links between these positive traits and sleep (Boggiss et al., 2020; Butz & Stahlberg, 2020; Ong & Moore, 2020; Tout et al., 2023a). Nevertheless, a few outstanding gaps in the literature remain:

Firstly, with the exception of one study that explored both gratitude and optimism in relation to daily sleep quality reports (Newman et al., 2021), and a dissertation project by the author of this thesis that explored the collective and relative contributions of the aforementioned positive traits to overall sleep quality and quantity cross-sectionally (see Tout, Jessop & Miles, 2023b, Study 1; Appendix B)[1], research investigating the links between each of these positive traits and sleep to date has remained exclusively focused on one positive trait at a time, meaning their collective and relative contributions to overall sleep quality and quantity remain unknown. As a result, it is unclear how much variation in sleep quality and quantity positive psychological traits might help us to understand, explain and predict when

[1]This dissertation project has been written up and submitted for publication alongside the cross-sectional study presented in Chapter 2 of this thesis (see Tout, Jessop & Miles, 2023b, Study 1; Appendix B).

taken together. Exploring these positive traits together may also help to determine which (if any) make the largest independent contribution(s) to sleep, and thus which positive trait(s) might provide the best additional and/or alternative component(s) to positive psychology-based sleep interventions. Indeed, recent research has emphasised the need to consider positive psychological traits together in order to understand their unique contributions to health and wellbeing outcomes (Newman et al., 2021). In light of the above, the first aim of this thesis was to determine the collective and relative contributions of mindfulness, self-compassion, gratitude and optimism to overall sleep quality and quantity cross-sectionally (see Chapter 2). It was hypothesised that the four positive psychological traits would collectively account for a significant proportion of variance in overall sleep. Relative contributions were also examined, but no specific predictions were made regarding which (if any) positive trait(s) might emerge as a unique linear predictor(s) of sleep.

Secondly, while mindfulness, self-compassion and gratitude interventions suggest that cultivating each of these positive traits might help to improve sleep outcomes (Boggio et al., 2020; Butz & Stahlberg, 2020; Ong & Moore, 2020; Tout et al., 2023a), and while a handful of longitudinal studies have suggested that baseline levels of optimism and mindfulness might also predict subsequent improvements in future sleep (Hernandez et al., 2020; Murphy et al., 2012; Pagnini et al., 2019; Ren et al., 2019), prospective links between gratitude and sleep and self-compassion and sleep have remained unexplored in the published literature to date. Accordingly, prospective studies are needed to begin integrating and extending the current literature and overcome the restrictions of cross-sectional studies, which have tended to focus on one positive trait at a time, are restricted in timeframe, and rarely explore the opposite direction of effect. The second aim of this thesis was therefore to replicate and extend the findings of Chapter 2 by conducting a prospective examination of the collective and relative contributions of mindfulness, self-compassion, gratitude and optimism towards *future* sleep quality and quantity (see Chapter 3). It was hypothesised that the four positive traits would collectively predict subsequent changes in future sleep outcomes. Relative contributions were also examined, but no predictions were made regarding which (if any) positive trait(s) might emerge as significant linear predictors of sleep prospectively. The opportunity was also taken to explore reverse causality.

Third, while higher levels of mindfulness, self-compassion, gratitude and optimism have all been linked to the cultivation of positive emotions, healthy coping methods and personal regulation resources, as well as the reduction of negative affective states and emotions (Boggio et al., 2020; Carver & Scheier, 2017; Finlay-Jones, 2017; Garland et al., 2015a; 2015b; Lin, 2022; Roemer et al., 2015; Sirois et al., 2015a; 2019; Wood et al., 2007; 2010; Zou & Yuan, 2021), the possibility that these positive traits might share common underlying mechanisms has not yet been explored. Given the links between each of the positive traits and emotion regulation (Boggio et al., 2020; Finlay-Jones, 2017; Lin et al., 2022; Roemer et al., 2015; Zou & Yuan, 2021), and the links between emotion regulation and sleep (Kahn et al., 2013; Palmer & Alfano, 2017; Vandekerckhove & Wang, 2018), the third aim of this thesis was to investigate emotion regulation as a potential common mediator of the relationships between each of the positive traits and sleep in order to determine whether these relationships could be unified within a common, positive psychology–sleep framework. Based on the literature discussed previously, higher levels of adaptive emotion regulation and lower levels of maladaptive emotion regulation were hypothesised to mediate the relationships between each of the positive traits and sleep quality and quantity in both cross-sectional and prospective studies (see Chapters 2 and 3).

Fourth, while systematic reviews and meta-analyses have provided up-to-date consolidations of the literature regarding the links between mindfulness and sleep and self-compassion and sleep (Brown et al., 2021; Butz & Stahlberg, 2020; Ong & Moore, 2020; Sala et al., 2020), and while links between gratitude-promoting interventions and sleep have also been consolidated (Boggiss et al., 2020; see also Tout et al., 2023a, Appendix A, for a review of the wider literature), research exploring the links between optimism and sleep has not yet been subject to the same review. Thus, the strength and consistency of the relationships between optimism and sleep across sample populations, measures and experimental designs remains unclear. In light of the increasing body of evidence linking optimism to sleep, and the current absence of intervention studies, a review of the optimism–sleep literature was deemed to be particularly useful for consolidating findings to date and driving future research questions. Accordingly, this thesis aimed to provide a systematic review of the published optimism–sleep literature to date and quantitatively synthesise a subset of methodologically comparable studies (see Chapter 4).

Fifth, while previous research has explored the effectiveness of mindfulness, self-compassion and gratitude-promoting interventions in relation to sleep (Boggiss et al., 2020; Butz & Stahlberg, 2020; Ong & Moore, 2020; Tout et al., 2023a), and while optimism interventions have been shown to improve other health and wellbeing related outcomes (Carillo et al., 2019; Malouffe & Schutte, 2017), the effects of promoting optimism on sleep have not yet been explored. Accordingly, the final aim of this thesis was to investigate whether a brief optimism intervention might lead to improvements in sleep quality and quantity within a student sample (see Chapter 5). Given that optimism emerged as a unique linear predictor of overall sleep quality and quantity within both cross-sectional (see Chapter 2) and prospective studies (see Chapter 3), and the wealth of literature demonstrating consistent links between optimism and sleep across a variety of sample population, measures and study designs (see Chapter 4), it was hypothesised that a brief optimism intervention would lead to improvements in sleep quality and quantity within a student sample. As with both cross-sectional and prospective studies, changes in adaptive and maladaptive emotion regulation were also investigated as potential underlying mechanisms of change.

In sum, this thesis aimed to consolidate, integrate and extend the current positive psychology–sleep literature by:

1) Determining the collective and relative contributions of mindfulness, self-compassion, gratitude and optimism to overall sleep quality and quantity cross-sectionally (Chapter 2).

2) Determining the collective and relative contributions of mindfulness, self-compassion, gratitude and optimism to overall sleep quality and quantity prospectively (Chapter 3).

3) Exploring the role of emotion regulation as a potential common mediator of the relationships between each of aforementioned positive psychological traits and sleep within both cross-sectional (Chapter 2) and prospective (Chapter 3) studies.

4) Systematically reviewing the published optimism–sleep literature to date and quantitatively synthesising a subset of methodologically comparable cross-sectional studies (Chapter 4).

5) Investigating whether a brief optimism intervention could be used promote sleep quality and quantity in a student sample (Chapter 5).

CHAPTER 2 – POSITIVE PSYCHOLOGICAL TRAITS AND SLEEP: EXPLORING THE MEDIATING ROLE OF EMOTION REGULATION (TOUT, JESSOP & MILES, 2023b, STUDY 2)

Abstract

The current study explored the relationships between positive psychological traits (mindfulness, self-compassion, gratitude, optimism) and overall sleep quality and quantity and investigated the potential mediating role of emotion regulation. Student participants (*N* = 333) completed questionnaire assessments of the relevant constructs. Multiple regression analysis indicated that the positive traits collectively predicted a significant proportion of variance in sleep, with mindfulness and optimism emerging as significant linear predictors. Maladaptive (but not adaptive) emotion regulation provided a common mechanism through which associations were mediated. Positive psychological traits are associated with good sleep outcomes through a decreased level of maladaptive emotion regulation.

Introduction

Sleep is essential to the maintenance of good health and wellbeing. Poor sleep quality and quantity not only weakens the immune system and increases the risk of cancer, cardiovascular disease, obesity, stroke, Alzheimer's Disease and psychiatric illness, but also reduces cognitive performance and puts others at risk via fatigue-related accidents (Chattu et al., 2019; Irwin, 2015). The importance of sleep as a fundamental health behaviour has further been demonstrated in studies that identify benefits to wellbeing over and above the effects of diet and exercise (Wickham, et al., 2020); indeed, sleep often sets the foundation for food choices and activity levels (Holfeld & Ruthig, 2014; Lundahl & Nelson, 2015). However, despite the importance of good quality and quantity sleep, between one-third and one-half of adults are estimated to be getting 7 hours or less per night (Liu et al., 2016; Wild et al., 2018). Accordingly, research that identifies variables which contribute to good sleep outcomes may prove beneficial for public health.

Despite the need to identify factors underpinning good quality and quantity sleep, research over the last few decades has been dominated by a medical model that focuses on the absence of poor sleep as opposed to the presence of good sleep; consequently, surprisingly little is known about the positive antecedents of this health-related behaviour (Linley et al., 2009). One area beginning to address this bias is the field of positive psychology, which focuses on identifying those positive traits and behaviours that enable individuals to flourish within themselves, their communities and the world (Seligman & Csikszentmihalyi, 2014). In reframing health as a presence of good health versus an absence of poor health, positive psychology provides a relatively new area of investigation when it comes to identifying individual differences associated with better health outcomes (Schmidt et al., 2011). Indeed, identifying positive antecedents of good sleep quality and quantity could prove beneficial in the development of new interventions.

When it comes to sleep specifically, research in the last ten years has identified promising relationships between the constructs of mindfulness, self-compassion, gratitude and optimism and sleep quality and quantity (e.g., Brown et al., 2021; Lemola et al., 2011; Ong & Moore, 2020; Wood et al., 2009). While it is acknowledged that other positive psychological traits may influence sleep, the aforementioned constructs have been shown to have the most consistent relationships with good sleep outcomes in the literature, as described below, and thus form the focus of the current study's investigation.

Mindfulness

Mindfulness can be conceptualized as an increased level of acceptance and awareness of present moment thoughts, emotions and sensations, and a decreased tendency to engage in rumination and worry (Bishop et al., 2004; Ong et al., 2012). Correlational research has repeatedly demonstrated significant positive relationships between levels of dispositional mindfulness and sleep quality and quantity (e.g., Howell et al., 2010; Kemper et al., 2015). In addition, meta-analyses evaluating the results of experimental studies have indicated that mindfulness-based interventions (MBIs) may be as effective in improving sleep and reducing insomnia symptoms as insomnia-specific treatments (see Ong & Moore, 2020, for a review), adding credence to the position that mindfulness plays a causal role in impacting sleep outcomes. Current work suggests that higher levels of dispositional mindfulness may promote sleep by increasing awareness of bodily sensations such as sleepiness and reducing engagement in ruminative thinking, which in turn reduces levels of sleep-impairing arousal (Howell et al., 2010; Ong et al., 2012;).

Self-Compassion

Self-compassion involves displaying kindness towards oneself in the face of suffering, and an increased ability to accept negative emotions as part of the common human experience (Neff, 2003). Recent meta-analyses have demonstrated consistent relationships between levels of dispositional self-compassion and sleep, with those who score more highly on measures of self-compassion reporting better sleep quality and quantity (Brown et al., 2021; Butz & Stahlberg, 2020). Further to this, the effectiveness of self-compassion interventions in improving sleep outcomes provides additional evidence in support of self-compassion playing a causal role (Butz & Stahlberg, 2020). Studies investigating the mechanisms underlying these relationships have suggested that self-compassion may act as a valuable psychological resource and facilitate good quality and quantity sleep via the downregulation of critical thoughts, emotions and perceived levels of stress (Brown et al., 2021).

Gratitude

Gratitude refers to the level of thankfulness that an individual experiences in relation to the positive outcomes they encounter in their day to day lives (Emmons et al., 2003). In one of the first studies to explore the relationship between gratitude and sleep, Wood et al. (2009) demonstrated that higher levels of dispositional gratitude were associated with better sleep quality and quantity. Further studies have since replicated these cross-sectional relationships (e.g., Alkozei et al., 2019), and indeed, as with mindfulness and self-compassion, gratitude interventions have also been shown to be effective in improving sleep outcomes, thus providing evidence of potentially causal relationships (Jackowska et al., 2016a; Ng & Wong, 2013). Current work suggests that dispositional gratitude may exert its positive effects on sleep by increasing positive (and decreasing negative) pre-sleep cognitions, which in turn reduces sleep-impairing thoughts and worries (Wood et al., 2009).

Optimism

Dispositional optimism is the general expectation that more good things will happen in the future than bad (Carver & Scheier, 2014). Research has demonstrated that those who score more highly on measures of dispositional optimism display reduced levels of insomnia and improved sleep quality and quantity (Hernandez et al., 2020; Lemola et al., 2013; Uchino et al., 2017). However, it is important to note that the effectiveness of optimism-based interventions on sleep have not yet been explored, meaning that questions regarding causality still remain. Furthermore, there exists the possibility that those high in optimism may be biased towards reporting better sleep outcomes. Nevertheless, objective assessments have provided evidence that optimistic individuals are more likely to experience optimal sleep durations, suggesting this may not be the case (Lemola et al., 2011, but see also Mezick et al., 2010). Current work has also proposed plausible mechanisms underlying the relationships found between dispositional optimism and sleep, whereby optimism has been suggested to aid sleep via mood-regulation processes and adaptive coping strategies, which in turn reduce the effect of sleep-impairing stressors and negative emotions (Lau et al., 2017).

In sum, an increasing body of evidence supports the presence of associations between the four positive psychological traits outlined above and sleep quality and quantity, with the effectiveness of interventions in relation to mindfulness, self-compassion and gratitude further highlighting the potential for these traits to play a causal role in impacting sleep. However, while these individual links have been relatively well-established, previous studies have typically only examined the effects of one positive trait at a time (but see Tout, Jessop & Miles, 2023b, Study 1 for a recent exception; Appendix B), meaning their combined and unique contributions to sleep quality and quantity are not well understood. As a result, relatively little is known about which positive psychological trait(s) may be most strongly and uniquely associated with sleep, although the findings of Tout et al., (2023b; Study 1) suggest that mindfulness and optimism might make a unique contribution to overall sleep quality and quantity.

Moreover, relatively little is known about *how* these positive psychological traits may affect sleep. While previous studies have identified individual mechanisms specific to a particular positive trait (such as those mentioned above), research has not yet attempted to determine whether the *same* underlying mechanisms exist across *all* positive traits. We propose a broader positive psychology – sleep framework, which unifies the literature on positive psychology and sleep by introducing emotion regulation as a common mechanism.

Emotion regulation refers to a level of awareness, understanding and acceptance of one's emotions, as well as the ability to control and modulate emotions in accordance with desired goals by using situationally appropriate strategies (Gratz &

Roemer, 2004; Garnefski et al., 2001). Emotion regulation strategies can be considered as adaptive (e.g., acceptance, positive reappraisal) or maladaptive (e.g., rumination, blaming others) in nature due to their differential relationships with health and wellbeing outcomes (Garnefski et al., 2001). When it comes to sleep more specifically, maladaptive strategies such as rumination, catastrophizing and self-blame are related to higher levels of sleep-impairing arousal, insomnia and worse overall sleep quality and quantity, whereas adaptive strategies such as acceptance and positive reappraisal are generally linked to better sleep outcomes (Palmer et al., 2018; Cheng et al., 2020). Indeed, models of insomnia suggest that to initiate sleep, an individual must be able to de-arouse or disengage from active emotional processing of daytime events (Harvey, 2002).

Our framework also draws upon theories that suggest adaptive emotional processes may help to account for the links between positive psychological traits and beneficial health and wellbeing outcomes more broadly. These theories suggest that positive traits foster the upregulation of positive emotions and adaptive coping mechanisms, while undoing the psychological and physical effects of negative emotional states such as anxiety, sadness and stress (Cohn et al., 2009; Fredrickson, 2001; 2004, 2013; Fredrickson & Joiner, 2018; Garland et al., 2010). In support of these effects, research has demonstrated that constructs such as mindfulness, self-compassion and gratitude are linked to increased levels of engagement in adaptive, and deceased levels of engagement in maladaptive, emotion regulation (Boggio et al., 2020; Inwood and Ferrari, 2018; Roemer et al., 2015). For instance, writing about grateful experiences has been shown to increase an individual’s tendency to employ emotional reappraisal strategies when viewing negative images (Boggio et al., 2020).

We propose that the association between positive psychological traits and sleep quality and quantity is also mediated by emotion regulation. In support of this hypothesis, stress, depressive mood and rumination have all been previously implicated as underpinning relationships between particular positive traits and sleep (e.g., Bogusch et al., 2016; Butz and Stahlberg, 2018; Hu et al., 2019; Uchino et al., 2017), and arguably, all relate to an individual's (in)ability to regulate their emotions. Indeed, not only can the negative emotional states associated with stress and depressive mood lead to difficulties in falling asleep initially, but they can also lead to additional disturbances throughout the night, thus highlighting the need to consider emotion regulation when attempting to understand variation in sleep quality and quantity (Kahn et al., 2013; Vandekerckhove & Wang, 2018).

How might individuals with higher levels of positive psychological traits regulate their emotions differently? Engaging in adaptive emotion regulation strategies (and up-regulating positive emotions and cognitions) and disengaging from maladaptive emotion regulation strategies (and down-regulating negative emotions and cognitions) could both be plausible mechanisms. Identifying whether emotion regulation mediates the relationships between each of these positive traits and sleep quality and quantity will be informative both for understanding how these individuals achieve better sleep, and for determining whether the relationships between positive traits and sleep can be situated within a broader statistical model, unified by emotion regulation.

The Current Study

The first aim of the current study was to test our pre-registered hypothesis that, collectively, mindfulness, self-compassion, gratitude and optimism could account for a significant amount of variation in sleep quality and quantity. To supplement this first aim, we also examined which (if any) of these positive trait(s) would make a significant unique contribution to overall sleep quality and quantity.

The second aim of the current study was to test our pre-registered hypothesis that emotion regulation would significantly mediate the relationships between each of mindfulness, self-compassion, gratitude and optimism and sleep quality and quantity. At the time of pre-registration, we intended to explore emotion regulation as a unidimensional mediator; however, in light of the theory and research presented above suggesting that maladaptive and adaptive emotion regulation strategies were likely to be orthogonal in nature and thus have different implications for sleep, we took the decision to explore maladaptive and adaptive emotion regulation separately. The accompanying hypothesis was therefore revised to specify greater engagement in adaptive emotion regulation strategies and decreased engagement in maladaptive emotion regulation strategies as mediators.

Method

The current study was pre-registered with the Open Science Framework (Link to pre-registration) where associated sample size rationale is provided.

Participants

A total of 333 psychology undergraduate students recruited from a university in the South of England took part in the present study and met the inclusion criteria that they did not work night shifts or have a diagnosed sleep disorder. Of these, 282 identified as female (84.68%), 49 identified as male (14.71%), and 2 identified as another gender (0.30%) or elected not to say (0.30%). The mean age of the sample was 19.92 (*SD* = 2.71), with ages ranging from 18 to 49 years. The majority of participants indicated that their nationality was British (78.97%); no other nationality was represented by more than 2.00% of the sample. When indicating their ethnicity, 267 participants identified their ethnicity as 'White' (80.18%), 30 (9.01%) identified as 'Asian / Asian British', 15 (4.50%) identified as 'mixed / multiple ethnic group', 12 (3.60%) identified as 'other ethnic group' and 9 (2.02%) identified as 'Black / African / Caribbean / Black British'.

Design and Procedure

The current study employed a cross-sectional, correlational design. Participants were recruited via SONA – an online participant recruitment tool in which students sign up to studies in exchange for course credits – and invited to take part in a study about their thoughts, feelings and sleep. Participants were informed that the online questionnaire would take approximately 25 minutes to complete. Participants who signed up to the study were given a link to the online questionnaire, which was hosted by the online survey platform Qualtrics. All participants provided their informed consent electronically on the first page of the questionnaire and were compensated for their time with course credits. The study protocol was approved by the Sciences and Technology Cross-Schools Research Ethics Committee at the hosting university.

Measures

All participants completed an online questionnaire, which included the following measures[2]. Unless otherwise indicated, mean scores were computed for scales, with higher scores indicating higher levels of the construct in question.

Demographic information. Participants were asked to provide their age, gender, nationality and ethnicity.

Gratitude. The Gratitude Questionnaire-Six-Item Form (GQ-6; McCullough et al., 2002) was employed to assess participants' tendency to experience gratitude in daily life. The GQ-6 comprises six items (e.g., "I am grateful to a wide variety of people"). Responses were given on a 7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7); $\alpha = .74$.

Optimism. Optimism was assessed using the Life Orientation Test – Revised (LOT-R; Scheier et al., 1994), which includes six items to assess participants' levels of optimism (e.g., "Overall, I expect more good things to happen to me than bad").

[2] These measures were collected as part of a larger questionnaire. Only those measures relevant to the present research are described here. Details of additional measures are available via the Open Science Framework (Link to pre-registration).

Responses were given on a 5-point Likert scale, ranging from *I disagree a lot* (1), to *I agree a lot* (5); α = .80.

Self-Compassion. The Self-Compassion Scale Short-Form (SCS-SF; Raes et al., 2011) was used to assess self-compassion. This scale consists of twelve items (e.g., "I try to be understanding and patient towards those aspects of my personality I don't like"). Responses were given on a 5-point Likert scale ranging from *almost never* (1) to *almost always* (5); α = .84.

Mindfulness. Mindfulness was assessed with the 15 item Five-Facet Mindfulness Questionnaire (FFMQ-15; Baer et al., 2008). Participants were asked to indicate how true each statement was of them (e.g., "I pay attention to sensations, such as the wind in my hair or sun on my face"). Responses were given on a 5-point Likert scale, ranging from *never or very rarely true* (1) to *very often or always true* (5); α = .73.

Sleep Quality and Quantity. Sleep quality and quantity was assessed via the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989). This scale includes 19 items assessing the following seven components of sleep quality and quantity: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction over the last month. The PSQI involves completing a number of open-ended questions (e.g., "During the past month, how long (in minutes) has it usually taken you to fall asleep each night?"), and responding to a number of items via fixed response scales (e.g., "During the past month how often have you had trouble sleeping because you wake up in the middle of the night or early morning?"; *not during the past month* [0] to *three of more* *times a week* [3]). Responses were scored in accordance with the PSQI manual to provide summary scores for each component, whereby possible scores range from 0 to 3, with higher scores representing *worse* sleep in relation to each component. A global sleep score was then calculated for each individual by summing their scores across the seven components; thus, possible global sleep scores range from 0 to 21, with higher scores representing poorer sleep quality and quantity overall.

Emotion Regulation. Emotion regulation was assessed with the Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski & Kraaij, 2007). This scale includes a total of thirty-six items assessing nine emotion regulation strategies (five adaptive: acceptance, positive refocusing, refocus on planning, positive reappraisal, putting into perspective; and four maladaptive: self-blame, rumination, catastrophizing and other-blame). Participants were asked to indicate how they generally think in response to the negative or unpleasant events they experience (example positive refocusing item: “I think that I can become a stronger person as a result of the experience”; example catastrophizing item: “I keep thinking about how terrible my experience was”). Responses to all items were given on a 5-point Likert scale, ranging from *almost never* (1) to *almost always* (5). An overall adaptive emotion regulation score was computed for each participant by calculating the mean of the twenty-five adaptive emotion regulation items, $\alpha = .89$. An overall maladaptive emotion regulation score was also computed for each participant by calculating the mean of the twenty maladaptive emotion regulation items, $\alpha = .78$.

Statistical Analysis

Statistical analysis was conducted using SPSS 27.0. Preliminary analysis was performed using descriptive statistics to obtain mean values and standard deviations. Pearson's correlations were also obtained. In order to assess our first pre-registered hypothesis that, collectively, mindfulness, self-compassion, gratitude and optimism would account for a significant proportion of variance in sleep quality and quantity, multiple regression analysis was performed in which global sleep score was entered as the outcome variable, and the four positive psychological traits were entered as the predictor variables.

To assess our second hypothesis, that emotion regulation would significantly mediate the relationships between each of mindfulness, self-compassion, gratitude and optimism and sleep quality and quantity, mediation analyses were conducted using Hayes PROCESS for SPSS v3.5, taking 5,000 bootstrap samples to compute bias corrected confidence intervals (BCBCI), and adjusting for potential violations of heteroscedasticity (heteroscedasticity-consistent inference: HC2). For each of the four models, the positive psychological trait in question was entered as the predictor variable, global sleep score was entered as the outcome variable, and adaptive emotion regulation and maladaptive emotion regulation scores were entered as the mediating variables.

Data Sharing Statement

Data files are available online via the OSF (Link to OSF Project Files)

Results

Preliminary Analyses.

Descriptive statistics and bivariate correlations between the measures of the four positive psychological traits, sleep quality and quantity and emotion regulation are given in Table 1. It can be seen that each of the positive traits was significantly associated with adaptive emotion regulation, maladaptive emotion regulation and overall sleep quality and quantity. Furthermore, the measures of adaptive and maladaptive emotion regulation were also significantly associated with overall sleep.

Table 1. *Descriptive statistics and bivariate correlations between each of the positive traits, emotion regulation and overall sleep quality and quantity (*N *= 333).*

	2.	3.	4.	5.	6.	7.	*Min.*	*Max.*	*M*	*SD*
1. Mindfulness	$.52^{***}$	$.30^{***}$	$.45^{***}$	$.42^{***}$	$-.30^{***}$	$-.32^{***}$	1.80	4.40	3.03	0.44
2. Self-compassion		$.33^{***}$	$.57^{***}$	$.61^{***}$	$-.45^{***}$	$-.29^{***}$	1.25	4.33	2.73	0.62
3. Gratitude			$.49^{***}$	$.34^{***}$	$-.34^{***}$	$-.26^{***}$	2.83	7.00	5.72	0.77
4. Optimism				$.39^{***}$	$-.37^{***}$	$-.33^{***}$	1.17	5.00	2.99	0.76
5. Adaptive emotion regulation					$-.25^{***}$	$-.17^{**}$	1.35	4.90	3.21	0.57
6. Maladaptive emotion regulation						$.31^{***}$	1.75	4.50	2.99	0.48
7. Global sleep score							0.00	18.00	7.15	3.03

Note: In accordance with the PSQI, lower scores are indicative of better sleep, hence negative correlations with positive psychology-related traits and adaptive emotion regulation.

*** $p \leq .001$ ** $p \leq .01$

Exploring Associations Between Positive Psychological Traits and Sleep Quality and Quantity.

In order to address our first pre-registered hypothesis that, collectively, mindfulness, self-compassion, gratitude and optimism would significantly predict better sleep quality and quantity, global sleep scores were regressed onto these four positive traits. The resulting regression model indicated that, collectively, mindfulness, self-compassion, gratitude and optimism accounted for 15.81% of the variation in global sleep score: $F(4, 328) = 15.40$, $p < .001$. Mindfulness ($\beta = -.18$, $p = .004$) and optimism ($\beta = -.16$, $p = .022$) both emerged as significant linear predictors of global sleep score, with higher levels of mindfulness and optimism being related to better overall sleep quality and quantity. Gratitude ($\beta = -.10$, $p = .089$) and self-compassion ($\beta = -.08$, $p = .219$) did not emerge as significant linear predictors of global sleep score.[3]

Exploring Emotion Regulation as a Mediator of the Relationships Between Positive Psychological Traits and Sleep Quality and Quantity.

In order to address our second hypothesis, that emotion regulation would significantly mediate the relationships between each of the four positive traits (mindfulness, self-compassion, gratitude and optimism) and overall sleep quality and quantity, a series of mediation analyses were conducted; the resultant models are depicted in Figure 1.

Analyses revealed that there was no significant indirect effect of mindfulness, self-compassion, gratitude or optimism on global sleep score via adaptive emotion regulation (mindfulness: $b = -0.02$, BCBCI [-.33, .26]; self-compassion: $b = 0.17$,

[3] The above pattern of results did not differ when controlling for age and gender.

BCBCI [-.35, .39]; gratitude: *b* = -0.76, BCBCI [-.23, .06]; optimism: *b* = -0.03, BCBCI [-.20, .14]). By contrast, there was a significant indirect effect of mindfulness, self-compassion, gratitude and optimism on global sleep score via maladaptive emotion regulation (mindfulness (*b* = -0.47, 95% BCBCI [-.75, -.24]), self-compassion (*b* = -0.48, 95% BCBCI [-.74, -.24]), gratitude (*b* = -0.32, 95% BCBCI[-.48, -.17]), and optimism (*b* = -0.31, 95% BCBCI [-.49, -.15]). Thus, the impact of mindfulness, self-compassion, gratitude and optimism on sleep quality and quantity was partially mediated through maladaptive emotion regulation. In each case, higher levels of the positive trait in question were associated with lower levels of maladaptive emotion regulation, which in turn was associated with better quality and quantity sleep.

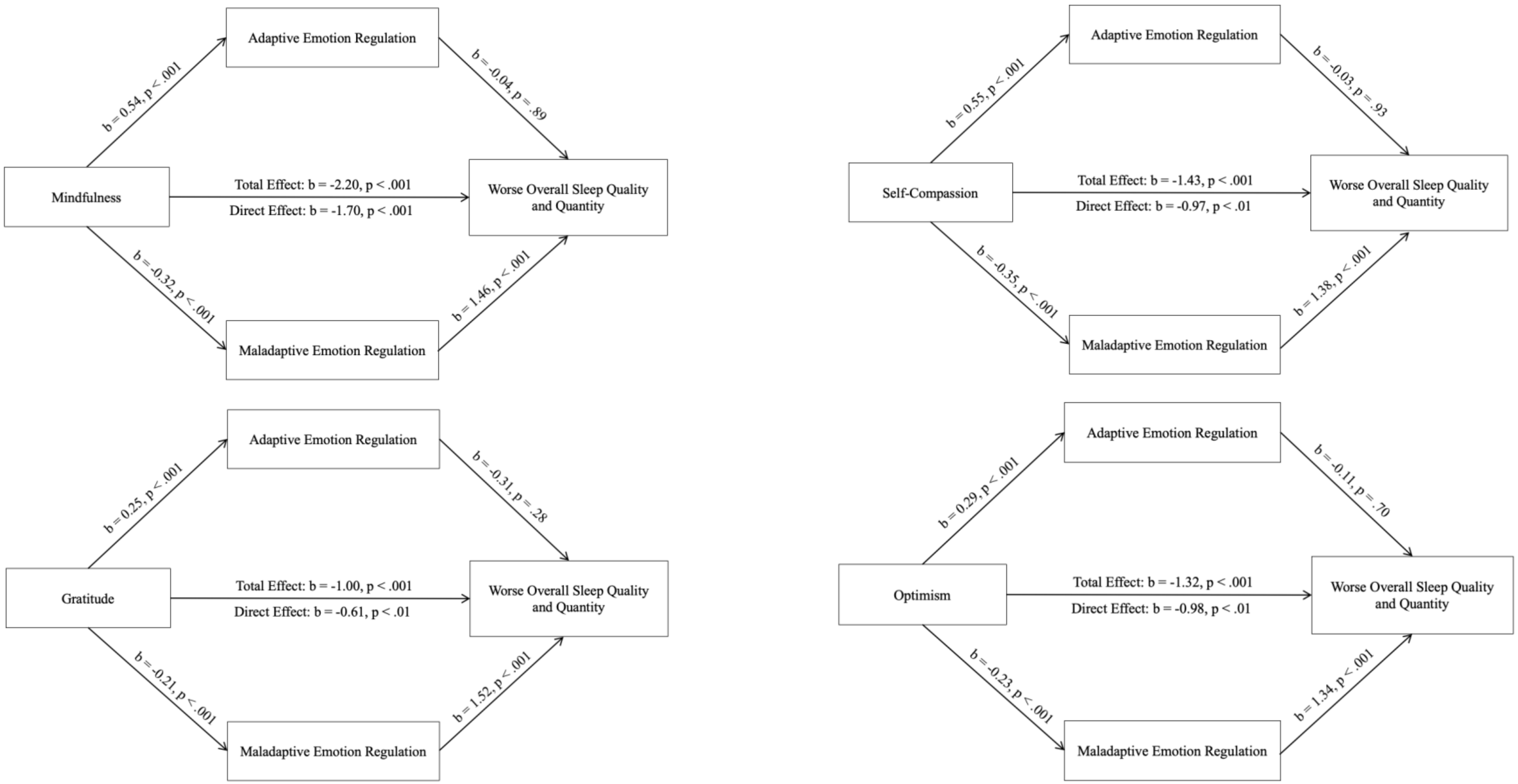

Figure 1. *Mediation analyses displaying the associations between the four positive traits and sleep quality and quantity through adaptive and maladaptive emotion regulation.*

Discussion

Our study demonstrates that positive psychological traits predict better sleep quality and quantity, and that decreased use of maladaptive emotion regulation strategies can help us to understand why. Specifically, mindfulness, self-compassion, gratitude and optimism together accounted for a significant proportion of variance in overall sleep quality and quantity (15.81%), with optimism and mindfulness emerging as unique predictors of overall sleep quality and quantity; and maladaptive emotion regulation, but not adaptive emotion regulation, consistently mediating the associations between each positive trait and sleep.

While this finding that mindfulness and optimism were significant linear predictors of overall sleep quality and quantity replicates the findings of Tout et al., (2023b, Study 1), it is important to note that the bi-variate correlations indicated that gratitude and self-compassion also had significant relationships with sleep outcomes, as evidenced in previous research (Wood et al., 2009; Brown et al., 2021). Therefore, the present findings regarding optimism and mindfulness should not be interpreted to mean that these traits are the most important predictors of sleep, rather that they make a unique contribution to sleep over and above the shared variance amongst the four positive psychology-related traits. The fact that optimism contributed uniquely to predicting sleep highlights the need to examine the effect of manipulating optimism on sleep outcomes. Indeed, while mindfulness, self-compassion and gratitude interventions have all been shown to be effective in improving sleep, the potential utility of manipulating optimism (perhaps via the Best Possible Self intervention, King, 2001) remains unexplored.

Our second pre-registered hypothesis that emotion regulation would significantly mediate the relationships between each of mindfulness, self-compassion, gratitude and optimism and overall sleep quality and quantity was partially supported; maladaptive emotion regulation, but not adaptive emotion regulation, consistently mediated the associations between each positive trait and sleep. Higher levels of mindfulness, self-compassion, gratitude and optimism were each associated with lower levels of maladaptive emotion regulation, which in turn was associated with better sleep quality and quantity. The current study is therefore the first to identify emotion regulation as a common mechanism underlying the relationships between positive psychological traits and sleep. Future work may now benefit from testing more complex models that situate these relationships within a broader, unified framework.

Indeed, the existence of this common mechanism may help to unify the various positive psychology – sleep relationships found previously. In other words, studies linking positive psychological traits to sleep via reduced levels of negative emotional states such as depression, rumination and stress (e.g., Butz & Stahlberg, 2018; Hu et al., 2019; Lau et al., 2017) may be understood through the impact of these traits on maladaptive emotion regulation. That is, when it comes to sleep as a specific health-related behaviour, the emphasis appears to be on the potential for certain positive traits to 'undo' the physical and psychological effects of negative cognitive-emotional states known to impair sleep (Fredrickson, 2013; Fredrickson & Joiner, 2018; Garland et al., 2010). Accordingly, determining an individual's level of engagement in maladaptive emotion regulation strategies may provide useful when it comes to identifying those at risk of poor sleep outcomes in future work.

Surprisingly, while adaptive emotion regulation was linked to higher levels of each positive psychological trait and to better sleep, it did not mediate any of the relationships. These findings do not support theories proposing the upregulation of positive thoughts and emotions as the mechanisms through which positive traits benefit health and wellbeing (Cohn et al., 2009; Fredrickson et al., 2013). Indeed, the broader literature on the link between adaptive emotion regulation and sleep suggests strategies such as cognitive reappraisal and acceptance relate to sleep outcomes in some instances and not others (Cheng et al., 2020; Palmer et al., 2018). One explanation for these mixed findings could be that the use or impact of emotion regulation strategies varies by age. Specifically, younger individuals and students are generally less reliant on cognitive reappraisal strategies (Palmer et al., 2018). Alternatively, adaptive emotion regulation may be more relevant to behaviours not assessed in the current study such as engagement in sleep hygiene practices or bedtime procrastination, which – although important to sleep – are not necessarily related to subjective reports of quality and quantity (Stepanski & Wyatt, 2003). Overall, this finding suggests that adaptive emotion regulation may not explain why individuals with higher levels of positive psychological traits experience better sleep quality and quantity.

While there were indirect routes from mindfulness, self-compassion, gratitude, and optimism to better sleep quality and quantity through maladaptive emotion regulation, it is important to note that the direct effect of each of these traits on sleep remained significant. Future work may therefore benefit from developing a model that encompasses additional common mechanisms in order to better situate current findings within a broader framework.

Due to the cross-sectional correlational design of our study, the reported relationships could also be bidirectional in nature; for instance, it is equally possible that good sleep improves emotion regulation, which in turn increases positive feelings and ratings across the various positive psychological traits, as is suggested to be the case with optimism, depression and sleep (Lau et al., 2017). However, previous experimental work reporting that mindfulness, self-compassion and gratitude interventions can improve sleep outcomes supports our interpretation that these traits may have a causal impact on sleep (e.g., Brown et al., 2021; Boggiss et al., 2020; Ong et al., 2020). Future work could attempt to demonstrate temporal precedence of the aforementioned relationships across time in order to draw causal conclusions. Additionally, despite the use of validated questionnaires, the current study is subject to the limitations and inaccuracies of self-report assessments. Future research could therefore benefit from determining whether the present findings hold using objective measures of sleep outcomes such as polysomnography or actigraphy; nevertheless, the importance of subjective sleep ratings and their relation to health and wellbeing outcomes should not be neglected and remain essential to current diagnoses of insomnia.

Conclusion

Overall, the current study supported the position that the positive psychological traits of mindfulness, self-compassion, gratitude and optimism collectively accounted for a significant amount of variation in sleep quality and quantity. The finding that optimism and mindfulness made a significant unique contribution to this relationship further highlights the importance of these traits as potential targets for future work and – possibly – intervention. Moreover, reduced levels of maladaptive emotion regulation were found to mediate the associations between each of the positive traits and sleep, thus helping to integrate previous findings and providing evidence that common underlying mechanisms may exist as part of a broader positive psychology – sleep framework. Exploring additional common mechanisms and addressing questions of causality will prove important for future research.

CHAPTER 3 – POSITIVE PSYCHOLOGICAL TRAITS PREDICT FUTURE SLEEP QUALITY AND QUANTITY: EXPLORING EMOTION REGULATION AS A COMMON MEDIATOR (TOUT, JESSOP & MILES, 2023c)

Abstract

Objectives. Gratitude, optimism, self-compassion and mindfulness have each been associated with better sleep; however, their collective and relative contributions to future sleep outcomes remain unexplored. The current study therefore investigated whether baseline levels of these positive psychological traits could predict subsequent changes in sleep quality and quantity. In addition, emotion regulation was examined as a possible mediator of any relationships between positive traits and sleep. *Methods.* A prospective, correlational design was employed. Student participants (N = 220) completed self-report measures of gratitude, optimism, self-compassion, mindfulness, emotion regulation and sleep quality and quantity at three separate time-points, each approximately 12-weeks apart. *Results.* Hierarchical regression analyses indicated that, collectively, the positive traits at baseline predicted subsequent changes in overall sleep quality and quantity at 12-weeks and 24-weeks. Optimism emerged as a unique predictor of sleep at each time-point, with higher levels of optimism predicting subsequent improvements in sleep. Maladaptive emotion regulation mediated the relationships between optimism and sleep and self-compassion and sleep. *Conclusions.* Findings are consistent with the idea that positive psychological traits facilitate good sleep quality and quantity and indicate that reductions in maladaptive emotion regulation may underpin associations between some positive traits and sleep.

Introduction

Sleep is essential to the maintenance of physical health and psychological functioning; thus, it is not surprising that a lack of good quality and quantity sleep has been associated with a variety of negative consequences, including increased risk of cardiovascular disease, cancer, psychiatric illness, suicidality and overall premature mortality (Tubbs & Grandner, 2021). Despite the importance of good sleep, however, around a third of adults and one half of adolescents fail to achieve the recommended amount of sleep per night (Chattu et al., 2018; Kocevska et al., 2021; Liu et al., 2016; Owens et al., 2014; Soldatos et al., 2005), with declines in sleep duration over the past twenty years accompanied by increasing rates of insomnia and daytime sleepiness across nations and age-groups (Bixler, 2009; Keyes et al., 2015; Kocevska et al., 2021; Matricciani et al., 2012; Owens et al., 2014). Accordingly, identifying factors associated with good sleep should be a priority for public health (Chattu et al., 2018).

In response to calls for new and integrative approaches to sleep medicine, researchers have started to recognise the importance of positive psychological traits when it comes to understanding variation in sleep outcomes and improving overall sleep quality and quantity (Linley et al., 2009; Wickwire, 2021). Four positive psychological traits that have been consistently linked to better sleep outcomes in the literature more recently, comprise: gratitude, optimism, self-compassion and mindfulness. Indeed, systematic reviews and meta-analyses have further consolidated and confirmed the presence of significant links between better sleep quality and quantity and higher levels of gratitude (Boggiss et al., 2021; Tout et al., 2023a), optimism (Tout et al., 2023d), self-compassion (Brown et al., 2021; Butz & Stahlberg et al., 2020) and mindfulness (Ong & Moore, 2020; Sala et al., 2020).

The vast majority of current literature establishing links between each of the aforementioned positive traits and sleep, however, has relied upon cross-sectional research designs, wherein conclusions of causality and directionality cannot be made (Fairchild & McDaniel, 2017). Despite this, intervention studies have shown that boosting levels of gratitude, self-compassion and mindfulness can lead to improvements in sleep outcomes, providing support for this causal direction of effect (Boggiss et al., 2021; Brown et al., 2021; Butz & Stahlberg, 2020; Ong & Moore, 2020). Nevertheless, systematically exploring prospective longitudinal associations between each of the aforementioned positive traits and sleep will help to further current understanding.

Indeed, while there is some prospective evidence to suggest that optimism (Hernandez et al., 2020; Lau et al., 2015; 2017) and mindfulness (Murphy et al., 2012; Pagnini et al., 2019) can predict subsequent improvements in future sleep, to the best of the author's knowledge, prospective associations between gratitude and sleep and self-compassion and sleep have remained unexplored. Thus, determining whether gratitude, optimism, self-compassion and mindfulness can predict subsequent changes in future sleep represents an important step for research, especially given that positive traits and emotions have generally been overlooked as predictors of sleep within the literature (Baglioni et al., 2010; Linley et al., 2009; Wickwire et al., 2021). By allowing for an examination of reverse causality, prospective methods may also help to determine which direction of effect allows for the strongest causal interpretation, and/or highlight the need to consider the bidirectional effects more thoroughly. Certainly, it is possible that sleep could also predict subsequent changes in levels of gratitude, optimism, self-compassion and mindfulness, given the links between good sleep and positive mood and emotions (Palmer & Alfano, 2017; Ten Brink et al., 2022).

In addition to the above, the vast majority of current literature to date has focused on examining links between individual positive traits and sleep, meaning very little is known about the collective and relative contributions of gratitude, optimism, self-compassion and mindfulness to overall sleep quality and quantity, and thus how much variation in future sleep outcomes positive psychological traits may help us to predict. Indeed, only two cross-sectional studies have examined the collective and relative contributions of these positive traits to sleep, wherein gratitude, optimism, self-compassion and mindfulness were found to collectively account for 16% and 25% of variance in overall sleep quality and quantity (Tout et al., 2023b). Interestingly, these studies also found that optimism and mindfulness made significant independent contributions to sleep, suggesting there may be something unique about these traits when it comes to understanding variation in sleep quality and quantity (Tout et al., 2023b). Given the relevance of positive traits to explaining variation in sleep outcomes cross-sectionally then, prospective methods are now necessary to extend findings and elucidate their collective and relative contributions to *future* sleep.

While the above research indicates that positive psychological traits may have a positive impact on sleep, there is less certainty as to how they might exert this effect, and indeed, whether they all exert their effects via common underlying pathways. Current cross-sectional studies focusing on one positive trait at a time have implicated depression (Alkozei et al., 2019; Uchino et al., 2017), anxiety (Bogusch et al., 2016), stress (Hu et al., 2018; Simione et al., 2020), ruminative thinking (Butz & Stahlberg, 2018; Liu et al., 2018) and pre-sleep cognitions (Wood et al., 2009) as mediators of the relationships between some of these positive traits and sleep. However, another variable relevant to each of these positive traits and to sleep, and thus a potential candidate for a common underlying mechanism, is emotion regulation – the (in)ability to manage emotions and modify strategies in line with situational circumstances and goals (Gratz & Roemer, 2004; Garnefski & Kraaij, 2007) – which arguably relates to many previously implicated mediators by definition. Indeed, research has implicated rumination and self-blame (maladaptive emotion regulation strategies) as mediators of the relationship between self-compassion and sleep (Butz & Stahlberg, 2018; Semenchuk et al., 2022), while mindfulness-based sleep interventions are thought to exert their beneficial effects in part by reducing maladaptive cognitions and negative emotions (Ong et al., 2012; 2018).

Supporting the idea that emotion regulation may be a common mediator of the relationships between positive psychological traits and sleep, recent cross-sectional work has identified maladaptive emotion regulation as a mediator of the relationships between each of gratitude, optimism, self-compassion and mindfulness and overall sleep quality and quantity (Tout et al., 2023b, Study 2). Certainly, the importance of emotion regulation is also acknowledged within the sleep literature and cognitive models of insomnia (Harvey, 2002; Riemann et al., 2010), wherein maladaptive strategies such as rumination are thought to impair sleep via increased levels of sympathetic nervous system activity and cognitive arousal, while adaptive strategies such as cognitive reappraisal have generally been linked to better sleep outcomes (Cheng et al., 2020; Fairholme & Manber, 2015; Palmer et al., 2018; Vandekerckhove & Wang, 2018). Higher levels of gratitude (Boggio et al., 2020), optimism (Zou & Yuan, 2021), self-compassion (Finlay-Jones, 2017) and mindfulness (Roemer et al., 2015) have also all been independently associated with an increased tendency to engage in adaptive emotion regulation strategies such as acceptance and reappraisal, alongside the decreased tendency to engage in maladaptive emotion regulation strategies such as rumination and catastrophising. Accordingly, emotion regulation could help unify the positive psychology and sleep literatures – that is, higher levels of gratitude, optimism, self-compassion and mindfulness may *all* encourage the upregulation of adaptive emotion regulation strategies and the downregulation of maladaptive emotion regulation strategies, which in turn supports good sleep quality and quantity. This suggestion is also in line with current theoretical ideas, whereby positive traits and emotions are thought to increase personal resources and initiate an 'upward spiral' of benefits for health and wellbeing, while 'undoing' negative affective states and their associated effects (Fredrickson, 2001; 2014; Garland et al., 2010). Thus, as well as determining whether gratitude, optimism, self-compassion and mindfulness have a causal impact on sleep, prospective methods may also help to provide further insight as to how they might exert this effect.

Overall, and in light of the above, the current study aimed to address the following research questions:

1. Do Positive Psychological Traits Predict Sleep Cross-sectionally?

Based on the findings of Tout et al., (2023b), our first pre-registered hypothesis stated that there would be significant cross-sectional relationships between the positive psychological traits and overall sleep quality and quantity; specifically, it was hypothesised that gratitude, optimism, self-compassion and mindfulness would collectively predict a significant proportion of variation in overall sleep quality and quantity at baseline.

2. Do Positive Psychological Traits Predict Subsequent Changes in Sleep?

Our second pre-registered hypothesis stated that, collectively, levels of gratitude, optimism, self-compassion and mindfulness at baseline would predict subsequent changes in overall sleep quality and quantity at 12-weeks and 24-weeks.

3. Can Sleep Predict Subsequent Changes in Positive Psychological Traits?

To test for reverse causality, we examined whether overall sleep quality and quantity at baseline could predict subsequent changes in levels of gratitude, optimism, self-compassion and/or mindfulness at 12-weeks and 24-weeks. Due to a lack of previous research, no specific hypotheses were pre-registered regarding this direction of effect.

4. Is Emotion Regulation a Common Mediator of the Relationships Between Positive Psychological Traits and Sleep?

If a significant relationship between a positive trait at baseline and overall sleep at 24-weeks was found, we examined whether emotion regulation at 12-weeks was a mediator of the relationship. Due to a lack of previous research, no specific hypotheses were pre-registered, although, in light of the literature presented above, we expect each of the positive traits to be associated with higher levels of adaptive emotion regulation and lower levels of maladaptive emotion regulation, which in turn will relate to better overall sleep.

Method

The current study was pre-registered with the Open Science Framework (link) where associated sample size calculations are provided.

Participants

A total of 603 students recruited from universities in the United Kingdom completed the first wave of data collection (October – December 2020). Of these, 487 identified as female (80.76%), 102 identified as male (16.92%), and 14 identified as another gender (2.16%) or elected not to say (0.17%). Participants' ages ranged from 18–52 years (M = 20.29, SD = 3.75). The majority of participants indicated that their nationality was British (70.81%) or Scottish (3.48%); no other nationality was represented by more than 3.00% of the sample. When indicating their ethnicity, 486 participants identified their ethnicity as White (80.60%), 56 identified as Asian/Asian British (9.29%), 27 identified as mixed/multiple ethnic group (4.48%), 18 identified as other ethnic group (2.99%) and 16 identified as Black/African/Caribbean/Black British (2.65%).

Of the 603 participants who completed the Time 1 questionnaire, 361 went on to complete the Time 2 questionnaire (Time 1 to Time 2 attrition, 40.13%). Of the 361 who completed *both* the Time 1 and Time 2 questionnaires, 220 went on to complete the Time 3 questionnaire (Time 2 to Time 3 attrition, 39.06%); six participants completed the Time 1 and Time 3 questionnaires only. A comparison of those who dropped out at Time 2 and/or Time 3 (n = 383) with those who stayed in the project until completion (N = 220) can be found in Table 2. With the exception of ethnicity, which showed an association between being White and being more likely to complete the study (p = .038), comparisons did not yield significant associations between any of the study variables and completion.

Table 2. *Demographic and psychological characteristics of participants who dropped out at Time 2 and/or Time 3 (dropouts) compared to those who completed all three time-points (completers).*

	Dropouts (n = 383) % /Mean (*SD*)	**Completers** (N = 220) % / Mean (*SD*)	**Significance Tests** x^2 / F	**Effect Sizes** V / η_p^2
Gender				
Female	80.16% / 307	81.82% / 180		
Male	17.49% / 67	15.91% / 35	$x^2(2) = .26$, $p = .879$	.02
Another gender/ Prefer not to say	2.35% / 9	2.27% / 5		
Nationality				
British	72.32% / 277	68.18% / 150	$x^2(1) = 1.16$, $p = .281$	.04
Not British	27.68% / 106	31.82% / 70		
Ethnicity				
White	78.07% / 299	85.00% / 187	$x^2(1) = 4.29$, $p = .038^*$	.08
Not White	21.93% / 84	15.00% / 33		
Age				
Mean	20.17 (3.42)	20.50 (4.25)	$F(1, 601) = 1.06$, $p = .304$	.002
Range	18-47	18-52		
Global Sleep Score T1	7.51 (3.22)	7.28 (3.10)	$F(1, 587) = .71$, $p = .399$	.001
Gratitude T1	5.52 (.96)	5.57 (.88)	$F(1, 601) = .31$, $p = .578$	.001
Optimism T1	2.85 (.89)	2.92 (.83)	$F(1, 601) = .99$, $p = .319$	.002
Self-Compassion T1	2.60 (.69)	2.67 (.67)	$F(1, 601) = 1.05$, $p = .306$	.002
Mindfulness T1	2.99 (.51)	3.02 (.55)	$F(1, 601) = .61$, $p = .435$	.001

$^*p < .05$

Note: As some categories within the variables of Gender, Nationality and Ethnicity had an $n < 5$, and were thus unsuitable for chi-square testing, these variables have been separated into superordinate categories. When it comes to effect sizes, Cramer's *V* and partial eta-squared were reported for chi-squared tests and one-way ANOVAs, respectively.

Design and Procedure

The current study employed a prospective, correlational, questionnaire-based design. Participants were recruited both via SONA (an online participant recruitment tool used by the hosting university on which students sign up to studies in exchange for course credits) and opportunistically via a study recruitment message which was emailed to external university departments with the request that they circulate the message to their students. This resulted in participants being recruited from the following five universities within the United Kingdom: Bristol, Glasgow, Portsmouth, Sussex and York.

All participants were invited to take part in a study about their "thoughts, feelings and sleep" and were informed that participation would involve the completion of three, 25-minute, online questionnaires, approximately 12-weeks apart (Time 1: Autumn-Winter Term, 2020; Time 2: Spring Term, 2021, Time 3: Summer Term, 2021). Participants who signed up to the study were given a link to the Time 1 questionnaire, which was hosted by the online survey platform Qualtrics. A link to the Time 2 questionnaire was sent out 12-weeks after completion of the Time 1 questionnaire, and a link to the Time 3 questionnaire was sent out 24-weeks after completion of the Time 1 questionnaire. Upon the completion of each questionnaire, participants recruited via SONA were awarded course credits, while those recruited via emails to university departments were entered into a prize draw for the chance to win a £25 e-voucher.

All participants provided informed consent electronically on the first page of each questionnaire. Participants were also asked to provide their names and email addresses in order to link their responses across time and remove their data from the study if they later requested to withdraw (and for the purposes of awarding the prize draw in the case of those recruited via emails to external university departments). Participants were assured that their names and email addresses would remain strictly confidential and were recorded for the purposes of the current study only, after which they would be erased. Before submitting their responses, participants were again asked to confirm their consent and reminded of their right to withdraw. Participants who did not provide their informed consent had the relevant questionnaire responses excluded from analysis. The study protocol was approved by the Science and Technology Cross-School Research Ethics Committee at the hosting university.

Measures

With the exception of demographic information, which was collected at Time 1 only, participants completed online questionnaire assessments of the following constructs at each time-point.[4] Unless otherwise specified, for each of the scales mean scores were computed for each participant at each time-point, with higher scores indicating higher levels of the construct in question.

Demographic information. Participants were asked to provide their age, gender, nationality and ethnicity at Time 1 only.

Gratitude. The Gratitude Questionnaire-Six-Item Form (GQ-6; McCullough et al., 2002) was employed to assess participants' tendency to experience gratitude in daily life. The GQ-6 comprises six items (e.g., "I am grateful to a wide variety of people"). Responses were given on a 7-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7); Time 1: $\alpha = .79$, Time 2: $\alpha = .82$, Time 3: $\alpha = .82$.

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[4]Only those measures relevant to the present research hypotheses are described here. Details of additional pre-registered exploratory measures are available via the OSF (link).

Optimism. Optimism was assessed using the Life Orientation Test – Revised (LOT-R; Scheier et al., 1994), which includes six items to assess participants' levels of optimism (e.g., "Overall, I expect more good things to happen to me than bad"). Responses were given on a 5-point Likert scale, ranging from *I disagree a lot* (1), to *I agree a lot* (5); Time 1: $\alpha = .84$, Time 2: $\alpha = .86$, Time 3: $\alpha = .86$.

Self-Compassion. The Self-Compassion Scale Short-Form (SCS-SF; Raes et al., 2011) was used to assess participants' levels of self-compassion. This scale consists of 12 items (e.g., "I try to be understanding and patient towards those aspects of my personality I don't like"). Responses were given on a 5-point Likert scale ranging from *almost never* (1) to *almost always* (5); Time 1: $\alpha = 85$, Time 2: $\alpha = .73$, Time 3: $\alpha = .86$.

Mindfulness. Mindfulness was assessed with the 15 item Five-Facet Mindfulness Questionnaire (FFMQ-15; Baer et al., 2008). Participants were asked to indicate how true each statement was of them (e.g., "I pay attention to sensations, such as the wind in my hair or sun on my face"). Responses were given on a 5-point Likert scale, ranging from *never or very rarely true* (1) to *very often or always true* (5); Time 1: $\alpha = .78$, Time 2: $\alpha = .78$, Time 3: $\alpha = .80$.

Emotion Regulation. Emotion regulation was assessed with the Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski and Kraaij, 2007). This scale includes a total of 36 items assessing nine emotion regulation strategies (*five adaptive*: acceptance, positive refocusing, refocus on planning, positive reappraisal, putting into perspective; and *four maladaptive*: self-blame, rumination, catastrophizing and other blame). Participants were asked to indicate how they generally think in response to the negative or unpleasant events that they experience (example positive refocusing item: “I think I can become a stronger person as a result of the experience”; example catastrophizing item: “I keep thinking about how terrible my experience was”). Responses to all items were given on a 5-point Likert scale, ranging from *almost never* (1) to *almost always* (5). An overall adaptive emotion regulation score was computed for each participant by calculating the mean of the 20 adaptive emotion regulation items; Time 1: $\alpha = .85$, Time 2: $\alpha = .87$, Time 3: $\alpha = .89$. An overall maladaptive emotion regulation score was also computed for each participant by calculating the mean of the 16 maladaptive emotion regulation items; Time 1: $\alpha = .81$, Time 2: $\alpha = .79$, Time 3: $\alpha = .81$.

Sleep Quality and Quantity. Sleep quality and quantity was assessed via the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989). This scale includes 19 items assessing the following seven components of sleep quality and quantity over the preceding month: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction over the last month. The PSQI involves completing a number of open-ended questions (e.g., “During the past month, how long (in minutes) has is usually taken you to fall asleep each night?”), and responding to a number of items via fixed response scales (e.g., “During the past month how often have you had trouble sleeping because you wake up in the middle of the night or early morning?”; *not during the past month* [0] to *three or more times a week* [3]). Responses were scored in accordance with the PSQI manual to provide summary scores for each component, whereby possible scores range from 0 to 3, with higher scores representing worse sleep in relation to each component. A global sleep score was then calculated for each individual by summing their scores across the seven components, thus possible global sleep scores range from 0 to 21, with higher scores representing poorer sleep quality and quantity overall.

Statistical Analysis

Statistical analysis was conducted using SPSS 27.0. Preliminary analysis was performed using descriptive statistics to obtain mean values and standard deviations. Pearson's correlations were also obtained.

1. Do Positive Psychological Traits Predict Sleep Cross-sectionally? In order to replicate previous findings and assess our first pre-registered hypothesis that, collectively, gratitude, optimism, self-compassion and mindfulness would predict a significant proportion of variance in overall sleep quality and quantity cross-sectionally, multiple regression analysis was conducted. For this analysis, global sleep scores at Time 1 were entered as the outcome variable, and the four positive traits at Time 1 were entered as the predictor variables.

2. Do Positive Psychological Traits Predict Subsequent Changes in Sleep? To assess our second pre-registered hypothesis that, collectively, baseline levels of gratitude, optimism, self-compassion and mindfulness would predict subsequent changes in overall sleep quality and quantity at 12-weeks and 24-weeks respectively, hierarchical multiple regression analyses were performed. In the first analysis, Time 1 global sleep scores were entered at step one, the four positive traits at Time 1 were entered at step two, and Time 2 global sleep scores were entered as the outcome variable. In the second model, Time 1 global sleep scores were entered at step one, the four positive traits at Time 1 were entered at step two, and Time 3 global sleep scores were entered as the outcome variable.

3. Can Sleep Predict Subsequent Changes in Positive Psychological Traits? In order to determine whether sleep at baseline could predict the positive traits at 12-weeks and 24-weeks, a further series of pre-registered hierarchical regression analyses were conducted. For these analyses, the relevant Time 1 positive trait was entered at step one, global sleep score at

Time 1 was entered at step two, and the relevant positive trait at Time 2 (or Time 3) was entered as the outcome variable.

4. Is Emotion Regulation a Common Mediator of the Relationships Between Positive Psychological Traits and Sleep? In order to examine our pre-registered exploratory interest in emotion regulation as a potential common mediator of the relationships between baseline positive traits and sleep (if a significant relationship between a baseline positive trait and sleep at 24-weeks was found), a series of mediation analyses were conducted using Hayes' PROCESS v3.5 in SPSS, taking 5,000 bootstrap samples to compute bias corrected confidence intervals (BCBCI). For each model, Time 1 scores of the positive trait in question were entered as the predictor variable, global sleep scores at Time 3 were entered as the outcome variable, and adaptive and maladaptive emotion regulation scores at Time 2 were entered as the mediators.

Data Sharing Statement

Data files are available online via the OSF (link).

Results

Means, standard deviations and inter-correlations between gratitude, optimism, self-compassion, mindfulness and overall sleep quality and quantity at each time-point are available in Table 3.

1. Do Positive Psychological Traits Predict Sleep Cross-sectionally?

In support of the first pre-registered hypothesis, multiple regression analysis revealed that the four positive traits collectively accounted for a significant proportion of variance in global sleep scores at Time 1, $F(4, 584) = 38.70$, $p < .001$; $R^2 = 20.95\%$. Interestingly, optimism ($\beta = -.26$, $p < .001$) and mindfulness ($\beta = -.19$, $p < .001$) emerged as significant linear predictors of overall sleep quality and quantity in their own right, while gratitude ($\beta = -.004$, $p = .919$) and self-compassion ($\beta = -.09$, $p = .101$) did not. It can be seen from the negative standardized beta-coefficients that higher levels of mindfulness and optimism were related to better overall sleep quality and quantity – *note* lower PSQI scores indicate better overall sleep, while higher scores indicate higher levels of the positive traits. A similar pattern of cross-sectional findings was also observed at Times 2 and 3[5].

[5]The four positive psychological traits accounted for 23.17%, $F(4, 357) = 26.91$, $p < .001$, and 23.92%, $F(4, 219) = 17.21$, $p < .001$, of variance at Time 2 and Time 3, respectively. As with Time 1, mindfulness and optimism also emerged as significant linear predictors of global sleep score in their own right at Times 2 and 3 (Time 2 mindfulness: $\beta = -.18$, $p = .002$; Time 2 optimism, $\beta = -.24$, $p < .001$; Time 3 mindfulness, $\beta = -.15$, $p = .043$; Time 3 optimism, $\beta = -.23$, $p = .006$), while gratitude did not (Time 2 gratitude, $\beta = -.01$, $p = .805$; Time 3 gratitude: $\beta = -.01$, $p = .931$). Interestingly, unlike at Time 1, self-compassion also emerged as a significant linear predictor of global sleep scores at Times 2 and 3 (Time 2 self-compassion, $\beta = -.14$, $p = .035$; Time 3 self-compassion, $\beta = -.19$, $p = .018$).

Table 3. *Means, standard deviations and inter-correlations for each of the positive traits and overall sleep quality and quantity*[6].

	n	M (*SD*)	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. Global PSQI T1	589	7.42 (3.17)	$-.21^{***}$	$-.41^{***}$	$-.37^{***}$	$-.37^{***}$	$.67^{***}$	$-.21^{***}$	$-.36^{***}$	$-.39^{***}$	$-.39^{***}$	$.63^{***}$	$-.19^{**}$	$-.30^{***}$	$-.33^{***}$	$-.33^{***}$
2. Gratitude T1	603	5.54 (.93)		$.46^{***}$	$.34^{***}$	$.31^{***}$	$-.21^{***}$	$.71^{***}$	$.39^{***}$	$.29^{***}$	$.28^{***}$	-.10	$.74^{***}$	$.40^{***}$	$.21^{**}$	$.27^{***}$
3. Optimism T1	603	2.88 (.87)			$.64^{***}$	$.50^{***}$	$-.44^{***}$	$.43^{***}$	$.78^{***}$	$.54^{***}$	$.45^{***}$	$-.38^{***}$	$.44^{***}$	$.77^{***}$	$.53^{***}$	$.42^{***}$
4. Self-Compassion T1	603	2.62 (.69)				$.60^{***}$	$-.39^{***}$	$.34^{***}$	$.57^{***}$	$.77^{***}$	$.51^{***}$	$-.40^{***}$	$.32^{***}$	$.58^{***}$	$.79^{***}$	$.56^{***}$
5. Mindfulness T1	603	3.00 (.52)					$-.34^{***}$	$.32^{***}$	$.46^{***}$	$.51^{***}$	$.76^{***}$	$-.26^{***}$	$.24^{***}$	$.40^{***}$	$.45^{***}$	$.74^{***}$
6. Global PSQI T2	362	7.62 (3.26)						$-.25^{***}$	$-.43^{***}$	$-.41^{***}$	$-.39^{***}$	$.74^{***}$	$-.22^{**}$	$-.39^{***}$	$-.38^{***}$	$-.38^{***}$
7. Gratitude T2	365	5.44 (.97)							$.48^{***}$	$.40^{***}$	$.34^{***}$	$-.17^{*}$	$.73^{***}$	$.39^{***}$	$.26^{***}$	$.31^{***}$
8. Optimism T2	365	2.96 (.87)								$.65^{***}$	$.49^{***}$	$-.40^{***}$	$.46^{***}$	$.82^{***}$	$.62^{***}$	$.51^{***}$
9. Self-Compassion T2	365	2.68 (.64)									$.58^{***}$	$-.38^{***}$	$.36^{***}$	$.57^{***}$	$.79^{***}$	$.56^{***}$
10. Mindfulness T2	365	2.97 (.52)										$-.32^{***}$	$.29^{***}$	$.39^{***}$	$.48^{***}$	$.77^{***}$
11. Global PSQI T3	224	6.94 (3.18)											$-.25^{***}$	$-.43^{***}$	$-.42^{***}$	$-.37^{***}$
12. Gratitude T3	226	5.45 (.91)												$.52^{***}$	$.36^{***}$	$.37^{***}$
13. Optimism T3	226	3.00 (.86)													$.62^{***}$	$.51^{***}$
14. Self-Compassion T3	226	2.72 (.66)														$.57^{***}$
15. Mindfulness T3	226	3.04 (.53)														

$^{***}p \leq .001$, $^{**}p \leq .01$, $^{*}p < .05$

[6] Lower PSQI scores indicate better sleep, while higher scores indicate higher levels of each of the positive psychological traits, hence negative correlations.

2. Do Positive Psychological Traits Predict Subsequent Changes in Sleep?

In support of the second pre-registered hypothesis, hierarchical regression analyses revealed that the four positive traits at Time 1 collectively predicted subsequent changes in overall sleep quality and quantity at Time 2, $\Delta F(4, 346) = 4.84$, $p < .001$; $\Delta R^2 = 2.91\%$, and Time 3, $\Delta F(4, 214) = 4.20$, $p = .003$; $\Delta R^2 = 4.39\%$. The resultant regression equations can be found in Table 4. Interestingly, optimism emerged as a significant linear predictor of overall sleep quality and quantity at Time 2 ($\beta = -.14$, $p = .010$) and Time 3 ($\beta = -.14$, $p = .044$), while self-compassion emerged as a significant linear predictor of sleep at Time 3 only ($\beta = -.16$, $p = .030$). It can be seen from the negative regression coefficients that higher initial levels of optimism and self-compassion were associated with subsequent improvements in overall sleep quality and quantity.

3. Can Sleep Predict Subsequent Changes in Positive Psychological Traits?

When exploring the opposite direction of effect, a further series of pre-registered hierarchical regression analyses revealed that sleep quality and quantity at Time 1 predicted subsequent changes self-compassion, $\Delta F(1, 352) = 8.94$, $p = .003$; $\Delta R^2 = 1.03\%$; $\beta = -.11$, $p = .003$, and mindfulness, $\Delta F(1, 352) = 9.49$, $p = .002$; $\Delta R^2 = 1.10\%$; $\beta = -.11$, $p = .002$, at Time 2. It can be seen from the negative regression coefficients that better sleep quality and quantity at Time 1 was associated with subsequent improvements in both self-compassion and mindfulness at Time 2. Time 1 sleep did not predict any of the other positive traits at Time 2, nor any positive trait at Time 3. The resultant regression equations can be found in Table 5.

Table 4. *Hierarchical regression analyses exploring whether levels of the positive traits at baseline predict future sleep.*

Step	Predictors Entered	β	Model F	Model R^2	Model ΔF	Model ΔR^2
Regression 1						
Predicting Time 2 Global Sleep Score						
1	Global Sleep Score Time 1	$.67^{***}$	287.78^{***}	$.45^{***}$		
2	Global Sleep Score Time 1	$.59^{***}$	63.96^{***}	$.48^{***}$	4.84^{***}	$.03^{***}$
	Gratitude Time 1	.01				
	Optimism Time 1	$-.14^{*}$				
	Self-Compassion Time 1	-.07				
	Mindfulness Time 1	-.01				
Regression 2						
Predicting Time 3 Global Sleep Score						
1	Global Sleep Score Time 1	$.63^{***}$	143.39^{***}	$.38^{***}$		
2	Global Sleep Score Time 1	$.55^{***}$	33.72^{***}	$.44^{***}$	4.20^{***}	$.04^{***}$
	Gratitude Time 1	.05				
	Optimism Time 1	$-.14^{*}$				
	Self-Compassion Time 1	$-.16^{*}$				
	Mindfulness Time 1	.06				

$^{*}p < .05$, $^{**}p \leq .01$, $^{***}p < .001$

Table 5. *Hierarchical regression analyses exploring whether sleep predicts future positive traits.*

Step	Predictors Entered	β	Model *F*	Model R^2	Model ΔF	Model ΔR^2
Predicting T2 Gratitude						
1	Gratitude T1	$.71^{***}$	363.47^{***}	$.51^{***}$		
2	Gratitude T1	$.70^{***}$				
	Global Sleep Score T1	-.06	183.41^{***}	$.51^{***}$	2.16	.00
Predicting T2 Optimism						
1	Optimism T1	$.79^{***}$	566.67^{***}	$.62^{***}$		
2	Optimism T1	$.77^{***}$				
	Global Sleep Score T1	-.04	283.84^{***}	$.62^{***}$	1.01	.00
Predicting T2 Self-Compassion						
1	Self-Compassion T1	$.76^{***}$	495.25^{***}	$.58^{***}$		
2	Self-Compassion T1	$.72^{***}$				
	Global Sleep Score T1	$-.11^{**}$	257.67^{***}	$.59^{***}$	8.94^{**}	$.01^{**}$
Predicting T2 Mindfulness						
1	Mindfulness T1	$.76^{***}$	491.57^{***}	$.58^{***}$		
2	Mindfulness T1	$.72^{***}$				
	Global Sleep Score T1	$-.11^{**}$	256.44^{***}	$.59^{***}$	9.49^{**}	$.01^{**}$
Predicting T3 Gratitude						
1	Gratitude T1	$.75^{***}$	274.19^{***}	$.56^{***}$		
2	Gratitude T1	$.73^{***}$				
	Global Sleep Score T1	-.09	140.57^{***}	$.56^{***}$	3.65	.01
Predicting T3 Optimism						
1	Optimism T1	$.77^{***}$	318.26^{***}	$.59^{***}$		
2	Optimism T1	$.76^{***}$				
	Global Sleep Score T1	-.04	159.26^{***}	$.59^{***}$	0.70	.00
Predicting T3 Self-Compassion						
1	Self-Compassion T1	$.79^{***}$	352.84^{***}	$.62^{***}$		
2	Self-Compassion T1	$.77^{***}$				
	Global Sleep Score T1	-.05	177.08^{***}	$.62^{***}$	1.13	.00
Predicting T3 Mindfulness						
1	Mindfulness T1	$.74^{***}$	264.37^{***}	$.55^{***}$		
2	Mindfulness T1	$.71^{***}$				
	Global Sleep Score T1	-.09	135.07^{***}	$.55^{***}$	3.17	.01

$^{**}p < .01$, $^{***}p < .001$

4. Is Emotion Regulation a Common Mediator of the Relationships Between Positive Psychological Traits and Sleep?

As higher levels of optimism, self-compassion and mindfulness at baseline were significantly correlated with better overall sleep quality and quantity at 24-weeks (see Table 3), we examined our pre-registered exploratory interest in emotion regulation at 12-weeks as a potential common mediator of these relationships. The resulting mediation models are displayed in Figure 2.

Mediation analyses revealed no significant indirect effect of any positive trait at Time 1 on overall sleep quality and quantity at Time 3 via adaptive emotion regulation at Time 2 (optimism: b = -.13, BCBCI[-.39, .09]; self-compassion: b = -.07, BCBCI[-.51, .39]; mindfulness: b = -.27, BCBCI[-.67, .08]). However, there was a significant indirect effect of Time 1 optimism (b = -.18, BCBCI[-.37, -.03]) and Time 1 self-compassion (b = -.25, BCBCI[-.53, -.02]) on Time 3 sleep via Time 2 maladaptive emotion regulation. Specifically, higher levels of optimism and self-compassion at Time 1, were linked to better sleep quality and quantity at Time 3 via reduced levels of maladaptive emotion regulation at Time 2. Despite significant correlations between each of the variables, the indirect of Time 1 mindfulness on Time 3 sleep via Time 2 maladaptive emotion regulation was not found to be significant (b = -.08, BCBCI[-.32, .09]).

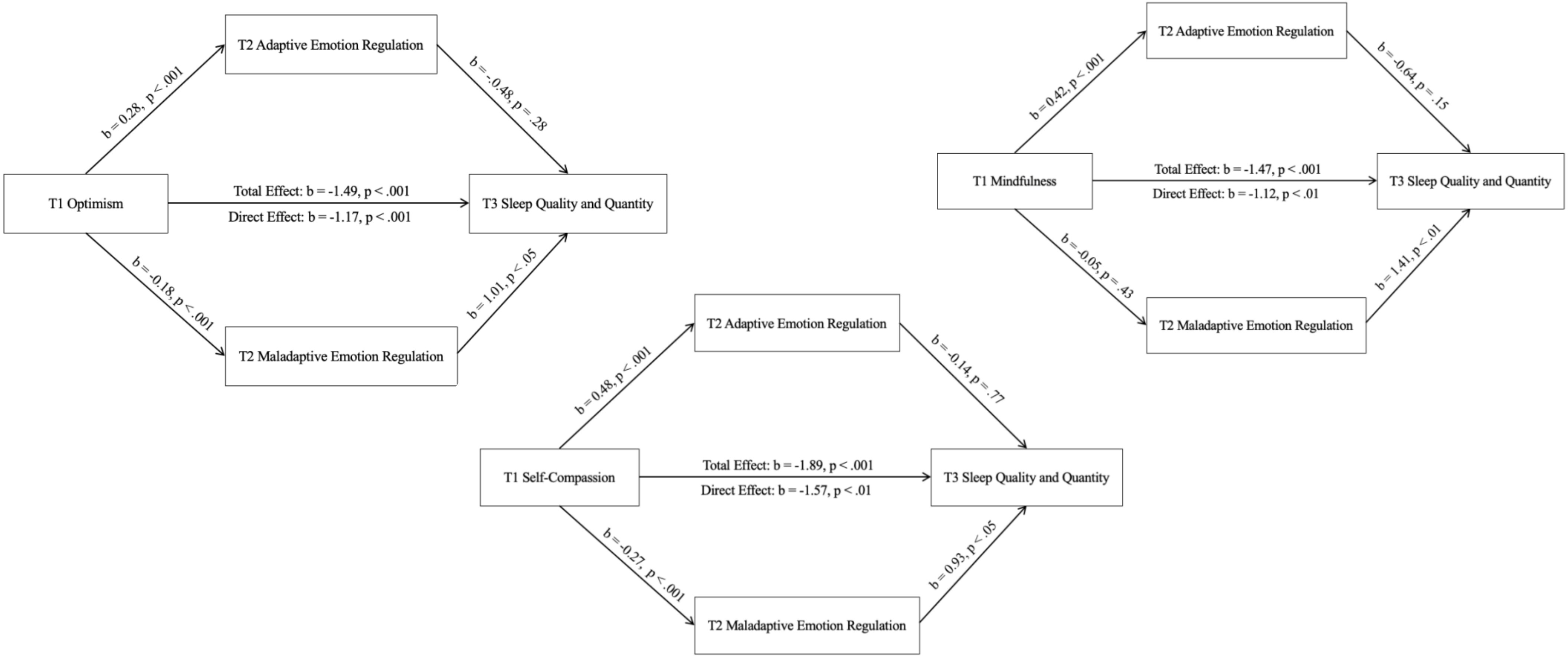


Figure 2. *Mediation analyses displaying the associations between levels of optimism, self-compassion and mindfulness at Time 1 and overall sleep quality and quantity at Time 3 through adaptive and maladaptive emotion regulation at Time 2*[7].

[7] Coefficients representing the relationships between positive psychological traits/adaptive emotion regulation and sleep quality and quantity are negative because better sleep quality and quantity is indicated by *lower* PSQI scores, while higher levels of the positive psychological traits/adaptive emotion regulation are indicated by higher scores. Relationships between maladaptive emotion regulation and sleep quality and quantity are positive because better sleep quality and quantity is indicated by *lower* PSQI scores, while higher levels of maladaptive emotion regulation are indicated by higher scores.

Discussion

The current study aimed to replicate and extend the findings of previous work by investigating whether gratitude, optimism, self-compassion and mindfulness could account for a significant proportion of variance in sleep quality and quantity cross-sectionally and predict subsequent changes in sleep over time. The opportunity was also taken to test for reverse causality. In addition, the role of emotion regulation as a potential common mediator of the relationships between the positive psychological traits and sleep was explored.

In support of the first hypothesis that, collectively, the four positive psychological traits would account for a significant proportion of variance in overall sleep quality and quantity cross-sectionally, the four positive traits were found to account for 21% of the variation in overall sleep. These results replicate the findings of previous cross-sectional work, wherein gratitude, optimism, self-compassion and mindfulness were found to collectively account for 16–25% of the variation in self-reported sleep outcomes (Tout et al., 2023b). In addition, within the present study, optimism and mindfulness emerged as significant linear predictors of sleep in their own right, further replicating the findings of Tout et al., (2023b) and supporting the idea that these traits make the largest independent contributions to sleep cross-sectionally.

Extending cross-sectional findings, the current study was the first to explore whether baseline levels of gratitude, optimism, self-compassion and mindfulness could collectively predict subsequent changes in sleep quality and quantity prospectively. Specifically, and in support of the second hypothesis that the positive traits at baseline would collectively predict subsequent changes in overall sleep quality and quantity at 12-weeks and 24-weeks, baseline levels of the positive traits were associated with better overall sleep quality and quantity at both time-points. These findings replicate and extend the results of previous cross-sectional work and add to the paucity of prospective research that has reported links between higher levels of individual positive traits such as optimism and mindfulness and better future sleep outcomes (Hernandez et al., 2020; Lau et al., 2015; 2017; Pagnini et al., 2019). Indeed, the current study also helps to integrate a growing body of literature that has focused on identifying significant links between each of these positive traits and sleep independently (Boggiss et al., 2020; Brown et al., 2021; Butz & Stahlberg, 2020; Ong & Moore, 2020; Sala et al., 2020; Tout et al., 2023a; 2023d), and demonstrates the importance of considering positive traits when it comes to predicting and facilitating good sleep quality and quantity in the future.

Interestingly, as with cross-sectional findings, prospective results also revealed that baseline optimism was a significant linear predictor of improvements in sleep quality and quantity at 12-weeks and 24-weeks, highlighting the ability of this positive trait to predict better long-term sleep outcomes, while self-compassion emerged as a significant linear predictor of sleep at 24-weeks only. Given that optimism consistently appears to make the largest independent contribution to sleep, it could be interesting for future interventions to incorporate an optimism component when attempting to improve sleep quality and quantity. Indeed, while gratitude, self-compassion and mindfulness interventions have been shown to improve sleep more recently (Boggiss et al., 2020; Brown et al., 2021; Ong & Moore, 2020), the effects of experimentally increasing optimism remain untested. Thus, promoting optimism could offer an additional and/or alternative component to current sleep interventions and provide individuals with a new, inexpensive and self-administrable solution to sleep problems in day-to-day life, without the negative side-effects of sedative medications (Shroeck et al., 2016) or demands of cognitive behavioural therapy for insomnia (Koffel et al., 2018).

When exploring the opposite direction of effect, better sleep at baseline was found to predict subsequent improvements in mindfulness and self-compassion (but not optimism or gratitude) at 12-weeks, but did not predict any of the positive traits at 24-weeks. Thus, while baseline positive traits predicted subsequent changes in sleep at 12-weeks and 24-weeks, a reciprocal causal relationship was not evident at 24-weeks, suggesting that sleep may have less of a long-term influence on future positive traits. Indeed, short-term sleep deprivation can inhibit frontal regions of the brain and associated cognitive functions (Lim & Dinges, 2010), which may *temporarily* inhibit an individual’s capacity to be mindful and/or self-compassionate as a result (Campbell et al., 2018; Woodruff & Stevens, 2018). Here, however, it is important to note that poor sleep was found to be associated with lower levels of future optimism in a study by Lau et al., (2017). Accordingly, further prospective research may be required to examine potential (bi)directional effects more thoroughly and clarify these mixed findings.

This study was also the first to explore the role of emotion regulation as a potential common mediator of the relationships between positive psychological traits and sleep quality and quantity via prospective methods. Results revealed that optimism and self-compassion had significant indirect effects on sleep via maladaptive emotion regulation; specifically, higher levels of optimism and self-compassion at baseline were associated with lower levels of maladaptive emotion regulation at 12-weeks, which in turn, related to better sleep quality and quantity at 24-weeks. These findings support the results of previous cross-sectional work, wherein maladaptive emotion regulation emerged as a common mediator of the relationships between each of the positive traits and sleep (Tout et al., 2023b, Study 2). Indeed, previous findings have also linked self-compassion to sleep via reductions in rumination and self-blame – maladaptive emotion regulation strategies (Butz & Stahlberg, 2018; Semenchuk et al., 2022). However, in contrast to previous work (Tout et al., 2023b, Study 2), maladaptive emotion regulation did not emerge as a significant mediator of the relationship between mindfulness and sleep, despite being significantly correlated with both variables. Here, it is important to note that the mediation via maladaptive emotion regulation was not full for optimism or self-compassion either. Thus, additional mechanisms are likely to be helpful when it comes to understanding these relationships, especially in the case of mindfulness, where other common and/or unique mediators could be more relevant. Previous research, for instance, has shown that clinically significant variables such as depression and/or anxiety may also mediate the relationships between each of gratitude (Alkozei et al., 2019; Hirsch et al., 2021), optimism (Hernandez et al., 2020; Lau et al., 2015; 2017; Uchino et al., 2017; Weitzer et al., 2021), self-compassion (Bian et al., 2020), mindfulness (Bogusch et al., 2018) and sleep, thus providing interesting candidates for common mechanisms in future study.

In contrast, adaptive emotion regulation did not mediate the effects of optimism, self-compassion or mindfulness on sleep. These findings are surprising given that each of these positive psychological traits has previously been associated with an increased tendency to engage in adaptive emotion regulation strategies (Finlay-Jones, 2017; Roemer et al., 2015; Zou & Yuan, 2021), and that adaptive emotion regulation has generally been linked to better sleep outcomes (Cheng et al., 2020; Fairholme & Manber, 2015; Vandekerckhove & Wang, 2018). Despite this, relationships between adaptive emotion regulation and sleep do appear to be more mixed in the literature (Palmer et al., 2018; Reddy et al., 2017). Results are also consistent with previous cross-sectional work, wherein adaptive emotion regulation was not found to mediate the relationships between gratitude, optimism, self-compassion or mindfulness and sleep (Tout et al., 2023b, Study 2). Thus, when it comes to sleep as a specific health-related behaviour, positive psychological traits may not exert their benefits via an ‘upward spiral’ of adaptive emotion regulation resources as current theories might expect (Fredrickson, 2001; 2014). Instead, positive traits may be more relevant when it comes to reducing engagement in maladaptive emotion regulation and ‘undoing’ any associated negative effects (Fredrickson & Joiner, 2018; Garland et al., 2010).

While the current study has replicated and extended previous research and overcome the constraints of cross-sectional mediation by employing a prospective design, there are some limitations to consider. Firstly, this study involved an opportunistic, female-dominated, student sample; further research is therefore needed to determine whether findings can be replicated in samples that are more demographically representative of the wider population. For instance, while cross-sectional relationships between positive traits and sleep seem fairly consistent upon first glance, there is some evidence to suggest that the relationship between optimism and sleep could be influenced by demographic variables such as gender and age (Tout et al., 2023d). Interestingly, demographic differences in participant retention were also found, with participants who identified as non-White being more likely to drop out of the study. Indeed, research suggests that individuals from minority groups often feel less socially connected to their communities, leading them to drop out of survey-based research (Ofstedal & Weir, 2011). Future work could therefore attempt to supplement self-administered surveys with interviewer-administered telephone follow-ups, as this has been shown to reduce such differentials (Ofstedal & Weir, 2011). Secondly, assessments of sleep were based purely on subjective self-report measures, meaning it remains unclear whether these positive traits also relate to objective levels of sleep quality or quantity, although reviews have suggested that optimism and mindfulness do in some instances (Tout et al., 2023d; Ong & Smith, 2017). While objective assessments could help to verify relationships between subjective measures, the importance of self-report should not be overlooked when self-referral is the predominant means by which individuals seek help for problems with sleep (Wood et al., 2009). Indeed, discrepancies in subjective and objective sleep are a common feature of clinical insomnia – described as the *subjective* inability to get to sleep or stay asleep despite adequate opportunity to do so (Edinger et al., 2021; Kay et al., 2015) – and are only marginally correlated within themselves (Jackowska et al., 2016b).

In conclusion, the current study has replicated and extended previous findings by demonstrating that gratitude, optimism, self-compassion and mindfulness can predict subsequent improvements in sleep quality and quantity up to 24-weeks in the future. In line with current models of insomnia (Harvey, 2002; Ong et al., 2012;

Riemann et al., 2010), reductions in maladaptive emotion regulation could be one important means by which certain positive traits help to facilitate better sleep outcomes, although additional mechanisms should also be investigated. Overall, positive psychological traits should be considered when it comes to understanding, explaining and promoting future sleep outcomes, given their ability to predict improvements in overall sleep quality and quantity.

CHAPTER 4 – OPTIMISM AND SLEEP: A SYSTEMATIC SCOPING REVIEW AND META-ANALYSIS (TOUT, JESSOP & MILES, 2023d)

Abstract

Background. Optimism is associated with a variety of beneficial health and wellbeing outcomes, including better sleep; however, literature investigating the relationship between optimism and sleep has not been consolidated. *Purpose.* To provide a systematic scoping review of the optimism-sleep literature to date and quantitatively synthesise a subset of methodologically comparable studies. *Methods.* Systematic literature searches were conducted using PsycINFO and Web of Science databases. Search terms required the presence of "*optimis**" AND "*sleep*" OR "*insomnia*" in the abstract. Results were refined by type, language and methodology, and were only included if the study contained a measure of sleep *and* optimism *and* tested for a statistical association between them. A random effects meta-analysis was used to synthesise a subset of methodologically comparable studies. *Results.* A total of 32 independent articles met the inclusion criteria for review, 29 of which reported some statistically significant association between levels of optimism and sleep. The majority of studies used self-report measures, with the Life-Orientation Test Revised (LOT-R) and Pittsburgh Sleep Quality Index (PSQI) comprising the most frequently utilized measures of optimism and sleep, respectively. For a subset of studies reporting cross-sectional correlations between these measures (n = 6), a meta-analysis revealed that higher levels of optimism were significantly associated with better overall sleep, r = .30, 95%CI[.21, .39]. *Conclusions.* Optimism is consistently associated with better subjective sleep outcomes; however, research has not yet explored whether optimism interventions can improve sleep, and associations with objective sleep measures remain mixed.

Introduction

Optimism refers to the general expectation that more good things will happen in the future than bad (Carver & Scheier, 2014; Carver et al., 2010), with optimistic individuals being more likely to regard positive events as permanent, pervasive and the result of internal rather than external causes (Gillham et al., 2001). Current theories suggest that optimism functions as a positive psychological resource and encourages the use of approach-based coping strategies in the face of problems (Nes & Segerstrom, 2006). Indeed, compared to pessimists, optimists are more proactive and motivated to pursue their goals, and are more likely to seek out health information, engage in positive health-related behaviours and draw upon social support (Carver & Scheier, 2014; Scheier et al., 2001). Thus, it is not surprising that optimism has been associated with a variety of beneficial health and wellbeing outcomes, including a decreased risk of cardiovascular problems (Boehm et al., 2018), lower levels of inflammation and disease (Rasmussen, Scheier & Greenhouse, 2009), less stress (Baumgartner, Schneider & Capiola, 2018), and higher levels of psychological wellbeing (Ferguson & Goodwin, 2010; Scheier, Carver & Bridges, 2001).

One important health-related behaviour that has been linked to optimism recently, is sleep – a non-negotiable biological state essential for the maintenance of good health and wellbeing (Grandner et al., 2019; Walker 2021). In support of its relevance to sleep, optimism has been found to predict sleep regardless of circadian preference (Lau et al., 2017), predict insomnia symptoms over and above anxiety and neuroticism (Ren et al., 2019), and predict daily sleep quality and quantity over and above other positive traits such as gratitude (Newman et al., 2021). Indeed, associations between optimism and sleep may also help to account for the associations between optimism and physical health mentioned above, given that insufficient sleep has been linked to many of the same health risks as lower levels of optimism (Hernandez et al., 2020). However, while there have been attempts to review the literature linking optimism to physical health more widely (Rasmussen et al., 2009; Scheier & Carver, 2018), research exploring associations between optimism and sleep has yet to be subject to systematic review and/or meta-analysis. This is perhaps especially surprising given the importance of sleep to overall health, and the increasing volume of studies that have now demonstrated significant associations between this positive trait and sleep.

The majority of the published research on optimism and sleep to date has focused on cross-sectional associations; for example, Lemola et al., (2013) found that lower levels of optimism were related to higher levels of self-reported insomnia and shorter sleep durations (as well as excessively long sleep durations of more than 9hrs). Interestingly, these relationships held even when controlling for demographic variables, suggesting there may be something unique about optimism when it comes to predicting sleep outcomes independent of other characteristics (Lemola et al., 2013). Subsequent studies have since replicated these cross-sectional associations (Song et al., 2020; Uchino et al., 2017; Weitzer et al., 2021).

Although fewer prospective studies appear to have examined links between optimism and sleep, these are nevertheless informative given that cross-sectional studies can only demonstrate that higher levels of optimism *relate* to better sleep outcomes and cannot lead to conclusions of causality and/or temporal ordering of events. In a recent prospective study by Hernandez et al., (2020), a 1-standard deviation increase in baseline optimism was related to an increased odds of reporting very good sleep quality up to five-years later, and a 22% improvement in overall sleep quality and quantity as assessed via the Pittsburgh Sleep Quality Index (PSQI). Further prospective work by Lau et al., (2015; 2017) has demonstrated that the links between optimism and sleep could be bidirectional in nature, with poor sleep also aggravating future pessimism. Consequently, identifying and integrating the findings of recent prospective work alongside cross-sectional findings is important for furthering current understanding, elucidating causal links and clarifying bidirectional relationships.

In addition, while the majority of aforementioned studies have assessed sleep via subjective self-report measures, a review of the wider literature will also help to identify studies that have investigated the links between optimism and objective assessments of sleep. Integrating the results of objective work may help to verify subjective findings and/or further clarify the correlates of this positive trait. Indeed, studies that have used objective measures of sleep seem to demonstrate a higher degree of variability when it comes to the relationships between optimism and sleep; for example, while Lemola et al., (2011) found that children rated as highly optimistic by their parents had optimum sleep durations and shorter sleep latencies as assessed via wristwatch actigraphy, Mezick et al., (2010) reported no relationship between levels of optimism and sleep latency or fragmentation assessed via this method. Similarly, in the prospective study by Hernandez et al., (2020), higher levels of optimism were reported to be associated with objective measures of sleep efficiency, but not objective sleep latency or duration (Hernandez et al., 2020).

As well as providing an up-to-date consolidation of the wider literature, a systematic review may also help to highlight optimism as a potential target for sleep intervention. Indeed, while the use of an optimism intervention has not yet been explored in this regard, recent studies have recommended exploring their use when it comes to improving sleep outcomes (Hernandez et al., 2020; Weitzer et al., 2021). Certainly, calls for new and integrative approaches to sleep medicine have acknowledged the importance of considering positive psychological traits such as optimism in the development of new sleep interventions

(Wickwire, 2021), with the side-effects of sedative medications and constraints of cognitive behavioural therapy for insomnia highlighting the need for new approaches (Koffel et al., 2018; Qaseem et al., 2016; Schroeck et al., 2016). Thus, the findings of a review could add weight to individual research projects calling for the need to examine this future research direction (Hernandez et al., 2020; Weitzer et al., 2021).

Overall, a sizeable body of literature has now linked higher levels of optimism to better sleep; however, while there have been reviews of the links between optimism and health and wellbeing more widely (Rasmussen et al., 2009; Scheier & Carver, 2018), research to date has not yet attempted to systematically review the links between optimism and sleep. As a result, the strength and consistency of relationships between optimism and sleep across sample populations, assessment measures and study designs remains unclear; understanding of underlying mechanisms, causal links and direction(s) of effect remains limited; and avenues for future research remain to be determined. In light of the above, the current study aimed to provide a systematic scoping review of the optimism-sleep literature to date and conducted a meta-analysis on a subset of methodologically comparable cross-sectional studies in an effort to provide some meaningful conclusion of overall effect size.

Method

The current review was conducted according to the PRISMA guidelines (see Figure 3 for a flow diagram of the literature search and article selection).

Search Strategy

Systematic literature searches were conducted on the 3rd of February 2022 using PsycINFO and Web of Science databases. Search terms required the presence of both "*optimism*" OR "*optimist*" OR "*optimistic*" AND "*sleep*" OR "*insomnia*" in the abstract. Results were downloaded into *Endnote* and exported into *Rayyan*, where duplicates were removed, and articles were assessed for eligibility. Reviews were not included but were examined for additional sources, as were the reference lists and citing articles of eligible studies. The researcher's own database of studies linking optimism and sleep was also consulted.

Eligibility

After removing duplicates, results were refined by type (*journal article or dissertation*), language (*available in English*) and methodology (*quantitative*). Results were further excluded if the abstract was clearly irrelevant to the current review, such as when search terms appeared out of context (e.g., "…we are *optimistic* that"). The remaining articles were then read and excluded if they did not include a specific measure of *both* sleep *and* optimism *and* report on the unique statistical association between them. Measures that provided composite scores for general physical health and/or levels of daytime sleepiness were not considered to be specific measures of sleep. Similarly, measures that provided composite scores for general positive personality were not considered to be specific measures of optimism, nor were assessments that asked about optimism in relation to a specific situation or event (e.g., the Covid-19 pandemic).

Data Extraction

Studies meeting the inclusion criteria were examined for: year of publication, study design, sample size, participant characteristics (population, mean age, percent female), key outcome measures, conclusions of significance and all associated statistical results. For studies that included multiple measures of optimism and/or sleep, an effort was made to extract all relevant statistical results in order to avoid bias in the reporting of significant findings. Studies that cited $p > .05$ as significant were not considered significant for the purposes of the current review. For studies where the effect size was not reported, but sufficient data were present to calculate it, an effect size was calculated. A summary table of the extracted articles and their characteristics can be found in Table 6.

Statistical Analysis

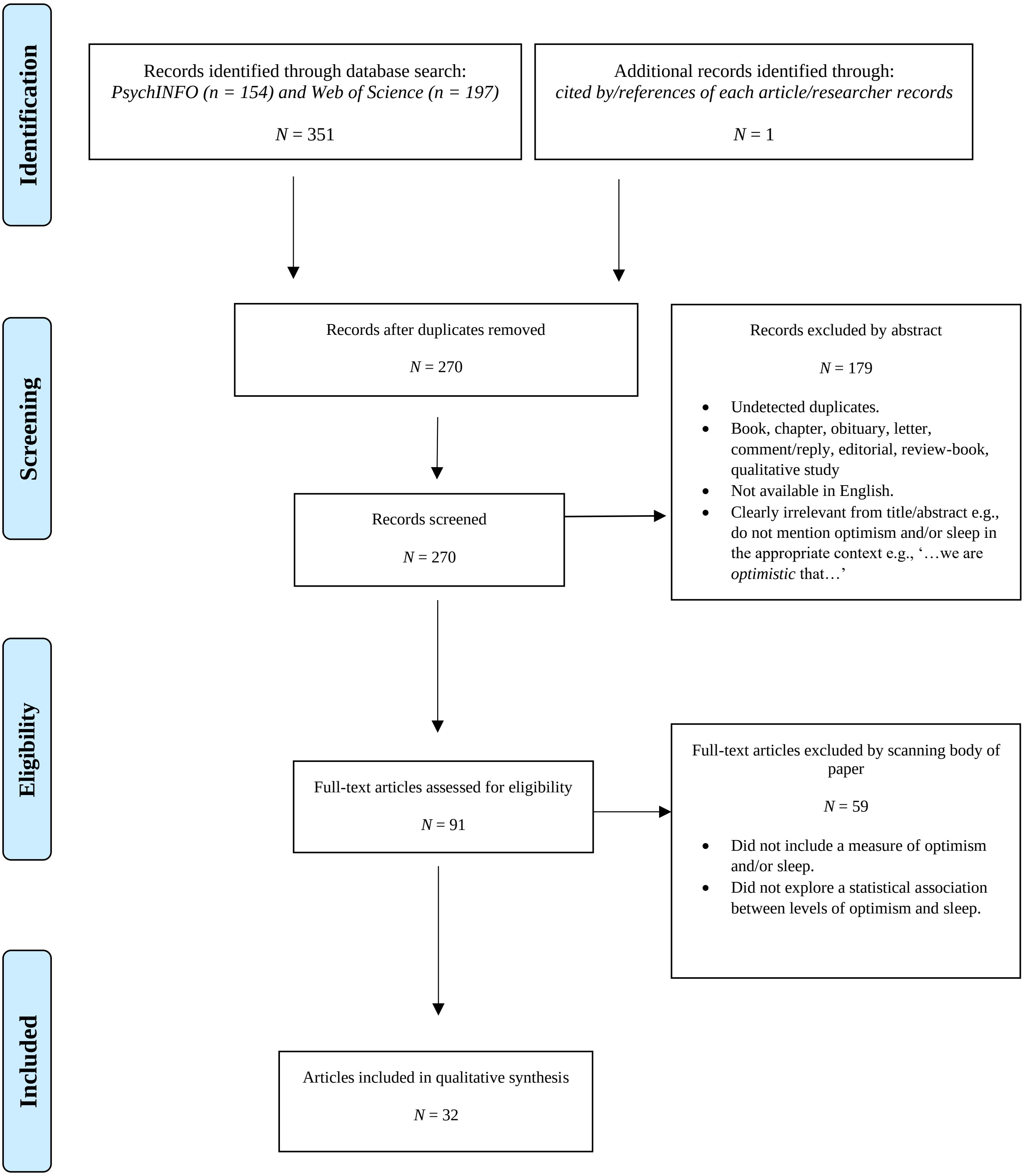
Upon reviewing the articles included the final synthesis, it became apparent that a subset of cross-sectional studies assessed correlational relationships between optimism and sleep via similar methodologies, rendering their findings comparable. Accordingly, for studies that provided a sample size and reported cross-sectional correlations between optimism (as assessed via the Life Orientation Test-Revised; Scheier et al., 1994) and overall sleep quality and quantity (as assessed via the Pittsburgh Sleep Quality Index; Buysse et al., 1989), a random effects meta-analysis was conducted using the *Metafor* package in R (Viechtbauer, 2010).

Pearson's r was used to provide the measure of effect size; r values were first transformed into Fisher's z before being converted back into r for interpretation of the final result. Q and I^2 statistics were used to assess levels of heterogeneity (a non-significant Q statistic and lower percentage score on the I^2 test indicate lower levels of heterogeneity;

Higgins et al., 2003). To determine which studies contributed most to levels of heterogeneity, a Baujat plot was constructed. Influential cases were identified using the influence function, wherein studies marked with an asterisk fulfil the criteria for an influential study. Publication bias was assessed via inspection of a funnel plot, the Egger's regression test and the Kendall rank correlation test, wherein asymmetry and significant results suggest evidence of bias. A quality analysis was also carried out on the six studies using the STROBE 22-item checklist for cross-sectional reports (Von Elm et al., 2007).

Figure 3.

PRISMA flow diagram.



Results

Study Selection

The database search yielded a total of 351 results. One further record was identified via the researcher's own database. After duplicates were removed, a total of 270 articles remained and were reviewed for eligibility. Thirty-two independent articles met the inclusion criteria for review, including three dissertations. A summary table of the extracted articles and their characteristics can be found in Table 6. In two instances, the same participant sample was used to produce two distinct articles (first instance: Jackowska et al., 2016a and 2016b; second instance: Sing & Wong, 2010 and 2011). As these articles were published separately and included slight variations in method, measures and/or results, they have been listed as separate studies in Table 6; however, participants were not counted twice when it came to calculating the total number of unique participants below, nor were these studies included twice when it came to the quantitative synthesis.

Of the 32 eligible studies, 24 provided results based on cross-sectional research designs (including one cross-cultural study; Doolin et al., 2018). Six studies explored prospective data (Culver, 2002; Dragun et al., 2020; Hernandez et al., 2020; Lau et al., 2015; 2017; Ren et al., 2019). One study used ecological momentary assessment data (Newman et al., 2021), and one observational study explored categorical differences between naturally short sleepers (3 – 6hrs) and normal sleepers (7 – 8.5hrs; Monk et al., 2001).

Sample Characteristics

A total of 43,915 unique participants took part in the 32 studies, with sample sizes ranging from 24 to 9,284 (M = 1,463.83 SD = 2,318.95). Out of the 30 studies that provided mean age values, the average age was 41.71 years (SD = 18.58), with average ages ranging from 8.15

years to 84.3 years. The majority of studies had a larger percentage of females than males (average percent female = 67.53%, *SD* = 25.36), with eight studies recruiting female participants only (Conway et al., 2008; Culver, 2002; Danhauer et al., 2019; Jackowska et al., 2016a; 2016b; Ren et al., 2019; Shirazi et al., 2016; Wiedman, 2014) and one study recruiting male participants only (Allen et al., 2021). All studies were conducted *on or after* the year 2001, 21 of which (65.60%) were conducted within the last 10 years, highlighting the recent increase of research in this area.

Many studies (12 out of 32) involved community samples of adults and/or working adults (Elo et al., 2003; Hernandez et al., 2020; Hinz et al., 2017; Lau et al., 2015; Lemola et al., 2013; Mathur et al., 2018; Mezick et al., 2010; Monk et al., 2001; Schou-Bredal et al., 2021; Song et al., 2020; Uchino et al., 2017; Weitzer et al., 2019; Williams 2009). Eight studies used students (Doolin et al., 2018; Dragun et al., 2020; Jackowska et al., 2016a; 2016b; Lau et al., 2017; Sing & Wong 2010; 2011; Zawadzki, 2015), two of which also included university staff (Jackowska et al., 2016a; 2016b). Other studies examined specific populations, such MyBPLab app users (Newman et al., 2021), caregivers of individuals with cancer (Carter & Acton, 2006), men over the age of 65 (Allen et al., 2021), spousal dyads (Strawbridge et al., 2004), grandmothers (Conway et al., 2008), pregnant women (Shirazi et al., 2016), mothers of nine-month-old infants (Wiedman, 2014), and eight-year-old children (Lemola et al., 2011). The remaining studies involved patient samples, including patients with Type 2 diabetes (Danhauer et al., 2019) and women with breast cancer (Culver, 2002; Ren et al., 2019). To this point, there do not appear to be any systematic differences in significant results between age groups or sample characteristics.

Outcome Measures

The measures used to assess optimism and sleep across studies are summarised in Table 6. It can be seen that the majority of studies used subjective self-report measures to assess optimism (31 out of 32), while one study used parent-rated assessments of optimism in children. Subjective self-reports were also the most common method used to assess sleep (30 out of 32 studies); however, objective sleep assessments were also included in four studies – two of which relied upon objective assessments exclusively. To this point, relationships between optimism and objective sleep measures appear to be more variable than relationships between optimism and subjective sleep measures.

Optimism. The Life-Orientation Test-Revised (LOT-R; Scheier et al., 1994) was the most commonly used method of assessing optimism and was used in 25 out of 32 studies. A further study used the unrevised version of the Life Orientation Test (LOT; Scheier & Carver, 1985), and one study used the Parent-Rated Life Orientation Test (P-LOT; Lemola et al., 2010). Other measures used to provide a measure of optimism included an adapted, Chinese version of the Attributional Style Questionnaire (ASQ; Lau et al., 2015), an optimistic worldview questionnaire, and single items/visual analogue scales.

Sleep. Sleep measures were more varied; however, the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) was the most frequently used method of assessing overall sleep quality and quantity and was used in 14 out of 32 studies. Two studies also used selected items from, or items based on, the PSQI. Four studies used wristwatch actigraphy to provide objective measures of sleep, one of which also used polysomnography. The Insomnia Severity Index (ISI; Morin et al., 2011) was used in two studies, while another study assessed sleep disturbances via the five-item Women's Health Initiative Insomnia Rating Scale (WHIIRS;

Levine et al., 2003). Other studies used the sleep disturbance/disorder subscales from the General Health Questionnaire (GHQ; Goldberg & Williams, 1988), the Patient Reported Outcomes Measurement Information System (PROMIS; Cella et al., 2007), and the Comprehensive Assessment and Referral Evaluation instrument (CARE; Teresi et al., 1984). The remaining studies used single items to assess sleep quality, sleep duration and insomnia or multiple items to assess different components of sleep.

Statistical Significance

Out of the 32 studies, 29 reported some statistically significant association between levels of optimism and sleep. In all instances, higher levels of optimism were associated with better sleep outcomes. The three non-significant findings came from one study that looked at differences in levels optimism (LOT-R) between *naturally* short sleepers (3 – 6hrs) and normal sleepers (7 – 8.5hrs; Monk et al., 2001), one study that used the PROMIS sleep scale and the unrevised version of the LOT (Mathur et al., 2018) and one study that used purely objective sleep measures and the LOT-R (Mezick et al., 2010).

Quantitative Synthesis of Results

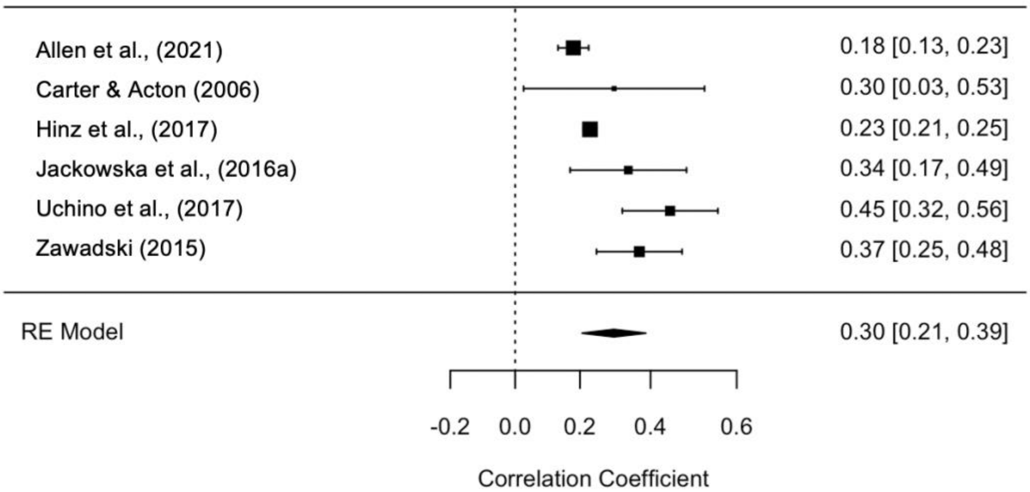
For the six cross-sectional studies that reported a correlation between optimism (assessed via the LOT-R) and overall sleep quality and quantity (assessed via the PSQI) in independent population samples[8] (Allen et al., 2021; Carter & Acton, 2006; Hinz et al., 2017; Jackowska et al., 2016a; Uchino et al., 2017; Zawadzki, 2015), a random effects meta-analysis revealed a

[8] In Jackowska et al., 2016a and 2016b, the same sample population (i.e., 119 women from UCL) was used to provide a relationship between optimism and sleep. To maintain statistical independence, only 2016a has been included when calculating the mean effect size.

significant association, whereby higher levels of optimism indicated better overall sleep quality and quantity (r = .30, 95%CI[.21, .41])[9]. See Figure 4 for a forest plot.

Figure 4

Forest plot of observed associations between optimism and overall sleep quality and quantity in the included studies.



Cochrane's Q was significant, suggesting the included studies may not share a common effect size: $q(5) = 22.39$, $p = .0004$. The I^2 statistic was 88.99 (95%CI [57.79, 98.09]) suggesting that 88.99% of the observed variation in effect sizes could be due to heterogeneity. Inspection of the Baujat plot revealed Study 1 (Allen et al., 2021) and Study 5 (Uchino et al., 2017) as significant sources of heterogeneity. These studies also fulfilled the criteria for influential cases using the influence function. When examining study attributes, both studies involved samples of older-aged participants (mean age = 84.3 years and 60.1 years, respectively), while the study by Allen et al., (2021) included male participants only, suggesting that the relationship between optimism and sleep could be more variable in such

[9]Some correlations were reported as negative in the original articles – high scores on the PSQI indicate *poor* sleep, while high scores on the LOT-R indicate high optimism. For ease of interpretation, correlations are reported as positive when reporting mean effect sizes to reflect the positive relationships between these two variables (i.e., higher levels of optimism are associated with better sleep quality and quantity).

samples. When assessing for publication bias, inspection of the funnel plot showed asymmetry and Egger's regression test was marginally significant, thus suggesting publication bias ($Z = 2.01$, $p = .044$); however, the rank correlation test was non-significant, suggesting no evidence of publication bias (Kendall $\tau = .20$, $p = .719$). The reporting quality of the studies was relatively high, with the six studies meeting an average of 17/22 STROBE checklist items. Indeed, the research objectives, variable descriptions, outcome data, statistical analyses and limitations were all well documented within each of the studies. Underreported domains included: not reporting how potential sources of bias were addressed (4/6), not providing a sample size rationale (4/6), and not describing how missing data was handled (4/6).

Table 6. *Characteristics of included studies.*

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Allen et al., (2021)	Cross-sectional	1,670 community dwelling ambulatory men aged 65+	84.3	0	LOT-R; PSQI	Optimism and overall sleep quality and quantity were significantly correlated.	r = -.*18*
Carter & Acton (2006)	Cross-sectional	51 adult caregivers of individuals with cancer	53.65	80.40	LOT-R; PSQI	Optimism and overall sleep quality and quantity were significantly correlated.	r = -.30
Conway et al., (2008)	Cross-sectional	67 African American and Latino grandmothers	59.1	100	LOT-R; Sleep disorder subscale from a wider CARE physical health scale.	Optimism and sleep disorder were significantly associated in grandmothers <65, but not in grandmothers 65+	*<65:* r = -.36 65+: r = .04
Culver (2002) – Dissertation	Prospective – baseline prior to surgery, 3-months, 6-months and 12-months post-surgery.	128 women with early-stage breast cancer	50.09	100	LOT-R; Subset of items from the PSQI	Baseline optimism was significantly related to sleep quality 3-months, 6-months and 12-months post-surgery.	3-months: β = .28 6-months: β = .27 12-months: β = .31
Danhauer et al., (2019)	Cross-sectional	8,895 women with T2 diabetes from the Women's Health Initiative (WHI).	63.80	100	LOT-R; 5-item WHIIRS to assess sleep disturbance.	Optimism and sleep disturbance were significantly related.	r = -.19
Doolin et al., (2018)	Cross-sectional/cultural	140 psychology undergraduate students (80 USA; 60 Bolivia)	24.9	80.45 75.9 USA; 85 Bolivia	9-item optimistic worldview scale; 4-item sleep quality index based on PSQI, sleep deprivation; sleep hygiene.	Optimistic worldview was not different between countries and was a significant predictor of sleep quality, even when controlling for stress, country and sleep deprivation/sleep hygiene.	Sleep quality: b = -.49 Sleep quality controlling for other variables: b = -.30

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Dragun et al., (2020)	Prospective	1,326 students pre-Covid; 531 students during Covid lockdown	18 Pre-Covid: 18.00; Post-Covid: 18.00	68.05 Pre-Covid: 63.8; Post-Covid: 72.3	Optimism for the future on a 0-10 scale; 3 sleep-items (bedtime, waketime, to calculate duration, how refreshed upon awakening).	Pre-covid, optimism was significantly associated with workday sleep duration (even when controlling for age, gender and study group), but not non-working day sleep duration. During covid, optimism was marginally associated with sleep duration (p = .05).	Sleep duration pre-covid: workdays: r = -.06; non-workdays: r = -.01; Sleep duration during covid: r =.09
Elo et al., (2003)	Cross-sectional	1,015 Nordic employees	NR	NR	LOT-R; Sleep disturbance scale from the GHQ	Significant correlation between optimism and sleep disturbance.	r = -.23
Hernandez et al., (2020)	Prospective	3,548 adults from the coronary artery risk development in young adults study	40.2	55.8	LOT-R; sleep quality and duration; insomnia (3 yes/no items – difficulty falling asleep, awakenings, early rising); subset of participants completed PSQI; actigraphy	Cross-sectional: 1SD greater optimism = sufficient sleep duration (6 to <9hrs), fewer insomnia symptoms, better PSQI score, and less daytime sleepiness. Prospective: 1SD greater optimism at baseline = better sleep quality over 5-years (even when adjusting for sociodemographic variables, physical health; attenuated when controlling for depression). Objective: No association with duration or fragmentation but was associated with better efficiency.	Controlling for age, sex and race/ethnicity, cross-sectional: duration (OR = 1.31), no insomnia symptoms (OR = 1.97), very good sleep quality (OR = 3.58), PSQI (OR = 1.73), Prospective: persistently good sleep quality (OR = 2.01), duration (OR = 1.39). Objective: duration (OR = 1.17; NS), efficiency (OR = 1.22), fragmentation (OR = 1.08; NS).

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Hinz et al., (2017)	Cross-sectional	9,284 German community sample	56.3	52.4	LOT-R; PSQI	Significant relationship between optimism and PSQI.	PSQI: *r* = -.23
Jackowska et al., (2016a)	Cross-sectional relationships reported within a gratitude intervention study.	119 women from UCL (working or studying)	26.27	100	LOT-R; average daily sleep quality ratings; PSQI	Significant correlation between optimism and PSQI scores/daily sleep quality ratings.	PSQI: *r* = -.34 Daily sleep quality: *r* = -.25
Jackowska et al., (2016b)	Cross-sectional	119 women from UCL (working or studying)	26.7	100	LOT-R; PSQI (phrased in the last week); actigraphy; average daily sleep duration	Significant correlation between optimism and PSQI scores. No relationship between optimism and actigraphy (efficiency, duration, latency) measures.	PSQI: *r* = -.33; Daily duration: *r* = .08; efficiency: *r* = -.05; duration: *r* = .04; latency: *r* = .09
Lau et al., (2015)	Prospective	987 Chinese working adults	32.59	63.4	Adapted Chinese ASQ; PSQI	Optimism and sleep were significantly correlated at W1; W3; W1 to W3. Significant bi-directional relationship – W1 sleep predicts W3 optimism and W1 optimism predicts W3 sleep.	W1: *r* = -.21; W3: *r* = -.22; W1 sleep and W3 optimism: *r* = -.21; W1 optimism and W3 sleep: *r* = -.18. W1 optimism predicted W3 sleep (*b* = -.086); W1 sleep predicted W3 optimism (*b* = -.103)
Lau et al., (2017)	Prospective	1,684 full-time Chinese students	20.90	67.6	Adapted Chinese ASQ; PSQI	Optimism and sleep were significantly correlated at W1; W3; W1 -> W3. Significant bi-directional relationship – W1 sleep predicts W3 optimism and W1 optimism predicts W3 sleep.	W1: *r* = -.24; W3: *r* = -.29; W1 sleep and W3 optimism: *r* = -.22; W1 optimism and W3 sleep: *r* = -.19. W1 optimism predicted W3 sleep (*b* = -.082); W1 sleep predicted W3 optimism: (*b* = -.088).

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Lemola et al., (2011)	Cross-sectional	291 8-year-old children	8.15	51.55	P-LOT; Actigraphy to assess sleep duration, efficiency and latency	Significant non-linear relationship with duration (short/long sleepers have lower optimism). Optimism significantly related to shorter sleep latency (even when adjusting for sociodemographic variables and parent optimism), but not related to efficiency.	Non-linear effect on duration: β = -.15; Linear effect on latency: β = -.15; No linear effect on efficiency: β = .07
Lemola et al., (2013)	Cross-sectional	1,805 community-based sample of adults	56.9	54.7	LOT-R; 3-items to assess insomnia symptoms; sleep duration (averaged over workdays/non-workdays).	Significant relationship between optimism and insomnia symptoms and optimism and overall sleep duration (short sleepers are sig. lower in optimism, long duration not associated with optimism). Independent of age, sex and depression/insomnia symptoms.	Duration: *r* = .11 (<6hrs, *r* = -.22; >9hrs, *r* = -.06). Insomnia symptoms: *r* = -.22
Mathur et al., (2018)	Cross-sectional	265 midlife community adults	46.4	65	LOT; PROMIS scale of sleep disturbance	No significant relationship between optimism and sleep disturbance and no difference in sleep disturbance between high vs. low optimists.	*r* = .09 *d* = .02
Mezick et al., (2010)	Cross-sectional	224 community-based adults from Heart SCORE study	60	50.4	LOT-R; 2 nights of PSG (to identify sleep apnea and % stage 1 sleep); 9 nights of actigraphy (sleep latency and fragmentation).	Optimism was not correlated with sleep latency, sleep fragmentation, % stage 1 sleep or apnea-hypopnea index.	Latency: *r* = .-.05; Fragmentation: r = .06; % Stage 1: *r* = -.06; apnea/hypopnea index: *r = -.01*

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Monk et al., (2001)	Observational Study – naturally short sleepers (3-6hrs) vs. matched normal sleepers (7-8.5hrs).	24 (12 short sleepers vs. 12 normal sleepers).	40.01 Short: 39.62; Normal: 40.40	25	LOT-R; PSQI; 2-week Pittsburgh sleep diary; Sleep timing questionnaire	Controlling for sleep duration, there were no significant differences in optimism between naturally short sleepers and normal sleepers.	$t = .97$, $p > .25$ ($d = .50$).
Newman et al., (2021)	Ecological Momentary Assessment	1,923 MyBPLab app users across the globe (this number filled out sleep measures, although 4,825 took part overall).	42.79	34.46	LOT-R; single item to assess daily sleep quality	Optimism significantly predicted sleep quality (and also predicted it over and above gratitude when gratitude added to the model).	$b = .13/r = .34$
Ren et al., (2019)	Prospective	749 women with breast cancer	48.13	100	Chinese version of LOT-R (1-week pre-surgery) and ISI (4 weeks post-surgery).	Baseline optimism was significantly associated with less insomnia 4-weeks post-surgery and was a better predictor of insomnia vs. neuroticism and anxiety.	$\beta = -.33$
Schou-Bredal et al., (2021)	Cross-sectional	4,527 over 18s from a Norwegian community sample	18 to 90	84.55	LOT-R; Item to assess insomnia (yes/no/just in the last month)	Optimists had a significantly lower level (19.3% vs. 39.8%) of insomnia during the lockdown vs. pessimists ($p < .001$).	$\chi2(1, 4527) = 209.15$, $p < .001$)
Shirazi et al., (2016)	Cross-sectional	268 pregnant women	26	100	Positive psychological states questionnaire, included a distinct component of optimism; PSQI	Significant relationship between optimism and overall sleep quality and quantity.	$r = -.27$

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Sing & Wong (2010)	Cross-sectional	529 college students from Hong Kong	21.01	54.3	LOT-R; PSQI (score of >5 used to signify insomnia)	Optimism is significantly higher in non-insomniacs vs. insomniacs	Group difference in optimism: t = 3.40, p < .001 d = .32
Sing & Wong (2011)	Cross-sectional	529 college students from Hong Kong	21.01	54.3	LOT-R; PSQI	Optimism significantly associated with decreased insomnia after accounting for age, gender and social support. Insomnia mediates the relationship between optimism and depression (but does not moderate it).	$\beta = -.16$
Song et al., (2020)	Cross-sectional	709 working Chinese adults	35.35	74.2	LOT-R; ISI	Optimism was significantly associated with insomnia – 1SD more optimism associated with 47% lower insomnia.	OR = 0.47
Strawbridge et al., (2004)	Cross-sectional	810 husbands and wives (405 couples)	68.63 Husbands: 70.2; Wives = 67.06	50	LOT-R; 3-items to assess sleep problems (trouble falling asleep, waking up and not getting back to sleep, waking up very early).	Each 1SD decrease in optimism is significantly associated with 24% increase in sleep problems and 15% increase in partner's sleep problems.	Own: OR = 1.24 Partner: OR = 1.15
Uchino et al., (2017)	Cross-sectional	175 community sample of middle-aged to older adults	60.1	53.14	LOT-R; PSQI	Significant association between optimism and overall sleep quality and quantity. This remained while controlling for demographic variables.	r = -.45

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Weitzer et al., (2021)	Cross-sectional	1,004 adults in the Austrian Sleep Survey	42	50.5	LOT-R; clinical definition of insomnia (assessed via 4 criteria)	Significantly lower risk of chronic insomnia for those with high and intermediate optimism.	Intermediate: OR = 0.39; High: OR = 0.28
Wiedman (2014) - Dissertation	Cross-sectional	41 mothers (and their 9-month-old infants)	31.08	100	LOT-R; Self-reported sleep deprivation and actual sleep deprivation calculated from hours needed to function minus average amount of sleep per night (diaries).	*Self-rated* sleep deprivation was significantly associated with optimism, but optimism was not related to actual deprivation.	Self-rated deprivation: r = -.32. Actual deprivation: r = .05
Williams (2009) – Dissertation	Cross-sectional	1,439 aging adults over 51 from the 2004 wave of the Health and Retirement study	66.48	47.50	LOT-R; sleep disruption (difficulty falling asleep, waking during the night and not being able to return to sleep, trouble waking too early, feeling well-rested when waking).	After controlling for demographic variables, sleep disruption still significantly predicted lower optimism.	β = -.13
Zawadzki, (2015)	Cross-sectional	218 undergraduates from psychology and biobehavioral health courses	20.31	75.69	LOT-R; PSQI	Significant relationship between optimism and sleep.	r = -.37

Key: LOT-R = Life-Orientation Test-Revised; PSQI = Pittsburgh Sleep Quality Index; LOT = Life-Orientation Test; GHQ = General Health Questionnaire; WHIIRS = Women's Health Initiative Insomnia Rating Scale; ASQ = Attributional Style Questionnaire; W1 = Wave 1; W3 = Wave 3; P-LOT = Parent-rated Life-Orientation Test; PSG = Polysomnography; ISI = Insomnia Severity Index; NR = Not Reported. NS = Not Significant.

Note: Some correlations in Table 6 are reported as negative as per the reporting in the original study. The majority of negative correlations are the result of *high* scores on sleep outcomes measures such as the ISI and PSQI indicating *poor* sleep quality, whereas high optimism scores indicate higher levels of optimism in all instances.

Discussion

This study is the first to systematically review the optimism–sleep literature to date. Overall, there is compelling evidence for associations between optimism and sleep, with the vast majority of studies demonstrating statistically significant associations between levels of optimism and sleep across a wide range of sample populations, assessment measures and study designs. Specifically, higher levels of optimism were related to better sleep outcomes in 29 out of 32 studies. For a subset of six cross-sectional studies that provided a sample size and reported correlations between optimism (as assessed via the LOT-R) and sleep quality and quantity (as assessed via the PSQI), a random effects meta-analysis further revealed a significant, medium-sized, positive correlation between optimism and overall sleep quality and quantity (r = .30, 95%CI[.21, .39]), providing further evidence of an association between this positive trait and sleep.

Here, it is important to note that the quantitative synthesis of cross-sectional studies revealed significant levels of heterogeneity and a lack of consistent effect size, despite the fact all studies used the same measures for both optimism and sleep. Thus, it seems that relationships between optimism and sleep could be confounded by additional study attributes. Indeed, the two studies identified as being influential in the analysis both involved populations over the age of sixty (Allen et al., 2021; Uchino et al., 2017), with the study by Allen et al., (2021) reporting the smallest effect size in a sample of male participants. Consequently, age and gender may be sources of variation to consider when it comes to the relationship between optimism and sleep. Additionally, while efforts were made to incorporate grey literature (dissertations) and extract all relevant statistical results regardless of assessment measure and significance, the meta-analysis also suggested potential issues with publication bias. Accordingly, it is possible that links between optimism and sleep could be overstated within the literature more widely, and thus may contribute to the lack of non-significant findings observed within the current review, although levels of publication bias outside of the quantitative analysis are only speculative and cannot be concluded with certainty.

In addition to finding significant associations between higher levels of optimism and better sleep across the vast majority of cross-sectional studies (24/26), a consolidation of the wider literature has helped to identify and integrate the findings of prospective work, wherein higher levels of optimism were found to predict better future sleep outcomes in all instances (6/6). Within these studies, optimism was found to predict better sleep outcomes anywhere from one-month up to five-years in the future. The results of prospective findings build upon cross-sectional work, wherein causal relationships cannot be concluded, and further suggest that optimism may have a positive causal impact on sleep. In addition to addressing issues of causality, two prospective studies also explored the opposite direction of effect, within which, poor sleep was also found to aggravate future pessimism (Lau et al., 2015; 2017). It was therefore concluded that optimism and sleep may have a reciprocal relationship, wherein poor sleep can also have an adverse effect on cognitive function and emotion regulation, thus leading to reductions in optimism (Lau et al., 2015; 2017). Thus, while earlier levels of optimism predict future sleep, additional research may wish to more closely examine the opposite direction of effect, as at present, only two published studies examining reciprocal links have been identified.

When it comes to explaining why higher levels of optimism might be associated with better sleep outcomes, only a handful of studies to date appear to have investigated underlying mechanisms. Specifically, lower levels of depressive symptoms (Hernandez et al., 2020; Lau et al., 2015; 2017; Uchino et al., 2017; Weitzer et al., 2021), anxiety and stress (Lau et al., 2017), and higher levels of life satisfaction (Uchino et al., 2017), happiness (Weitzer et al., 2021) and good health (Weitzer et al., 2021) have all been identified as mediators. In accordance with these findings, and in line with theoretical ideas (Fredrickson, 2001; 2014), when it comes to sleep, optimism could therefore help to boost positive emotions and cultivate personal regulation resources, while also ‘undoing’ the negative effects of anxiety, stress and depression. Future efforts to identify and explore such mechanisms may therefore be necessary to begin situating relationships between optimism and sleep within a broader theoretical model and will help to move research on from replicating relationships to explaining why such relationships might occur.

Upon closer examination of non-significant findings, it is interesting that one study explored psychological differences between short-sleepers and normal sleepers, suggesting that the lack of significant findings could be due to a loss of variability that occurs when treating sleep duration as a dichotomous variable (Monk et al., 2001). Another study that reported a lack of association assessed sleep via purely objective measures (Mezick et al., 2010). Indeed, mixed results were found in *all* studies that incorporated objective sleep assessments, suggesting that consistency in previously reported relationships may arise from a relationship between optimism and subjective sleep. For instance, while optimum sleep duration and latency were linked to higher levels of optimism in a study by Lemola et al., (2011), sleep efficiency was not. In contrast, Hernandez et al., (2020), found that sleep efficiency *was* linked to optimism when controlling for age, gender and race/ethnicity, while sleep latency and duration were not. Indeed, the relationship between optimism and objective sleep efficiency also attenuated when controlling for additional sociodemographic factors and symptoms of psychological distress (Hernandez et al., 2020). Lastly, despite finding links with PSQI score, like Mezick et al., (2010), Jackowska et al., (2016b) reported no association between optimism and sleep duration, latency or efficiency as assessed via sleep actigraphy.

Clearly then, links between optimism and objective sleep may be more variable than links between optimism and self-reported sleep. Interestingly, subjective and objective sleep reports could be expected to have different relationships with optimism given that these differing methods of assessment are only marginally correlated within themselves (Fernandez-Medoza et al., 2011; Jackowska et al., 2016b; Kay et al., 2015). Indeed, while subjective sleep assessments correlate with psychological characteristics, objective sleep assessments are more likely to relate to other objectively assessed variables (Jackowska et al., 2016b). These ideas may help to explain why objective sleep measures *were* linked to optimism in the study by Lemola et al., (2011), wherein optimism was rated by parents while controlling for parental optimism – an arguably more objective rating that in turn related to objectively assessed sleep. Further, despite differences in objective sleep duration, *naturally* short sleepers and normal sleepers showed no differences in levels of optimism or subjective sleep quality (Monk et al., 2001). Accordingly, objective and subjective indicators of sleep may assess distinct phenomena and have distinct correlates (Jackowska et al., 2016b), thus helping to account for the apparent lack of corroboration between the two. Future research may therefore wish to continue examining the relationships between optimism and objective measures of sleep and further clarify the correlates of optimism, as at present, only a handful of studies have done so.

Interestingly, the most pressing research gap identified by the current review is the absence of research examining the effect of optimism interventions on sleep. This is especially surprising given that optimism interventions, such as the Best Possible Self intervention (BPS; King, 2001), have been shown to effectively improve other health and wellbeing-related outcomes (see Carrillo et al., 2019; Loveday et al., 2018; Malouff & Schutte, 2017 for reviews). Indeed, the vast body of research now linking higher levels of optimism to better sleep outcomes adds emphasis to recent calls coming from individual research projects to begin exploring the utility of optimism interventions for improving sleep outcomes (Hernandez et al., 2020; Weitzer et al., 2021). As well as helping to establish causal links, determining whether increasing optimism can facilitate improvements in sleep could also help to provide new and integrative, positive psychological approaches to sleep medicine and provide individuals with an inexpensive and self-administrable solution to improving sleep in their day-to-day lives (Wickwire, 2021). Certainly, the high levels of insufficient sleep and associated economic costs represent a significant public health concern (Chattu et al., 2019; Hafner et al., 2017; Kocevska et al., 2021; Liu et al., 2016), with the side-effects of pharmacological treatments and constraints of cognitive behavioural therapy for insomnia (CBT-I) highlighting the need for alternative sleep solutions (Koffel et al., 2018; Qaseem et al., 2016; Schroeck et al., 2016; Wickwire, 2021).

Overall, this review is the first to consolidate the optimism–sleep literature to date and demonstrates promising associations between higher levels of optimism and self-reported sleep quality and quantity, with quantitative synthesis providing further support for significant positive relationships. Accordingly, optimism may require a more prominent position within the current sleep literature and could offer a particularly relevant candidate in the development of new, positive solutions to sleep health. In addition, further prospective research may help to overcome the constraints of cross-sectional studies that currently dominate this area of literature and help to clarify potential (bi)directional effects as well as underlying mechanisms of action. Determining whether optimism is linked to objective sleep measures will also be important for clarifying the correlates of this positive trait.

CHAPTER 5 – CAN INCREASING OPTIMISM VIA THE BEST POSSIBLE SELF INTERVENTION LEAD TO IMPROVEMENTS IN SLEEP QUALITY AND QUANTITY? (TOUT, JESSOP & MILES, 2023e)

Abstract

Optimism interventions may present a novel, practical and inexpensive means of improving sleep quality and quantity; however, their utility in this regard remains untested. Using a student sample (*N* = 58), the current study aimed to explore whether students who completed an optimism intervention for one-week (Best Possible Self) demonstrated improvements in optimism and sleep quality and quantity, compared to students who completed an active control task (Daily Activities). Changes in future expectancies, affect and emotion regulation were also examined. Unexpectedly, results indicated significant main effects of Time only – students in *both* conditions showed increased levels of optimism and improved sleep quality and quantity at the one-week follow-up, as well as reductions in negative future expectancies and negative affect. In conclusion, further research is needed to establish whether an optimism intervention can bring about improvements in sleep quality and quantity.

Introduction

Poor sleep is related to a variety of negative physical and mental health outcomes, including increased risk of cardiovascular disease, stroke, cancer, diabetes, Alzheimer's disease, anxiety, depression and suicidality (Chattu et al., 2019; Itani et al., 2017; Tubbs & Grandner, 2021). Thus, with around a third of adults and one half of adolescents failing to achieve the recommended amount of sleep per night (Keyes et al., 2015; Liu et al., 2016; Owens et al., 2014), and rates of daytime sleepiness and insomnia on the rise (Kocevska et al., 2021; Owens et al., 2014), identifying interventions that promote good quality and quantity sleep should be a priority for public health.

Despite this, current intervention options remain few in number and are subject to a variety of limitations. For instance, pharmacological treatments induce sedation rather than naturalistic sleep and produce many harmful side-effects, as well as issues of tolerance and dependency (Glass et al., 2005; Schroeck et al., 2016). As a result, clinical practice guidelines have suggested de-prescribing certain sleep medications altogether (Pottie et al., 2018), and now recommend cognitive behavioural therapy for insomnia (CBT-I) as the first line of treatment (Edinger et al., 2021a; Qaseem et al., 2016). However, while CBT-I can be effective and may increase an individual's self-efficacy for sleep in the long-term, the significant amount of time and effort required makes it unsuitable for some individuals (Koffel et al., 2018; Matthews et al., 2013). CBT-I can also be difficult to access due to a lack of available specialists (Koffel et al., 2018; Thomas et al., 2016), as well as a lack of confidence and knowledge on the part of general practitioners, who are more likely prescribe medications and hand out general sleep hygiene advice as a result (Everitt et al., 2014) – although digital technologies are beginning to address this (Wickwire, 2019). Unfortunately, while emphasising the reduction of sleep-impairing factors such as caffeine, blue light and stress, general sleep hygiene advice is not an effective standalone treatment for sleep problems either (Irish et al., 2015; Owens et al., 2014; Stepanski & Wyatt, 2003). Thus, current intervention options for sleep remain limited, especially for those with subclinical sleep problems who may not require medications or CBT-I and may well be following standard sleep hygiene practices already.

In contrast to current treatments, positive psychology interventions could offer a relatively easy, inexpensive and self-efficacious means to improve sleep in the general population, by helping to increase positive emotions, foster resilience and buffer the impact of negative emotions and cognitions on sleep (Wickwire, 2021). Indeed, recent calls for new and integrative approaches to sleep medicine have emphasised the importance of considering positive psychological traits when it comes to promoting sleep health (Linley et al., 2009; Wickwire, 2021). In support of their potential utility, findings have demonstrated that interventions based on the promotion of positive psychological traits can optimise sleep; for example, gratitude (Boggiss et al., 2020), self-compassion (Butz & Stahlberg, 2020) and mindfulness (Ong & Moore, 2020) interventions have all been shown to have significant benefits for sleep quality and quantity.

Another modifiable positive psychological trait that may be a particularly promising target for intervention is optimism. Dispositional optimism refers to the general expectation that more good events will happen in the future than bad (Carver & Scheier, 2014), with optimistic individuals tending to perceive positive events as permanent, pervasive, and the result of internal rather than external causes (Gillham et al., 2001). Higher levels of optimism have been linked to better self-reported sleep quality and quantity cross-sectionally (e.g., Uchino et al., 2017; Weitzer et al., 2021) and prospectively (e.g., Lau et al., 2015; 2017; Hernandez et al., 2020), with the consistency of findings lending further support to the idea that this positive trait could help to facilitate sleep outcomes (see Tout et al., 2023d for a review). In addition to subjective self-reports of sleep, studies have also provided evidence that higher levels of optimism relate to objective measures in some instances, thus helping to address concerns that optimists simply report better sleep (Hernandez et al., 2020; Lemola et al., 2011; but see also Mezick et al., 2010). Research has further shown that optimism can predict daily sleep quality ratings over and above other positive traits such as gratitude (Newman et al., 2021), with the results of currently unpublished work demonstrating that optimism emerges as a significant linear predictor of improvements in sleep quality and quantity up to six-months in the future after accounting for shared variance with gratitude, self-compassion and mindfulness (Tout et al., 2023c). Overall, these findings highlight the unique relevance of optimism to sleep and suggest that increasing levels of optimism could provide an additional and/or alternative solution to sleep problems.

Given the above, it is surprising that research to date has not yet explored whether experimentally increasing optimism can lead to improvements in sleep quality and quantity. Indeed, while optimism interventions have been used to reduce other biomarkers of poor health and stress (Carrillo et al., 2019; Loveday et al., 2018; Malouff & Schutte, 2017), research has not yet explored whether experimentally increasing optimism can lead to improvements in sleep. Thus, determining whether optimism interventions facilitate sleep quality and quantity could help to identify a novel, practical and inexpensive means to target sleep problems, and in turn, benefit health and wellbeing more broadly (Hernandez et al., 2020; Tout et al., 2023d; Weitzer et al., 2021). Accordingly, the primary aim of the current study was to explore whether an optimism intervention – the Best Possible Self intervention (BPS intervention; King, 2001) – could improve optimism and sleep quality and quantity in a student sample. Students represent a population in which effective interventions may be especially important considering the particularly high levels of insufficient sleep and associated rates of depression and anxiety (Owens & Weiss, 2017).

The BPS intervention has been considered the most effective way of experimentally increasing optimism and requires individuals to imagine themselves in a future in which everything has turned out as well as it possibly could (Malouff & Schutte, 2017). Previous systematic reviews and meta-analyses have supported the effectiveness of the BPS intervention as a means to increase optimism and other positive health and wellbeing outcomes relative to an active-control task, wherein individuals are asked to imagine their typical daily activities (Carrillo et al., 2019; Loveday et al., 2018).

In addition to establishing whether an optimism intervention can improve levels of optimism and sleep quality and quantity, the current study also aimed to explore potential underlying mechanisms of effect. Notably, when it comes to understanding how optimism might facilitate better sleep, it has been suggested that optimism encourages adaptive mood regulation processes, with an increased sense of hope versus worry providing a buffer against the daily hassles and stressors that ordinarily impair sleep (Lau et al., 2015; 2017; Hernandez et al., 2020). Indeed, cross-sectional and longitudinal studies have demonstrated that optimism is associated with lower levels of maladaptive emotion regulation (i.e., rumination, catastrophising, self-blame and other blame), which in turn benefits overall sleep quality and quantity (Tout et al., 2023b, Study 2; 2023c. Interestingly, optimism interventions are also thought to facilitate self-regulation and emotional processing (Layous et al., 2013), supporting the idea that increasing optimism could facilitate reductions in sleep problems via these mechanisms. In light of the above, the opportunity was taken to explore whether the optimism intervention might also promote levels of future expectancies, emotion regulation and affect.

In sum, the following hypotheses were pre-registered:

1. Students who complete an optimism intervention (Best Possible Self) will exhibit significantly higher levels of optimism at one-week follow-up vs. baseline, while those who complete an active control task (Daily Activities) will not show any change in levels of optimism.

2. Students who complete the optimism intervention (Best Possible Self) will report better overall sleep quality and quantity as assessed by the Pittsburgh Sleep Quality Index (PSQI) at one-week follow-up vs. baseline, while those who complete an active control task (Daily Activities) will not show any change in overall sleep quality and quantity.

The current study also pre-registered an exploratory interest in potential underlying mechanisms of effect and took the opportunity to examine changes in future expectancies (positive and negative), affect (positive and negative) and emotion regulation (adaptive and maladaptive); however, no specific predictions were made regarding changes in any of these variables.

Method

The current study was pre-registered with the Open Science Framework (link) where associated sample size calculations are provided.

Participants

A total of 60 psychology undergraduate students recruited from a university in the South of England signed up to take part in the present study and met the inclusion criteria that they did not work night shifts or have a diagnosed sleep disorder[10]. Two participants did not respond to the post-intervention questionnaire, leaving a total of 58 participants for analysis (optimism condition, n = 28; active control condition, n = 30). Of these, 44 identified as female (75.86%), nine identified as male (15.52%), four identified as another gender (6.90%) and one elected not to say (1.72%). The mean age of the sample was 20.02 (SD = 1.82), with ages ranging from 18 to 28 years. The majority of participants indicated that their nationality was British (84.48%). When indicating their ethnicity, 40 participants described their ethnicity as White (68.97%), six (10.34%) identified as mixed / multiple ethnic groups, five (8.62%) identified as Asian / Asian British, four (6.90%) identified as another ethnic group and three (5.17%) identified as Black / African / Caribbean / Black British.

Design

The current study employed a mixed-model prospective design with the Experimental Condition (optimism condition vs. active control condition) as the between-subjects variable and Time (baseline vs. one-week follow-up) as the within-subjects variable.

[10] Recruitment occurred from the 3rd March 2022 until the 29th April 2022.

Procedure

Participants were recruited via SONA – an online participant recruitment tool in which students can sign-up to studies in exchange for course credits – and invited to take part in a 'Student Wellbeing Study'. Participants who signed up to the study were invited to a computer lab where they completed baseline assessment measures and the intervention task, hosted by the online survey platform Qualtrics. One-week later, participants were sent a link to a second online questionnaire where they completed follow-up assessment measures[11]. All participants provided their informed consent electronically on the first page of each questionnaire and were compensated for their time with course credits. The study protocol was approved by the Sciences and Technology Cross-Schools Research Ethics Committee at the hosting university.

Materials

Participants completed each of the following measures at baseline. Unless otherwise specified, and with the exception of the intervention, which was completed at baseline only, each of the following measures was also assessed at the one-week follow-up:

Demographic information. Participants were asked to provide their age, gender, nationality and ethnicity at baseline only.

Optimism. Optimism was assessed using the Life Orientation Test – Revised (LOT-R; Scheier et al., 1994), which includes six items to assess participants' levels of optimism (e.g., "Overall, I expect more good things to happen to me than bad"). Responses were given on a

[11] Study materials, including intervention instructions and questionnaires can be found via the OSF (link).

5-point Likert scale, ranging from *I disagree a lot* (1), to *I agree a lot* (5). Mean optimism scores were calculated for each participant at each time-point, with higher scores indicating higher levels of optimism (baseline: $\alpha = .86$; one-week follow-up: $\alpha = .90$).

Future Expectancies. As dispositional measures of optimism such as the LOT-R assess relatively stable, generalised future expectancies, we also explored positive and negative future expectancies via the Subjective Probability Task (MacLeod, 1996), which encompasses more specific life domains and may be more sensitive to temporal changes in optimism (Peters et al., 2010). The SPT consists of 10 statements referring to positive expectancies for the future (e.g., "People will admire you") and 20 statements referring to negative expectancies for the future (e.g., "You will have health problems"). Participants are asked to judge how likely it is that they will experience each of these outcomes in the future on a 7-point scale, ranging from *not at all likely* (1) to *extremely likely* (7). Higher scores on this scale represent a higher estimated likelihood of positive of negative future events. An overall negative future expectancies score was computed for each participant at each time-point by calculating the mean of the 20 negative items (baseline: $\alpha = .94$; one-week follow-up: $\alpha = .97$). An overall positive future expectancies score was also computed for each participant at each time-point by calculating the mean of the 10 positive items (baseline: $\alpha = .91$; one-week follow-up: $\alpha = .93$).

Sleep Quality and Quantity. Sleep quality and quantity was assessed via the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989). This scale includes 19 items assessing the following seven components of sleep quality and quantity: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. For the purpose of the current study, the wording of the PSQI was amended to ask about sleep *during the past week*, as opposed to *during the past month* – a variation that has been compared to objective measures in previous intervention-based studies (e.g., Jackowska et al., 2016a) and used to detect clinically significant changes in sleep (e.g., Satheesh et al., 2020). The PSQI involves completing a number of open-ended questions (e.g., "During the past week, how long (in minutes) has it usually taken you to fall asleep each night?"), and responding to a number of items via fixed response scales (e.g., "During the past week how often have you had trouble sleeping because you wake up in the middle of the night or early morning?"; *not during the past week* [0] to *three or more times this week* [3]). Responses were scored in accordance with the PSQI manual to provide summary scores for each component, whereby possible scores range from 0 to 3, with higher scores representing *worse* sleep in relation to each component. A global sleep score was then calculated for each individual at each time-point by summing their scores across the seven components, thus, possible global sleep scores range from 0 to 21, with *higher* scores representing *poorer* sleep quality and quantity overall.

Affect. Affect was assessed via the short-form Positive and Negative Affect Schedule (I-PANAS-SF; Thompson, 2007). This scale consists of 10 items assessing five positive emotions and five negative emotions. Participants were asked to indicate the extent to which they had generally felt each emotion over the past week (e.g., "Upset"). Responses were given on a 5-point Likert scale, ranging from *never* (1) to *always* (5). An overall positive affect score was computed for each participant at each time-point by calculating the mean of the five positive affect items (baseline: $\alpha = .75$; one-week follow-up: $\alpha = .85$). An overall negative affect score was computed for each participant at each time-point by calculating the mean of the five negative affect items (baseline: $\alpha = .76$; one-week follow-up: $\alpha = .86$).

Emotion Regulation. Emotion regulation was assessed with the Cognitive Emotion Regulation Questionnaire- Short (CERQ-Short; Garnefski and Kraaij, 2006). This scale includes a total of 18 items assessing nine emotion regulation strategies (five adaptive: acceptance, positive refocusing, refocus on planning, positive reappraisal, putting into perspective; and four maladaptive: self-blame, rumination, catastrophizing and other blame). Participants were asked to indicate how they generally think in response to the negative or unpleasant events they experience (example positive refocusing item: “I think I can become a stronger person as a result of the experience”; example catastrophizing item: “I keep thinking about how terrible my experience was”). Responses to all items were given on a 5-point Likert scale, ranging from *almost never* (1) to *almost always* (5). An overall adaptive emotion regulation score was computed for each participant at each time-point by calculating the mean of the 10 adaptive emotion regulation items (baseline: $\alpha = .81$; one-week follow-up: $\alpha = .79$). An overall maladaptive emotion regulation score was also computed for each participant at each time-point by calculating the mean of the eight maladaptive emotion regulation items (baseline, $\alpha = .58$; one-week follow-up, $\alpha = .73$).

Intervention. Upon completing the above measures, participants were randomised to their condition within the survey flow and presented with intervention instructions, which were delivered via standardized video and transcript. The current study’s intervention protocol followed that of previous studies that have used the Best Possible Self (BPS) intervention as a means to increase optimism and other wellbeing outcomes (e.g., Carrillo et al., 2021; Meevissen et al., 2011; Peters et al., 2013). Instructions for both conditions had the same format and only differed in content (see Appendix C). After watching the instruction video, participants were given one-minute to think about their best possible self (optimism condition) or their typical daily activities (active control condition), followed by 15-minutes of writing about their best possible self (or daily activities) in as much detail as possible. After the writing task, participants were asked to spend five-minutes imagining their best possible self (or daily activities) as vividly as possible and were instructed to continue with five-minutes of daily visualisation for the next six-days (seven-days in total). Immediately after the intervention participants were asked to report their intention to spend five-minutes per day imagining themselves in the way they wrote about, ranging from *1 day* (1) to *6 days* (6), as well as *where* and *when* they intended to complete the exercise – this was left unspecified in order to provide flexibility and fit in with students' schedules. Students were then emailed a copy of their writing to use as a guide and instructed to continue with five-minutes of daily visualisation for the next six-days (seven-days in total), after which, they were emailed a link to a second questionnaire in order to complete the one-week follow-up measures.

Additional Questions. Participants were also asked to provide ratings of task difficulty and imagery vividness via two visual analogue scales (1–10). At follow-up, participants were also asked to report how many days (out of six) they had spent five-minutes imagining their best possible self (or daily activities) to provide a measure of self-reported frequency. Here, participants were also given the opportunity to respond to an open-ended question about their experience of the exercise and provide any further comments. On average, those in the optimism condition reported imagining their best possible self for an average of 4.82 days (SD = 1.06) out of six, while those in the active control condition imagined their daily activities for an average of 4.70 days (SD = 1.15). At follow-up, there were no significant differences in perceived task difficulty: $t(56) = -.65$, $p = .518$, imagery vividness: $t(56) = -1.11$, p = .272), or self-reported frequency at performing the task in days: $t(56) = .42$, $p = .677$) between the two conditions.

Statistical Analysis

Data was analysed in SPSS 27.0 Descriptive statistics were used to obtain mean values and standard deviations for each of the variables at baseline and one-week follow-up. Pearson's correlations were also obtained to examine relationships between each of the variables at baseline. Chi-squared tests and independent means *t*-tests were used to explore potential differences between the two conditions in terms of baseline variables.

To examine our pre-registered hypotheses that students who completed the optimism intervention would show improvements in optimism and overall sleep quality and quantity at one-week follow up vs. baseline, while those who completed the active control task would not show any changes, we ran two 2 x 2 mixed-model analyses of variance (ANOVAs). To determine the presence of significant interaction effects for the variables of optimism and sleep quality and quantity, the Experimental Condition (optimism condition vs. active control condition) was set as the between-subjects factor, while Time (baseline vs. one-week follow-up) was set as the within-subjects factor.

To investigate our pre-registered exploratory interest in potential underlying mechanisms of effect, we ran a further series of 2 x 2 mixed-model ANOVAs to examine changes in: future expectancies (positive and negative), affect (positive and negative) and emotion regulation (adaptive and maladaptive).

Results

Baseline descriptives

There were no significant differences in baseline variables between the two conditions (see Table 7). Means, standard deviations and correlations between each of the variables at baseline are available in Table 8 (see Appendix D for pre- vs. post-intervention correlations).

Table 7. *Comparison of variables between conditions at baseline.*

	Optimism Condition (n = 28) % /Mean (SD)	**Active Control Condition (n = 30) % / Mean (SD)**	x^2 / t
Gender			
Female	82.14	70.00	$x^2(1) = 1.17$, $p = .280$, $V = .14$
Other	17.86	30.00	
Nationality			
British	82.14	86.67	$x^2(1) = .23$, $p = .634$, $V = .06$
Not British	17.86	13.33	
Ethnicity			
White	67.86	70.00	$x^2(1) = .03$, $p = .860$, $V = .02$
Not White	32.14	30.00	
Age			
Mean	19.93 (1.41)	20.10 (2.16)	$t(56) = -.36$, $p = .724$, $d = -.09$
Range	18 – 24	18 – 28	
Optimism	2.86 (0.95)	2.91 (0.88)	$t(56) = -.20$, $p = .842$, $d = .05$
Global Sleep Quality and Quantity	7.86 (2.69)	7.70 (3.17)	$t(56) = .20$, $p = .840$, $d = -.05$
Positive Future Expectancies	4.24 (1.11)	4.37 (1.14)	$t(56) = -.47$, $p = .643$, $d = -.12$
Negative Future Expectancies	3.87 (1.16)	3.63 (1.07)	$t(56) = .81$, $p = .423$, $d = .21$
Positive Affect	2.78 (0.74)	3.00 (0.79)	$t(56) = -1.10$, $p = .278$, $d = -.29$
Negative Affect	2.89 (0.85)	2.56 (0.82)	$t(56) = 1.49$, $p = .142$, $d = .39$
Adaptive Emotion Regulation	3.33 (0.62)	3.25 (0.72)	$t(56) = .42$, $p = .674$, $d = .11$
Maladaptive Emotion Regulation	3.21 (0.49)	3.14 (0.56)	$t(56) = .49$, $p = .672$, $d = .13$

Note. Some categories had an $n < 5$ and were thus unsuitable for chi-square testing; consequently, Gender, Nationality and Ethnicity were separated into superordinate categories.

Table 8. *Condition-pooled means, standard deviations and correlations between each of the variables at baseline (*N *= 58).*

	M (*SD*)	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**
1. Optimism	2.88 (0.91)	$-.44^{***}$	$.74^{***}$	$-.65^{***}$	$.60^{***}$	$-.49^{***}$	$.61^{***}$	$-.50^{***}$
2. Global Sleep Quality and Quantity	7.78 (2.93)		$-.43^{***}$	$.42^{***}$	-.18	$.29^{*}$	-.14	$.49^{***}$
3. Positive Future Expectancies	4.31 (1.11)			$-.52^{***}$	$.64^{***}$	$-.32^{*}$	$.50^{***}$	$-.42^{***}$
4. Negative Future Expectancies	3.74 (1.11)				$-.54^{***}$	$.68^{***}$	$-.32^{*}$	$.46^{***}$
5. Positive Affect	2.89 (0.77)					$-.43^{***}$	$.40^{**}$	$-.30^{*}$
6. Negative Affect	2.72 (0.84)						-.16	$.57^{***}$
7. Adaptive Emotion Regulation	3.29 (0.67)							$-.43^{***}$
8. Maladaptive Emotion Regulation	3.17 (0.53)							

$^{***}p \leq .001$, $^{**}p < .01$, $^{*}p < .05$

Exploring the Effects of the Optimism Intervention on Optimism

In contrast to our first pre-registered hypothesis, results of the planned 2 (Experimental Condition: optimism vs. active control) x 2 (Time: baseline vs. one-week follow-up) mixed model ANOVA revealed no significant interaction effect for optimism – students in the optimism condition did not show an increase in optimism compared to those in the active control condition at the one-week follow-up (Experimental Condition x Time: $F(1, 56) = .169$, p = .683; $\eta^2 = .003$). Means and standard deviations are displayed in Table 3. However, there was a significant main effect of Time, $F(1, 56) = 4.39$, $p < .05$; $\eta^2 = .07$ – unexpectedly, students in *both* conditions displayed significant improvements in optimism at the one-week follow-up (marginal mean = 3.01, $SE = 0.12$) relative to baseline (marginal mean = 2.88, $SE = 0.12$). No significant main effect of Experimental Condition was found, $F(1, 56) = .01$, $p = .918$; $\eta^2 = .000$ (optimism marginal mean = 2.93, $SE = 0.17$; active control marginal mean = 2.96, $SE = 0.16$).

Exploring the Effects of the Optimism Intervention on Overall Sleep Quality and Quantity

In contrast to our second pre-registered hypothesis, results of the planned 2 (Experimental Condition: optimism vs. active control) x 2 (Time: baseline vs. one-week follow-up) mixed model ANOVA revealed no significant interaction effect on overall sleep quality and quantity – students in the optimism condition did not show an increase in overall sleep quality and quantity compared to those in the active control condition at the one-week follow-up (Experimental Condition x Time: $F(1, 55) = 3.43$, $p = .070$; $\eta^2 = .06$). Instead, as with optimism, there was an unexpected significant main effect of Time, $F(1, 55) = 5.99$, $p < .05$; $\eta^2 = .10$, reflecting the fact that participants in *both* conditions displayed significant improvements in sleep at the one-week follow-up (marginal mean = 7.02, $SE = 0.42$) relative to baseline (marginal mean = 7.78, *SE* = 0.40)[12]. No significant main effect of Experimental Condition was found, $F(1,55) = .93$, $p = .339$; $\eta^2 = .017$ (optimism marginal mean = 7.76, *SE* = 0.55; active control marginal mean = 7.03, *SE* = 0.52).

Exploring Underlying Mechanisms.

To investigate our pre-registered exploratory interest in potential underlying mechanisms of effect, a further series of 2 (Experimental Condition: optimism vs. active control) x 2 (Time: baseline vs. one-week follow-up) mixed-model ANOVAs were conducted to examine changes in future expectancies (positive and negative), affect (positive and negative) and emotion regulation (adaptive and maladaptive).

Future Expectancies.

Positive Future Expectancies. No significant interaction effect was found for positive future expectancies (Experimental Condition x Time: $F(1, 56) = .05$, $p = 818$; $\eta^2 = .00$). Nor were there any significant main effects of Time, $F(1, 56) = 2.07$, $p = .155$; $\eta^2 = .04$ (baseline: marginal mean = 4.31, *SE* = 0.15; one-week follow-up marginal mean = 4.41, *SE* = 0.16) or Condition, $F(1, 56) = .28$, $p = .601$; $\eta^2 = .01$ (optimism marginal mean = 4.28, *SE* = 0.21; active control marginal mean = 4.44 , *SE* = 0.20).

Negative Future Expectancies. No significant interaction effect was found for negative future expectancies (Experimental Condition x Time: $F(1, 56) = .02$, $p = .882$; $\eta^2 = .00$). However, there was a significant main effect of Time, $F(1, 56) = 5.94$, $p < .05$; $\eta^2 = .10$, reflecting the fact that participants in *both* the optimism condition and the active control condition showed

[11]A lower PSQI score indicates better overall sleep quality and quantity, therefore improvements in sleep are reflected in a decrease in PSQI scores from baseline to one-week follow-up.

a reduction in negative future expectancies at the one-week follow-up (marginal mean = 3.55, *SE* = 0.17) relative to baseline (marginal mean = 3.75, *SE* = 0.15). There was no significant effect of Experimental Condition, $F(1, 56) = .66$, $p = .421$; $\eta^2 = .01$ (optimism marginal mean = 3.77, *SE* = 0.22; active control marginal mean = 3.53, *SE* = 0.21).

Affect.

Positive Affect. No significant interaction effect was found for positive affect (Experimental Condition x Time: $F(1, 56) = 1.52$, $p = .223$; $\eta^2 = .03$). Nor were there any main effects of Time, $F(1, 56) = .02$, $p = .897$; $\eta^2 = .00$ (baseline marginal mean = 2.89, *SE* = 0.10; one-week follow-up marginal mean = 2.90, *SE* = 0.12) or Experimental Condition, $F(1, 56) = .35$, $p = .556$; $\eta^2 = .01$ (optimism marginal mean = 2.83, *SE* = 0.15; active control marginal mean = 2.96, *SE* = 0.15).

Negative Affect. No significant interaction effect was found for negative affect (Experimental Condition x Time: $F(1, 56) = .03$, $p = .868$; $\eta^2 = .00$). However, there was a significant main effect of Time, $F(1, 56) = 13.87$ $p < .001$; $\eta^2 = .20$, reflecting the fact that levels of negative affect significantly decreased for those in *both* the optimism condition and the active control condition at one-week follow-up (marginal mean = 2.38, *SE* = 0.12) relative to baseline (marginal mean = 2.72, *SE* = 0.11). There was no significant main effect of Experimental Condition, $F(1, 56) = 2.19$, $p = .144$; $\eta^2 = .04$ (optimism marginal mean = 2.71, *SE* = 0.15; active control marginal mean = 2.40, *SE* = 0.15).

Emotion Regulation.

Adaptive Emotion Regulation. No significant interaction effect was observed for adaptive emotion regulation (Experimental Condition x Time: $F(1, 56) = .09$, $p = .762$; $\eta^2 = .00$). Nor were there any significant main effects of Time, $F(1, 56) = .3.59$, $p = .063$; $\eta^2 = .06$ (baseline marginal mean = 3.29, $SE = 0.09$; one-week follow-up marginal mean = 3.41, $SE = 0.08$) or Experimental Condition, $F(1, 56) = .13$, $p = .725$; $\eta^2 = .00$ (optimism marginal mean = 3.38, $SE = 0.12$; active control marginal mean = 3.32, $SE = 0.11$).

Maladaptive Emotion Regulation. No significant interaction effect was observed for maladaptive emotion regulation (Experimental Condition x Time: $F(1, 56) = 1.34$, $p = .253$; $\eta^2 = .02$). Nor were there any significant main effects of Time, $F(1, 56) = .1.54$, $p = .221$; $\eta^2 = .03$ (baseline marginal mean = 3.18, $SE = 0.07$; one-week follow-up marginal mean = 3.11, $SE = 0.08$) or Experimental Condition, $F(1, 56) = .01$, $p = .945$; $\eta^2 = .00$ (optimism marginal mean = 3.15, $SE = 0.10$; active control marginal mean = 3.14, $SE = 0.10$).

Table 9. *Mean scores and standard deviations by Experimental Condition and Time for optimism, sleep quality and quantity, future expectancies (positive and negative), affect (positive and negative) and emotion regulation (adaptive and maladaptive) at baseline and one-week follow-up.*

	Optimism Condition (*n* = 28) Mean (*SD*)	**Active Control Condition (*n* = 30) Mean (*SD*)**
Optimism		
Baseline	2.86 (0.95)	2.91 (0.88)
One-week follow-up	3.01 (0.88)	3.01 (0.94)
Global Sleep Quality and Quantity		
Baseline	7.85 (2.74)	7.70 (3.17)
One-week follow-up	7.67 (3.46)	6.37 (2.86)
Positive Future Expectancies		
Baseline	4.24 (1.11)	4.37 (1.14)
One-week follow-up	4.33 (1.13)	4.49 (1.23)
Negative Future Expectancies		
Baseline	3.87 (1.16)	3.63 (1.07)
One-week follow-up	3.68 (1.26)	3.42 (1.31)
Positive Affect		
Baseline	2.78 (0.74)	2.89 (0.81)
One-week follow up	3.00 (0.79)	2.91 (1.03)
Negative Affect		
Baseline	2.89 (0.85)	2.54 (0.86)
One-week follow-up	2.56 (0.82)	2.24 (0.94)
Adaptive Emotion Regulation		
Baseline	3.33 (0.62)	3.25 (0.72)
One-week follow-up	3.43 (0.66)	3.39 (0.62)
Maladaptive Emotion Regulation		
Baseline	3.21 (0.49)	3.14 (0.56)
One-week follow-up	3.09 (0.66)	3.14 (0.67)

Discussion

The current study was the first to explore whether an optimism intervention could be used to improve sleep quality and quantity. In contrast to our pre-registered hypotheses, students in the optimism condition did not show higher levels of optimism or better sleep quality and quantity compared to those in the active control condition at one-week follow-up. Unexpectedly, students in *both* conditions showed significant increases in self-reported optimism and sleep quality and quantity relative to baseline. A similar pattern of findings was also observed for negative future expectancies and negative affect, whereby significant reductions occurred across both conditions over time.

The findings of the current study are somewhat surprising given that the Best Possible Self (BPS) intervention has been considered the most effective optimism intervention to date (Malouff & Schutte, 2017; Carrillo et al., 2019). Recent systematic reviews and meta-analyses have previously demonstrated that, in comparison to imagining one's daily activities, imagining one's best possible self generates small to moderate improvements in optimism, positive affect and wellbeing, alongside reductions in biomarkers of poor health and stress (Carrillo et al., 2019; Loveday et al., 2018; Malouff & Schutte, 2017). Although the findings of this study do not contradict the potential of using an optimism intervention to improve optimism and sleep quality and quantity, it is not possible to attribute any positive effects to the optimism intervention specifically, considering that improvements were also observed within the active control condition. Accordingly, additional mechanisms outside of the optimism intervention should be considered when it comes to explaining the observed improvements in optimism and sleep.

While the majority of studies support the use of the BPS intervention as an effective means to increase optimism relative to the Daily Activities active control task (Carrillo et al., 2019), it is important to note that some studies have observed similar benefits across both conditions. For instance, in two randomized control trials by Carrillo et al., (2021), those in *both* the BPS Condition and the Daily Activities Condition showed improvements in optimism, positive affect, life satisfaction, happiness and self-efficacy, as well as reductions in negative affect after one-week. Additionally, significant reductions in negative affect were also observed immediately post-intervention for those in both conditions in a study by Peters et al., (2010), while reductions in negative affect and increases in positive affect were reported in both conditions after two-weeks in a study by Meevissen et al., (2011). Thus, one explanation for current findings may be that the Daily Activities task is just as effective as the BPS intervention when it comes to promoting optimism and other positive outcomes under certain conditions, however the mechanisms by which these benefits occur remain unclear.

Why might imagining one's daily activities produce benefits for optimism and sleep? Previous research has suggested that active control groups can respond positively to the activation of self-relevant information (Mongrain et al., 2012). Indeed, increasing awareness of daily activities could have led to increased feelings of self-efficacy, which in turn may have prompted positive future-thinking and proactive behaviour in a similar way to the optimism condition (Carrillo et al., 2021). An examination of qualitative responses in the current study could lend support to this suggestion, with many individuals reporting that the Daily Activities task made them become "more aware of unwanted daily habits" and "re-think current routines", helping them to realise that their current lifestyles were “unhelpful” and “not in line with their goals”, which in turn “encouraged them to change”. In this way, thinking about daily activities may have been beneficial for students and led to associated changes in thoughts and behaviours, thus helping to explain why significant improvements in optimism and sleep were seen across both conditions in the current study.

The qualitative responses of those in the optimism condition may also provide some insight as to why optimism and sleep improved for those who imagined their best possible selves. For instance, individuals reported feeling more “motivated” and “determined” to “work harder”, as well as feeling more “proactive” and “encouraged” to “pursue goals” – all changes that indicate a broadening of thought-action repertoires and may have led to an upward spiral of positive outcomes in line with theoretical ideas (Fredrickson, 2001). These findings are particularly insightful and imply that manipulated optimism doesn’t just lead individuals to *think* that the future will be bright, but it may also cause them to begin acting in ways that make a bright future more likely – a key characteristic of naturally optimistic individuals (Carver & Scheier, 2014; Scheier et al., 2001). Future studies may benefit from examining additional measures of behaviour change in order to determine whether different underlying mechanisms of action bring about improvements in optimism conditions relative to active controls. For instance, when it comes to sleep, increased optimism could encourage the regulation of bedtime behaviour and proactive engagement in sleep hygiene practices, while also buffering sleep-impairing cognitions and worries about the future.

Here, it is also important to acknowledge the effectiveness of the BPS intervention could vary depending on baseline levels of optimism and/or sleep (although baseline optimism has not been found to moderate improvements in outcomes previously; Meevissen et al., 2011 and Peters et al., 2010). Indeed, due to ceiling effects, individuals who exhibited good sleep and/or high levels of optimism at baseline may not have benefitted from the intervention as much as those with poor sleep and/or low levels of optimism at baseline. Future research could therefore attempt to conduct sensitivity analyses to determine who the BPS intervention may (or may not) be most effective for.

It is also possible that the findings of the current study relate to the effects of being involved in an intervention more generally – i.e., the Hawthorne effect – wherein a triangulation of confounds, such as being observed by a researcher and given extra attention, can result in positive outcomes and/or desirable responding across all conditions (Chiesa & Hobbs, 2008). Indeed, although students were blind to the conditions and hypotheses, being involved in a ‘Student Wellbeing Study’ and having contact with the researcher may have resulted in positive outcomes or biased responses regardless of condition.

Improvements could also be the result of external factors unrelated to the intervention; however, this interpretation may be inadequate for a number of reasons. Firstly, positive mood and levels of sleep quality and quantity are known to gradually decline as term time goes on and students near assessment periods (Wang et al., 2014). Thus, observing positive changes in optimism and sleep would have been unlikely to occur outside of the intervention given that the recruitment period occurred towards the end of term, near to assessment time (3rd of March – 29th April 2022). Additionally, during this study, students lost an hour of sleep to Daylight Savings Time – a switch that is known to decrease sleep quality and quantity (Lahti et al., 2006; Owen et al., 2021). Further, it would be unusual to see significant increases in optimism – a relatively stable trait – within a one-week period outside of a manipulation (Peters et al., 2010). Accordingly, it could be argued that observing positive changes in levels of optimism and sleep quality and quantity during this time period would have been unusual outside of an intervention study.

When attempting to explain why the optimism intervention did not benefit optimism and/or sleep quality and quantity over and above the active control task, it could be argued that the seven-day intervention duration used in the current study did not provide the timeframe required to capture such interaction effects. Supporting this notion, other studies have demonstrated that increases in optimism continue to occur after one-week for those who take part in the BPS intervention, but not for those who complete the Daily Activities task (Meevissen et al., 2011; Peters et al., 2013). Thus, it is possible that the improvements observed within the active control condition could have plateaued after an initial increase, while improvements in the optimism condition could have continued into the longer-term. This explanation could be understood in line with theoretical ideas, wherein experiences of positive traits and emotions are thought to gradually build up personal resources and markers of health over time (Fredrickson, 2001). Future research may therefore wish to extend the duration of this intervention and/or incorporate multiple follow-up assessment points in order to provide a clearer picture of effects over a longer timeframe. However, while studies with long-term follow-up measures are needed, Carrillo et al., (2019) have noted that keeping the BPS intervention short provides more benefits and may help to maintain levels of participant practice and avoid hedonic adaptation. Thus, increasing intervention length could involve a trade-off with acceptability and increase rates of attrition. Alternatively, daily sleep reports may be more sensitive than the PSQI when it comes to capturing short-term changes in sleep within brief interventions, as has been found previously (Jackowska et al., 2016a). Research could also attempt to develop new methods of increasing optimism, given that intervention options outside of the BPS remain scarce (Malouff & Schutte, 2017).

Here, it becomes important to highlight some key limitations of the current study. Firstly, participants were recruited opportunistically from a pool of psychology students with predominantly 'WEIRD' sample characteristics – a limitation of positive psychological approaches more widely (Hendriks et al., 2019) – thus limiting generalisability and emphasising the need to determine the efficacy of the BPS intervention in other demographic and clinical populations (Carrillo et al., 2019). Secondly, the current study had a relatively small sample size, meaning that small differences between conditions may not have been detected. Future research may therefore benefit from replicating the current study in a larger, more representative sample, especially when it comes to exploring additional underlying mechanisms and clarifying any trending directions of effect. Additionally, the present study was reliant on subjective self-report measures, which are subject to a host of biases. Indeed, although the PSQI is considered to be the gold standard self-report assessment measure for sleep and incorporates a number of sleep components (Mollayeva et al., 2016), future research could benefit from incorporating objective measures alongside this outcome. Nevertheless, as with other health problems, the value and validity of self-report measures should not be overlooked. Certainly, a lack of objectively measurable sleep complaint does not mean self-reported sleep problems should be left untreated; for instance, individuals diagnosed with clinical insomnia – the *subjective* inability to get to sleep and/or stay asleep despite the adequate opportunity to do so (Edinger et al., 2021a) – do not always demonstrate objective sleep problems (Fernandez-Mendoza et al., 2011; Kay et al., 2015). Thus, if positive psychology interventions can help to reduce subjective sleep problems, then they are still valuable. Indeed, as subjective and objective sleep assessments have different psychological and biological correlates (Jackowska et al., 2016b), sleep medicine may benefit from considering the nature of the sleep complaint when it comes to selecting targets for intervention.

The current study also has its merits. Firstly, in order to standardise the format of delivery and enhance intervention fidelity, intervention instructions were administered to participants by the same researcher via a pre-recorded video and transcript and only differed in terms of the necessary, condition-specific content i.e., Best Possible Self or Daily Activities (see Appendix C). Results also demonstrated that task difficulty, imagery vividness and frequency of practice in days was equivalent across conditions. Secondly, 97% of students (58/60) stayed in the study until completion, suggesting that the intervention protocol, duration and cognitive load were acceptable to students, and thus provide a feasible template for future brief interventions. Encouragingly, a number of students in the optimism condition also expressed a desire to continue with the intervention outside of the study as part of their qualitative responses, further supporting the potential practicality of incorporating this novel, inexpensive and self-administrable intervention into daily life.

Conclusion

The current study has demonstrated that an active control task may be just as effective as a brief optimism intervention when it comes to improving optimism and sleep quality and quantity in a student sample; however, the underlying mechanisms of these improvements remain unclear. Replicating this exploratory study in a larger sample with active and measurement-only controls over a longer timeframe will be important for clarifying findings and will help to determine whether optimism interventions can improve sleep over and above more general intervention effects. Exploring the mechanisms through which these benefits occur and incorporating objective sleep assessment measures could also help to provide further insight.

CHAPTER 6 – GENERAL DISCUSSION

6.1 Recapitulation of the Research Background

The importance of a good night's sleep cannot be understated (Grandner, 2019; Walker, 2021); however, a significant number of individuals across the globe currently suffer from inadequate sleep quality and quantity (Chattu et al., 2019; Keyes et al., 2015; Kocevska et al., 2021; Liu et al., 2016; Owens et al., 2014). Accordingly, the identification and promotion of factors relating to good sleep may be important for improving sleep within the general population. Despite this, research to date has largely focused on the alleviation of disorder and the reduction of negative, sleep-impairing factors, while knowledge regarding the antecedents of good sleep and the identification of positive, sleep-promoting traits has remained comparatively limited until more recently (Baglioni et al., 2010; Linley et al., 2009; Steptoe et al., 2008; Wickwire, 2021). This thesis therefore adopted a positive psychological approach to sleep and introduced mindfulness, self-compassion, gratitude and optimism as four positive psychological traits that have been linked to good sleep in the literature to date (Boggiss et al., 2020; Brown et al., 2021; Butz & Stahlberg, 2020; Ong & Moore, 2020; Tout et al., 2023a; 2023d), and further presented cognitive emotion regulation as a potential common mechanism by which the relationships between of each of these positive traits and sleep might be unified.

6.2 Integrative Summary of Key Research Aims and Associated Findings

6.2.1 Determining the Collective and Relative Contributions of the Positive Psychological Traits to Overall Sleep Quality and Quantity Cross-sectionally

The first aim of this thesis was to determine the collective and relative contributions of mindfulness, self-compassion, gratitude and optimism to overall sleep quality and quantity cross-sectionally. In support of the first hypothesis, which stated that the four positive psychological traits would collectively account for a significant proportion of variance in overall sleep quality and quantity, cross-sectional findings in Chapters 2 and 3 revealed that mindfulness, self-compassion, gratitude and optimism collectively accounted for 15.81–23.92% of the variation in overall sleep. When examining the relative contributions of the four positive traits, mindfulness and optimism emerged as consistent significant linear predictors of overall sleep quality and quantity in their own right within all cross-sectional analyses, while self-compassion also emerged as a significant cross-sectional linear predictor of sleep at Times 2 and 3 in Chapter 3.

6.2.2 Determining the Collective and Relative Contributions of the Positive Psychological Traits to Overall Sleep Quality and Quantity Prospectively

In an effort to extend cross-sectional findings and support the causal direction of effect, the second aim of this thesis was to determine the collective and relative contributions of mindfulness, self-compassion, gratitude and optimism to overall sleep quality and quantity prospectively. In support of the second hypothesis, which stated that the four positive psychological traits would collectively predict *future* sleep outcomes, mindfulness, self-compassion, gratitude and optimism were found to predict overall sleep quality and quantity approximately 12-weeks (Time 2) and 24-weeks (Time 3) later. Prospective analyses further revealed that optimism (but *not* mindfulness) emerged as a significant linear predictor of future sleep quality and quantity; specifically, higher levels of baseline optimism related to better sleep 12-weeks and 24-weeks later. Baseline self-compassion also emerged as a significant linear predictor of sleep 24-weeks later, with higher levels of this positive trait similarly relating to improvements in overall sleep quality and quantity.

6.2.3 Exploring Emotion Regulation as a Potential Common Mediator of the Relationships Between Each of the Positive Psychological Traits and Overall Sleep Quality and Quantity

The third aim of this thesis was to explore the role of emotion regulation as a potential common mediator of the relationships between each of the aforementioned positive psychological traits and overall sleep quality and quantity within both cross-sectional and prospective studies. It was hypothesised that higher levels of mindfulness, self-compassion, gratitude and optimism would all relate to higher levels of adaptive and lower levels of maladaptive emotion regulation, which in turn, would benefit overall sleep quality and quantity. In partial support of the hypothesis, cross-sectional findings revealed that each of the positive traits had an indirect benefit on sleep via lower levels of maladaptive (but *not* higher levels of adaptive) emotion regulation. Prospective results similarly revealed that optimism and self-compassion both had indirect benefits on sleep via reductions in maladaptive (but *not* increases in adaptive) emotion regulation. While correlated with sleep and maladaptive/ adaptive emotion regulation, however, the effects of mindfulness on sleep were not mediated via either mechanism in the prospective study. Further, as Time 1 gratitude did not correlate with Time 3 sleep, Time 2 emotion regulation as a mediator of the gratitude–sleep relationship was not explored.

6.2.4 Consolidating the Optimism–Sleep Literature

The fourth aim of this thesis was to systematically review and quantitatively synthesise the published optimism–sleep literature to date. In sum, 29 out of 32 eligible studies provided evidence of a significant positive association between some measure of optimism and sleep, including all six prospective investigations. A meta-analysis on a subset of methodologically comparable cross-sectional studies further revealed significant, medium-sized relationships between higher levels of dispositional optimism (as assessed via the LOT-R) and better overall sleep quality and quantity (as assessed via the PSQI), r = .30, 95% CI[.21, .39]. Helping to allay concerns that optimists might simply report better sleep, two studies found that optimism was also linked to objective measures of sleep latency, duration and efficiency (Hernandez et al., 2020; Lemola et al., 2011); however, a further two studies equally found no such significant associations between optimism and objective sleep parameters (Jackowska et al., 2016b; Mezick et al., 2010). Furthermore, there have been no tests of the effects of intervening to promote optimism on any sleep outcome(s) in the published literature to date. It was therefore concluded that future research would be necessary to clarify the objective and subjective sleep correlates of this positive trait and determine whether promoting optimism could lead to causal improvements in sleep.

6.2.5 Investigating Whether a Brief Optimism Intervention Can Improve Overall Sleep Quality and Quantity in a Student Sample

The final aim of this thesis was to investigate whether a brief optimism intervention could be used to improve overall sleep quality and quantity in a student sample. Based on the above findings, it was hypothesised that students in the optimism intervention condition would report better overall sleep quality and quantity at the one-week follow-up compared to baseline, while those who completed the active control task would not. However, in contrast to the hypothesis, results revealed a significant main effect of time and no significant interaction effect, such that all participants – on average – reported improvements in sleep quality and quantity between baseline and follow-up irrespective of condition. As a result, it was not possible to conclude that improvements in sleep were the result of the optimism manipulation specifically.

6.3 Theoretical and Practical Implications of the Research Findings

6.3.1 Positive Psychological Traits Predict and Facilitate Good Sleep Quality and Quantity

Overall, this thesis has consolidated, integrated and extended the current positive psychology–sleep literature, which up until now has largely focused on exploring the independent relationships between each of mindfulness (Ong & Moore, 2020), self-compassion (Brown et al., 2021; Butz & Stahlberg, 2020), gratitude (Boggiss et al., 2020; Tout et al., 2023a) and optimism (Tout et al., 2023d) and sleep (but see Newman et al., 2021 and Tout et al., 2023b, Study 1, for two exceptions). Given that these positive psychological traits can collectively account for almost one quarter of the variation in overall sleep quality and quantity cross-sectionally and can predict sleep outcomes up to six-months later, such traits may be important when it comes to understanding, explaining and predicting variation in sleep. Prospective findings are especially insightful in that they provide further support for the proposed causal direction of effect and add to the paucity of research that has explored prospective links between positive traits and sleep previously. Indeed, while mindfulness and optimism have been shown to predict better future sleep (e.g., Hernandez et al., 2020;

Murphy et al., 2012; Pagnini et al., 2019; Ren et al., 2019), prospective relationships between self-compassion and sleep and gratitude and sleep have not been explored in the published literature to date.

Future sleep medicine may therefore wish to consider the promotion of positive psychological traits when it comes treating sleep problems within the general population. Indeed, as well as predicting who may (and who may not) be sleeping well now and in the future, the maintenance and/or promotion of positive psychological traits could offer a relatively easy, inexpensive and self-administrable means to facilitate good sleep quality and quantity in the general population without the associated limitations of pharmacological treatments. Encouragingly, the recent success of mindfulness-based interventions and their incorporation into CBT-I could suggest that a future of positive sleep medicine is not too far off (Ong et al, 2008; Ong & Moore, 2020; Wickwire, 2021).

6.3.2 Considering the Reverse Relationship

Supporting the proposed causal direction of effect, an examination of the reverse relationship further revealed that baseline levels of sleep quality and quantity did not predict subsequent changes in any of the positive traits 24-weeks later. Nevertheless, baseline sleep *did* predict subsequent changes in mindfulness and self-compassion 12-weeks later. While a lack of previous research means that reciprocal relationships between sleep and self-compassion cannot be compared, when it comes to mindfulness, results partially support the findings of previous prospective work, wherein dispositional mindfulness has been found to have a (bi)directional relationship with sleep quality (Murphy et al., 2012; Pagnini et al., 2019).

When it comes to explaining why sleep might have an influence on levels of mindfulness and self-compassion in the short-term, it could be argued that these positive traits are more sensitive to changes in sleep due to their high level of cognitive demand and reliance on pre-frontal regions and emotional centres of the brain, which are highly vulnerable to the effects of poor sleep (Campbell et al., 2018; Guan et al., 2021; Lim & Dinges, 2010; Wheeler et al., 2017; Woodruff & Stevens, 2018). In contrast, positive traits such as dispositional optimism have been suggested to rely in part on implicit and unconscious forms of goal-directed, cognitive-emotional processing that occur outside of these regions, and thus may be more resilient to the cognitive consequences of poor sleep (Segerstrom, 2001; Zou & Yuan, 2021). Accordingly, intervening to promote self-compassion and/or mindfulness could present more of a challenge to those who are currently suffering from poor sleep.

A lack of reciprocal relationship between optimism and sleep may at first glance contradict the findings of the two published studies that have explored this (bi)directional relationship to date, wherein poor sleep was found to aggravate future pessimism (Lau et al., 2015; 2017). However, this discrepancy could arguably relate to variations in the conceptualisation and corresponding measurement of optimism (Reilley, 2005). Specifically, while this thesis explored dispositional optimism via the LOT-R (which assesses optimism on a unipolar spectrum), the studies by Lau et al., (2015; 2017) examined optimism via the Attributional Style Questionnaire (which assesses optimism on a bipolar spectrum with pessimism). Thus, while the findings of Lau et al., (2015; 2017) showed that poor sleep led to higher levels of pessimism (a negative construct), this may not necessarily be conceptually equivalent to lower levels of optimism (a positive construct; see e.g., Kubzansky et al., 2004, for a discussion). Accordingly, future research may wish to examine the (bi)directional relationships between sleep and optimism and pessimism separately in order to explore the possibility of differential relationships between the two.

6.3.3 Insights from an Examination of the Relative Contributions

The finding that optimism emerged as a consistent significant linear predictor of sleep across all cross-sectional and prospective analyses is particularly interesting given that optimism has arguably received less research attention compared to the other positive traits discussed within this thesis. Indeed, unlike mindfulness, self-compassion and gratitude, which have all been subject to forms of empirical review and meta-analysis previously (Boggiss et al., 2020; Brown et al., Butz & Stahlberg, 2020; Ong & Moore, 2020; Sala et al., 2020), the literature on optimism and sleep has not been consolidated outside of this thesis. Additionally, while mindfulness, self-compassion and gratitude interventions have all been explored as a means to improve sleep outcomes (Boggiss et al., 2020; Butz & Stahlberg, 2020; Ong & Moore, 2020), the effects of promoting optimism on sleep have not been explored elsewhere in the literature. Interestingly, the only other study to have examined associations between more than one positive trait (optimism and gratitude) and sleep also found that optimism was able to predict more variance in self-rated daily sleep quality than gratitude, further supporting its relevance and the need to consider positive traits together in order to clarify their individual contributions to sleep outcomes (Newman et al., 2021).

Given that optimism emerged as a consistent unique predictor of overall sleep quality and quantity both cross-sectionally and prospectively within the current programme of research, optimism may be a particularly relevant additional and/or alternative positive trait to consider when it comes to the development of new and integrative, positive psychological approaches to sleep intervention. Indeed, while mindfulness-based practices have been incorporated into CBT-I and have been shown to improve sleep outcomes previously (Ong et al., 2008; 2012; Ong & Moore, 2020), and while mindfulness emerged as a consistent linear predictor of sleep *cross-sectionally*, it did not emerge as a significant unique linear predictor of change in sleep prospectively. Prospective results further revealed that mindfulness was affected by baseline levels of sleep in the short-term, whereas optimism was not. Accordingly, intervening at the level of mindfulness could be more difficult if an individual has been suffering from poor sleep and its associated cognitive consequences, adding weight to the argument that optimism could be a particularly relevant positive trait to consider when it comes to targeting poor sleep in the first instance.

Although self-compassion did not emerge as a significant cross-sectional linear predictor of sleep in Chapter 2, nor at Time 1 within the prospective study presented in Chapter 3, it *did* emerge as a significant cross-sectional linear predictor of sleep at Times 2 and 3. Higher levels of baseline self-compassion also predicted subsequent improvements in sleep 24-weeks later. One possible explanation for why self-compassion may have had more of an influence on sleep outcomes at these later timepoints could be due to the fact their associated data collection points occurred nearer to the end-of-year assessment time – a potentially more stressful time of year for the student participants recruited in this study. Thus, treating oneself kindly may enable individuals to maintain and/or achieve better sleep in the midst of stressful life circumstances more specifically, helping to account for this pattern of findings. To explore this suggestion further, future research could attempt to determine whether the effects of this adaptive positive psychological trait on sleep are moderated by the effects of stress and/or contribute to more unique variance in sleep outcomes during stressful times. Indeed, self-compassion has been linked to better stress reactivity/recovery (Allen & Leary, 2010; Finlay-Jones, 2017; Sirois et al., 2015b) and has also been shown to have an indirect benefit on sleep via lower levels of stress in previous cross-sectional work (Hu et al., 2018; Hwang et al., 2019). Alternatively, the more variable unique contribution of self-compassion towards overall sleep quality and quantity may also be attributable to a degree of overlapping variance with the other positive traits. For instance, self-compassion encompasses an element of mindfulness by definition (i.e., mindful acceptance vs. overidentification; Neff, 2003b), potentially helping to explain why this positive trait did not always emerge as a unique predictor of sleep in its own right.

In contrast to the other positive traits, dispositional gratitude did not emerge as a significant linear predictor of sleep within any of the analyses conducted. Moreover, cross-sectional correlations also revealed that gratitude tended to exhibit ‘small-sized’ relationships with overall sleep quality and quantity (r = -.21 – -.33), whereas mindfulness (r = -.37 – -.39), self-compassion (r = -.29 – -.42) and optimism (r = -.33 – -.46) exhibited ‘medium-sized’ relationships (Cohen, 2013). Accordingly, dispositional gratitude may be comparatively limited in terms of its ability to predict sleep. Indeed, these findings are broadly in line with wider literature, which has tended to report smaller-sized associations between gratitude and sleep and may also help to account for the variable effectiveness of gratitude interventions when it comes to improving sleep (Boggiss et al., 2020; Tout et al., 2023a).

6.3.4 Maladaptive Emotion Regulation as a Common Mediator

When it comes to explaining *how* positive traits might exert their effects on sleep, findings suggest that the reduction of sleep-impairing maladaptive emotion regulation strategies are relevant, while increases in adaptive emotion regulation strategies are not. Indeed, while maladaptive emotion regulation strategies have been consistently associated with poor sleep outcomes, relationships between adaptive emotion regulation processes and good sleep have remained more varied in the literature to date (Cheng et al., 2020; Palmer et al., 2018; Reddy et al., 2017). Interestingly, previous research has suggested that adaptive emotion regulation strategies are employed less frequently by younger individuals (Garnefski & Kraaij, 2002), potentially helping to account for their weaker relationships with sleep outcomes in the current thesis. Future research may therefore wish to explore whether relationships between positive traits, adaptive emotion regulation mechanisms and sleep change as a function of age, and/or whether adaptive emotion regulation is more likely to mediate associations between positive traits and sleep in older adult samples.

The finding that maladaptive emotion regulation emerged as a fairly consistent mediator of the relationships between the positive traits and sleep is especially interesting in light of the fact that models of sleep disturbance and insomnia have similarly emphasised the role of maladaptive cognitive-emotional processes in the initiation, maintenance and perpetuation of sleep problems (Espie, 2007; Harvey, 2002; Ong et al., 2012; Reimann et al., 2010). However, current non-pharmacological treatments such as CBT-I and MBTI often aim to reduce negative sleep-related thoughts and emotions associated with insomnia disorder by promoting adaptive emotion regulation strategies such as cognitive reappraisal and acceptance (Maurer & Dedhia, 2021; Ong et al., 2012), meanwhile positive approaches aim to promote good sleep health through the cultivation of positive psychological traits and emotions (Wickwire, 2021). Thus, in a direct complement to current non-pharmacological treatments, the findings of the present programme of research suggest that promoting positive psychological traits could further help to improve sleep by reducing the maladaptive cognitive-emotional processes known to impair it. Indeed, positive psychological approaches could provide individuals with subclinical sleep problems an easy, inexpensive, and self-administrable means of improving sleep quality and quantity in day-to-day life, in contrast to CBT-I – a structured therapy focused on the alleviation of insomnia disorder.

While there were significant theoretical grounds to explore emotion regulation as a common mediator of the positive psychological trait–sleep relationships, it is important to acknowledge that other variables may also help to unify the literatures and situate these relationships within a broader, common framework. Despite making for a more parsimonious project and avoiding the complications of clinically significant mediators, levels of depressive symptoms, anxiety and stress have been shown to mediate some of the relationships between mindfulness (Bogusch et al., 2016; Simione et al., 2020), self-compassion (Bian et al., 2020; Hu et al., 2018; Hwang et al., 2019), gratitude (Alkozei et al., 2019; Hirsch et al., 2021) and optimism (Hernandez et al., 2020; Lau et al., 2015; 2017; Uchino et al., 2017; Weitzer et al., 2021) and sleep previously. Future research should therefore endeavour to widen the search for common underlying mechanisms in order to explore the unification of positive psychology–sleep literatures in further detail and extend the emotion regulation framework proposed here.

6.3.5 Optimistic About Optimism

While optimism did not lead to causal improvements in sleep *over and above the active control condition*, attempts to explore optimism interventions as a means to improve sleep should by no means end here. Instead, the initial exploratory investigation presented within this thesis should pave the way for further research, which could consider developing new optimism interventions specifically tailored with a view to optimising sleep; for example, participants could be encouraged to engage in such an intervention close to bedtime. In addition, future research could also benefit from assessing improvements over a longer-time frame and utilising more sensitive sleep outcome measures such as daily sleep quality reports and/or sleep tracking devices. In a similar way to mindfulness, exploring whether an optimism component can be effectively added into current CBT-I and/or MBTI treatments could also help to determine whether optimism provides a beneficial additional and/or alternative sleep-promoting element to current interventions.

While anecdotal in nature, qualitative responses from the intervention study reported in Chapter 5 did suggest that a level of cognitive refocusing and autonomous, goal-directed behaviour occurred across both conditions, despite potential differences in their instructional origins. Specifically, participants in *both* conditions reported feeling encouraged and motivated to pursue their goals; however, while those in the optimism condition reported this after *imagining their best possible* *selves*, those in the active control condition reported this after imagining their *"boring" daily activities*. Indeed, upon realising how "unwanted [their] daily habits" were (e.g., "scrolling through Instagram", "watching Netflix"), students in the active control condition seemed to notice that their behaviour was "not in line with [their] goals", which "encouraged [them] to change", despite the fact they were not asked to think about their future goals as part of the instructions (see Appendix C). Interestingly, previous research has shown that either imagining one's best possible self or imagining one's daily activities can both lead to increases in autonomy and competence (Auyeung & Mo, 2019; Layous et al., 2012), potentially helping to explain the benefits to sleep outcomes observed across both conditions. Future research may therefore wish to incorporate additional measures to capture changes in such variables and/or conduct more in-depth qualitative investigations to provide greater insight and understanding as to how optimism interventions exert their effects, and indeed, whether reflecting upon daily activities could also be of benefit to students' sleep within itself.

Future research may also wish to consider *who may* and *who may not* benefit from positive approaches to intervention (Hendriks et al., 2019; Ng, 2015). Indeed, despite the overwhelming majority of individuals responding positively to the best possible self task, two participants within the optimism condition did report feeling it was "bittersweet" and "unrealistic" to be imagining a good future when the current environmental, economic and political climate left them feeling "hopeless". Accordingly, it may be particularly insightful for future work to determine whether 'playing to your strengths' or 'playing to your weaknesses' proves the most beneficial when it comes to promoting sleep outcomes. Coinciding with the ethos of positive psychology, research suggests that actively working with individual strengths and positive dispositional characteristics (rather than simply being aware of them) can help to promote health and wellbeing outcomes (Ghielen et al., 2018; Proctor et al., 2011; Wood et al., 2011). Future studies could therefore conduct initial assessments of an individual's positive psychological characteristics at baseline and select intervention strategies according to their strengths (or weaknesses) in order to provide a precise and targeted form of positive sleep medicine (Ng, 2015; Wickwire, 2021).

6.4 Methodological Considerations and Limitations

The empirical chapters in this thesis are subject to a number of methodological constraints and limitations.

6.4.1 Sample Characteristics

Firstly, data was collected opportunistically via the recruitment of university students, who exhibited predominantly 'WEIRD' characteristics (Henrich et al., 2010). Although this is a common limitation to much of the published research in this area (Hendriks et al., 2019), it nevertheless remains unclear whether the same pattern of findings would be found upon examining a stratified sample of the general population. Indeed, when it comes to interventions, research has suggested that promoting certain positive traits may be less effective and/or have negative effects on individuals who lack autonomy, put the needs of others above their own and/or believe their needs should not be expressed (Wood et al., 2016), potentially highlighting the limited generality of positive interventions (Hendriks et al., 2019; Seligman et al., 2005).

While this thesis did not specifically set out to examine the effects of positive traits on sleep in a student sample per se, the use of an opportunistic student sample was a highly pragmatic decision made in light of the Covid-19 pandemic and the need to complete research within the allotted doctoral studentship timeframe (i.e., easy and inexpensive to recruit and track, easy to compensate, better quality data etc.,). Indeed, recruiting a representative sample of the population via tools such as MTurk and/or Prolific was impossible given budget constraints. Thus, as levels of adolescent sleep quality and quantity are known to be particularly poor, it was deemed to be worthwhile to identify positive antecedents and effective approaches to intervention in this population (Owens et al., 2014; Owens & Weiss, 2017). Efforts were also made to recruit outside of Sussex for the purposes of the prospective study. Nevertheless, one natural consequence of relying on a student sample is that findings may not be representative of the general population. Indeed, students were predominantly in their late teens/early twenties, female and students of psychology, meaning that findings may not generalize across broader populations and could be subject to demand characteristics. Although this is a common limitation to much of the published research in this area (Hendriks et al., 2019), it therefore remains unclear whether the same pattern of findings would be found upon examining a stratified sample of the general population. Encouragingly, systematic reviews and meta-analyses have suggested that mindfulness, self-compassion, gratitude and optimism exhibit relatively consistent relationships with sleep irrespective of the sample population (Brown et al., 2021; Sala et al., 2022; Ong & Moore, 2020; Tout et al., 2023a; 2023d), although these samples may be similarly restricted in terms of demographic variability; indeed, by contrast, there is also evidence that age and/or gender could lead to variation in the size of relationships between optimism and sleep

(Tout et al., 2023d). Accordingly, future research will be necessary to confirm whether the observed pattern of findings can be applied to the general population.

6.4.2 Reliance on Self-report Measures

Despite their use throughout the overwhelming majority of research cited within this thesis, self-report measures are subject to a host of biases (Paulhus & Vazire, 2007). Indeed, while the PSQI is considered to be the 'gold standard' self-report measure for assessing sleep quality and quantity (Buysse et al., 1989; Mollayeva et al., 2016), inaccuracies in the self-reporting of sleep timing could have led to unreliable estimates and results. Even so, it is important not to neglect or overlook the validity of self-report assessments, especially in situations where other forms of assessment are not readily available due to a lack of sufficient resources and/or funds to obtain them. Again, as much of the current research was conducted over the course of the Covid-19 pandemic, the use of self-report measures was a pragmatic decision and, indeed, the only option initially. Further, the self-report measures utilised here were employed upon an extensive search of the literature and in an effort to complement the majority of research in these areas. Indeed, the 15-item Five Facet Mindfulness Questionnaire (FFMQ-15; Baer et al., 2008), the Self-Compassion Scale/Self-Compassion Scale Short-Form (SCS/SCS-SF; Neff, 2003b; Raes et al., 2011), the Gratitude Questionnaire (GQ-6; McCullough et al., 2002), the Life-Orientation Test-Revised (LOT-R; Scheier et al., 1994) and the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) used within this project comprise the most frequently used methods of assessing mindfulness (Sala et al., 2020), self-compassion (Brown et al., 2021; Butz & Stahlberg, 2020), gratitude (Tout et al., 2023a), optimism (Tout et al., 2023d) and overall sleep quality and quantity (Brown et al., 2021; Tout et al., 2023a; 2023b) within the reviewed positive psychology-sleep literature to date.

As discussed within the empirical chapters of this thesis, the importance of subjective sleep reports should not be overlooked, especially when clinical sleep problems such as insomnia are defined by the *subjective* inability to get to sleep and/or stay asleep despite adequate opportunity to do so (Edinger et al., 2021a). Indeed, insomniacs often fail to demonstrate objective sleep problems, while objective and subjective parameters are rarely correlated within themselves (Fernandez-Mendoza et al., 2011; Jackowska et al., 2016b; Kay et al., 2015). Thus, as with any physical and/or mental health complaint, sleep complaints should not go untreated just because an individual fails to provide objective proof of a deficit in their neurochemical/ physiological/ anatomical profile. Indeed, given the subjective nature of many sleep complaints, psychological correlates of subjective sleep assessments may provide particularly useful targets when it comes to the development of inexpensive, easy and self-administrable, psychological solutions to sleep problems. Nevertheless, it is also important to acknowledge that certain health complications and conditions associated with short sleep may arise regardless of subjective perception. Thus, when the aim of an intervention is to improve health outcomes related with objective sleep (rather than reduce perceptions of poor sleep arising from feelings of stress and anxiety, for instance), then objective assessments should be sought. Indeed, when it comes to sleep outcomes, future research would benefit from exploring and determining whether positive traits also have objective sleep correlates, given the paucity of objective research in this area.

6.4.3 Pre-registration

The empirical studies discussed within Chapters 2, 3 and 5 were all pre-registered in an effort to adhere to current open-science practices and overcome the limitations of current work in the area, which has seldom engaged with this practice. Thus, pre-registration has helped to provide an additional level of transparency in this research area and makes it clear that findings are not the result of changes to hypothesis and/or 'data-fishing' projects that may have occurred in the past, with the open-availability of analytic plans and datasets enabling further replication (see Long & Dorison, 2021, for a review).

6.5 Conclusion

By demonstrating the ability of positive psychological traits to consistently predict and facilitate good sleep quality and quantity, this thesis has emphasised the need to consider new and integrative, positive psychological approaches to sleep medicine (Wickwire, 2021). In a direct complement to current non-pharmacological interventions such as CBT-I, and in line with (meta)cognitive and arousal-based models of insomnia (Espie, 2007; Harvey, 2002; Ong et al., 2012; Reimann, 2010), findings suggest that positive traits may be somewhat unified in terms of their ability to promote good sleep via the reduction of sleep-impairing maladaptive cognitive-emotional processes, although other mechanisms remain to be explored. In accordance with the above, and in light of the successful integration of mindfulness-based practices into CBT-I (Ong et al., 2008; Ong & Moore, 2020), the promotion of positive traits – and in particular, the promotion of optimism – could provide a promising additional and/or alternative means of facilitating good sleep quality and quantity within the general population.

APPENDICES

Appendix A – Gratitude and Sleep: A Systematic Review and Meta-analysis (Tout, Jessop & Miles, 2023a)

Abstract

Objective: Dispositional gratitude is associated with a variety of beneficial health and wellbeing outcomes, including better sleep; however, the literature investigating the relationship between gratitude and sleep has not yet been consolidated. *Purpose:* To provide a systematic review of the gratitude-sleep literature to date and quantitatively synthesise a subset of comparable studies. *Methods:* Systematic literature searches were conducted using PsycINFO and Web of Science databases. Search terms required the presence of "*gratitude*" OR "*grateful**" AND "*sleep*" OR "*insomnia*" in the abstract. Results were refined by type, language and methodology, and were only included if the study contained a measure of sleep *and* gratitude (*or* a manipulation of one *and* a measure of the other) *and* reported a statistical association between them. A random effects meta-analysis was used to synthesise the results of comparable studies. *Results:* A total of 20 articles, including 22 independent study samples, met the inclusion criteria for review. Eighteen reported some statistically significant association between levels of gratitude and sleep *or* a significant effect of a gratitude intervention on a sleep outcome. All studies used self-report assessments, with the Gratitude Questionnaire (GQ-6) and the Pittsburgh Sleep Quality Index (PSQI) comprising the most common methods of assessment. For a subset of studies reporting cross-sectional correlations between the GQ-6 and some measure of overall sleep quality (n = 6), a meta-analysis revealed that higher levels of gratitude were significantly associated with better sleep (r = .26, 95%CI[.15, .37]). *Conclusions*:

Gratitude is consistently associated with better subjective sleep; however, prospective research remains limited and associations with objective outcomes remain unknown. Further research is also needed to determine whether gratitude interventions provide a reliable way of improving sleep.

Introduction

Gratitude refers to a sense of thankfulness for the good things in life (for a review see Emmons & McCullough, 2004). As a state, feelings of gratitude can be induced by a particular situation or experience, while trait/dispositional gratitude refers to a more general tendency to notice and appreciate positive outcomes day-to-day (Emmons & McCullough, 2004; Wood, Froh & Gerahty, 2010). These positive outcomes do not necessarily have to be deserved or earned and can be felt in response to the actions of another, or towards an impersonal source such as nature or God (Emmons & McCullough, 2004; Wood et al., 2010). In line with theoretical ideas (Fredrickson, 2001; 2004), experiences of gratitude may help to broaden an individual's thought-action repertoires, which in turn increase personal resources and markers of good health, thus enabling them to cope more effectively in the face of future stress and adversity (Bono et al., 2004; Wood et al., 2010). Indeed, dispositional gratitude has been linked to a variety of benefits for psychological wellbeing (Cregg & Cheavens, 2021; Davis et al., 2016; Dickens, 2017; Wood et al., 2010), objective physical health, and also predicts engagement in positive health-related behaviours (Boggiss et al., 2020; Dickens, 2017).

One health-related behaviour that has been linked to trait gratitude more recently, is sleep. In the earliest study to comment on the relationship between these two variables, Emmons and McCullough (2003) identified mixed benefits when it came to writing about the things one is grateful for in life, with one study finding increases in sleep duration and reports of feeling refreshed upon awakening, while another found no improvement in any health-related outcome. In a subsequent cross-sectional study, Wood et al., (2009) demonstrated a significant relationship between trait gratitude and overall sleep quality and quantity as assessed via the Pittsburgh Sleep Quality Index (PSQI). This relationship remained significant even when controlling for social desirability and the Big 5 personality variables, suggesting there may be something unique about gratitude when it comes to predicting sleep outcomes over and above more general personality factors. Indeed, gratitude has also been shown to fully account for relationships between spiritual wellbeing and sleep (Mills et al., 2015).

Interestingly, Wood et al., (2009) further identified pre-sleep cognitions – specifically, a reduction in negative pre-sleep cognitions and an increase in positive pre-sleep cognitions – as a mediator of the relationships between gratitude and sleep. Accordingly, gratitude was suggested to facilitate sleep by reducing the negative thoughts and worries that ordinarily impair it, while simultaneously encouraging sleep-promoting positive cognitions (Wood et al., 2009). Multiple studies have since replicated the cross-sectional links between gratitude and sleep, providing further support for associations and insight as to underlying mechanisms (Alkozei et al., 2019; Hirsch et al., 2021; Mills et al., 2015). However, despite evidence for cross-sectional links between gratitude and sleep, as of yet, this literature has not been subject to a systematic review or meta-analysis, meaning it remains unclear whether relationships between gratitude and sleep hold across sample populations, assessment measures and study designs. Indeed, as cross-sectional research can only confirm that these two variables are *related* to one another, identifying studies that have examined prospective relationships between gratitude and sleep, and/or examine the effects of a gratitude intervention on sleep outcomes, may also help to integrate findings and address questions of causality and/or potential (bi)direction of effect.

When it comes to evidence for causal relationships, a recent systematic review that explored the effectiveness of gratitude *interventions* on physical health outcomes more widely, reported that sleep may be an especially promising area for further study, with five out of eight sleep-focused studies demonstrating significant effects of a gratitude intervention on sleep quality and quantity (Boggiss et al., 2020). It was further suggested that the beneficial impact of gratitude on sleep could help to account for the associations between gratitude and physical health observed previously, with good sleep being vital for cardiovascular health and self-reported physical symptoms (Boggiss et al., 2020). However, while reviews have helped to consolidate the literature on gratitude interventions and physical and/or psychological health more widely (Boggiss et al., 2020; Davis et al., 2016), sleep has never been the sole outcome of focus, and results have remained restricted to an examination of intervention-based studies. Consequently, there is a need to consolidate and integrate the wider literature on gratitude and sleep, with cross-sectional studies and dissertations providing further insight as to the strength and consistency of relationships, as well as associated mechanisms of action.

Integrating evidence for associations between modifiable positive traits such as gratitude and sleep also represents an important step when it comes to the identification of worthwhile targets for intervention. Indeed, with around a third of adults and one half of adolescents failing to get the recommended number of hours of sleep per night (Chattu et al., 2019; Liu et al., 2016), and rates of daytime sleepiness and insomnia on the rise (Kocevska et al., 2021), providing positive solutions to sleep problems should be a priority for public health. Certainly, recent calls for new and integrative approaches to sleep medicine have emphasized the importance of positive psychological traits when it comes to the development of future interventions (Linley et al., 2009; Wickwire, 2021). If effective, promoting positive traits such as gratitude, could help to provide an easy, inexpensive and practical means to improve sleep in the general population (Wood et al., 2010), while avoiding the side-effects of sedative medications (Qaseem et al., 2016) and the cognitive demands of less accessible treatments such as cognitive behavioural therapy for insomnia (CBT-I; Koffel et al., 2018).

In light of the above, the current study aimed to provide a systematic review of the wider gratitude-sleep literature to date and quantitively synthesised the results of comparable studies via meta-analysis in order to provide some meaningful conclusion of overall effect size.

Method

The current systematic review was conducted according to the PRISMA guidelines (see Figure 5 for a flow diagram of the literature search and article selection).

Search Strategy

Systematic literature searches were conducted on the 2nd of February 2022 using PsycINFO and Web of Science databases. Search terms required the presence of both "*gratitude*" OR "*gratefulness*" OR "*grateful*" AND "*sleep*" OR "*insomnia*" in the abstract. Synonyms of gratitude such as 'thankful' and 'appreciation' were initially considered for inclusion but drew up too many irrelevant results (i.e., articles with acknowledgement sections). Search results were downloaded into *Endnote* and exported into *Rayyan*, where duplicates were removed, and articles were assessed for eligibility. Reviews were not included but were examined for additional sources, as were the reference lists of eligible articles and citing articles. The researcher's own database of studies linking gratitude and sleep was also consulted.

Eligibility

After removing duplicates, results were refined by type (*journal article or dissertation*), language (*available in English*) and methodology (*quantitative*). Results were further excluded if the study was clearly irrelevant to the current review, such as when search terms were used in another context (i.e., acknowledgments sections). The remaining articles were then read and excluded if the study did not include a specific measure of *both* sleep *and* gratitude (*or* a manipulation of one *and* a measure of the other) *and* report a unique statistical association between them. Measures that provided composite scores for overall physical health and/or levels of daytime sleepiness/fatigue were not considered to be specific measures of sleep. Likewise, measures of general positive personality were not considered to be specific measures of trait gratitude, nor were assessments that asked about *receiving* expressions of gratitude from others.

Data Extraction

Studies meeting the inclusion criteria for review were examined for: year of publication, study design, sample size, participant characteristics (population, mean age, percent female), key outcome measures, conclusions of significance and associated statistical results/effect sizes. For studies that included multiple measures of gratitude and/or sleep, an effort was made to extract all relevant statistical relationships/effect sizes in order to avoid bias in the reporting of significant results. Studies reporting significant effects with a $p > .05$ were not considered significant for the purposes of the current review. For studies where the effect size was not reported but sufficient data were available to compute it, an effect size was calculated. A summary of the extracted articles and their characteristics can be found in Table 10.

Statistical Analyses

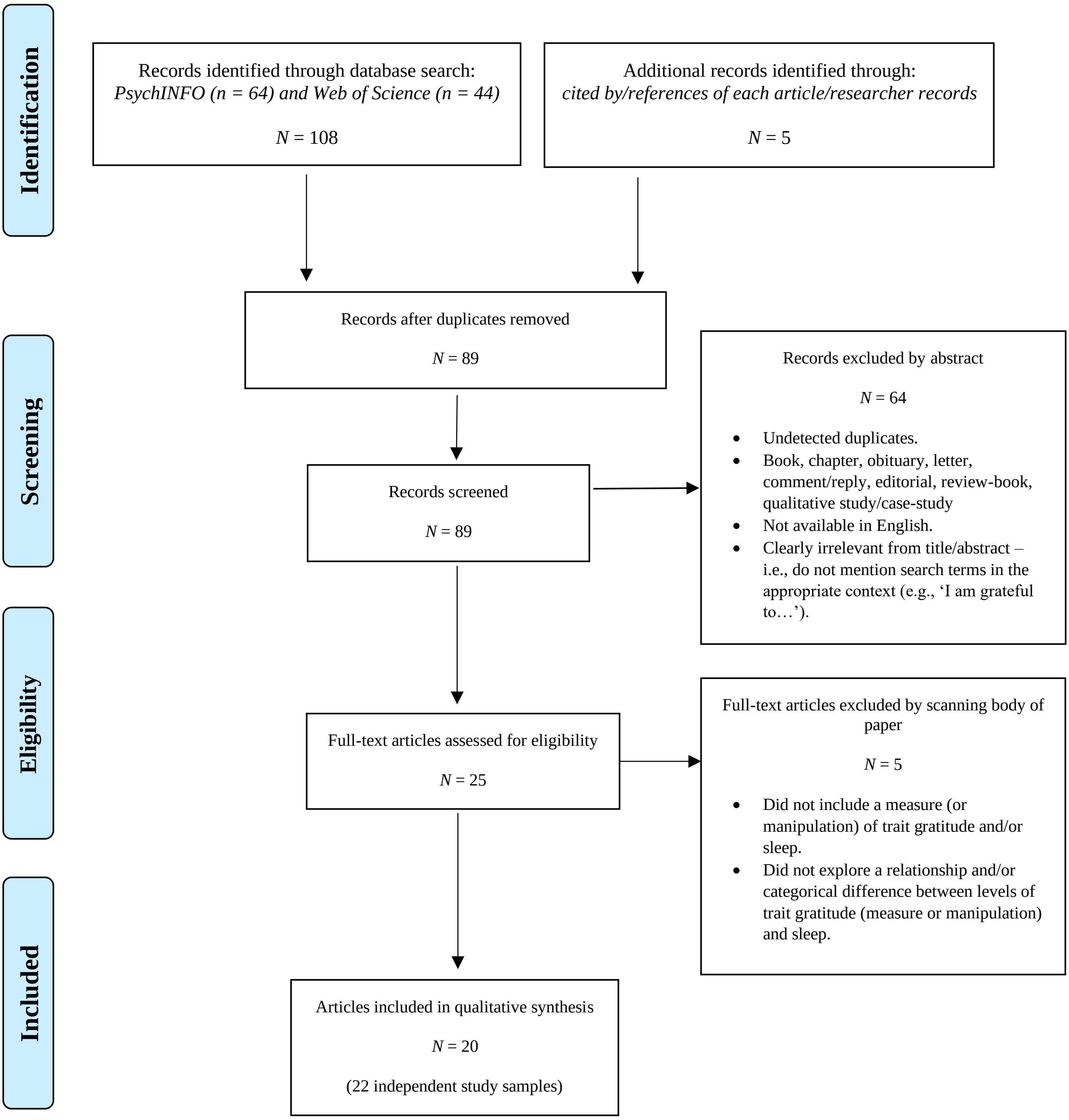
Upon reviewing the studies included in the final synthesis, it became apparent that a subset of cross-sectional studies using similar methodologies and assessment measures would enable meaningful conclusions of effect size. Accordingly, for studies that provided a sample size and reported the cross-sectional correlation (Pearson's r) between trait gratitude (assessed as a continuous variable via the GQ-6) and some indicator of overall sleep quality, a random effects meta-analysis was conducted using the Metafor package in R (Viechtbauer, 2010).

Pearson's r was used to provide the measure of effect size. As they are not normally distributed, r values were first transformed into Fisher's z before being converted back into r for interpretation. Q and I^2 statistics were used to assess levels of heterogeneity – a non-significant Q statistic and a percentage score of 25% or less on the I^2 test reflect low levels of heterogeneity (Higgins et al., 2003). To determine which studies contributed most to levels of heterogeneity, a Baujat plot was constructed. Potential outliers were identified using the influence function, wherein studies marked with an asterisk fulfil the criteria for an influential case. Publication bias was assessed via inspection of a funnel plot, the Egger's regression test and the Kendall rank correlation test, wherein asymmetry and significant results indicate bias.

While a meta-analysis of intervention effects was initially considered, this approach was deemed inappropriate, with the high level of variability in design, duration, valence of comparison control conditions, sample characteristics, outcome measures and type of reported effect size (or lack thereof), preventing meaningful conclusions.

Figure 5

PRISMA flow diagram.



Results

Study Selection

The database search yielded a total of 108 results. Four further records were identified in the references of eligible articles and one further record was identified from the researcher's own database. After duplicates were removed, a total of 89 articles remained and were reviewed for eligibility. Twenty independent articles met the inclusion criteria for review, including three dissertations. Two articles (Emmons & McCullough, 2003; Mitchell, 2010) provided two independent study samples, resulting in a total of 22 independent study samples overall.

Of the 22 total study samples, nine provided results based on cross-sectional relationships – all of which reported some statistically significant relationship between gratitude and sleep (Alkozei et al., 2019; Coleman et al., 2016; Hirsch et al., 2021; Marzabadi et al., 2021 – Study 1; Mills et al., 2015; Mitchell, 2010 – Study 1; Ng & Wong, 2013; Starkey, 2019 – Study 3; Wood et al., 2009). Eleven studies involved gratitude interventions (Bai et al., 2019; Czyzowska & Gurba, 2021; Digdon & Koble, 2011; Emmons & McCullough, 2003 – Study 2 and Study 3; Heckendorf et al., 2019; Hyland et al., 2007; Jackowska et al., 2016a; Martinez-Marti et al., 2010; Mitchell, 2010 – Study 2; Southwell & Gould, 2017) – only four of which reported no significant effect of a gratitude intervention on sleep (Bai et al., 2019; Digdon & Koble, 2011; Emmons & McCullough, 2003 – Study 2; Martinez-Marti et al., 2010). The remaining studies included a prospective study, which reported a significant relationship between sleep disturbances and gratitude (Altier, 2020) and an ecological momentary assessment study, which reported a significant relationship between gratitude and daily sleep quality ratings (Newman et al., 2021). A summary table of the extracted articles and their associated characteristics can be found in Table 10.

Sample Characteristics

A total of 7,161 participants took part in the 22 studies, with sample sizes ranging from 41 to 1,923 (M = 325.50, SD = 444.69). Out of the 18 studies that provided mean age values, the average age was 34.85 years (SD = 14.16), with average ages ranging from 19.06 to 66.50 years. The majority of studies had a larger percentage of females than males (average percent female = 63.96%, SD = 27.05), with three studies recruiting female participants only (Bai et al., 2019; Coleman et al., 2016; Jackowska et al., 2016a) and one study recruiting male participants only (Marzabadi et al., 2021). All 22 studies were conducted *on or after* the year 2003, 14 of which (64%) were conducted within the last 10 years, highlighting the recent increase of research in this area and the need for review.

Many studies (9 out of 22) used student samples (Alkozei et al., 2019; Coleman et al., 2016; Digdon & Koble, 2011; Emmons & McCullough, 2003 – Study 2; Hyland et al., 2007; Jackowska et al., 2016a; Martinez-Marti et al., 2010; Mitchell et al., 2010 – Study 1 and Study 2), three of which also included university staff (Jackowska et al., 2016a; Mitchell, 2010 – Study 1 and Study 2). One study used a young adult sample (Czyzowska & Gurba, 2021), one study looked at a sample of male soldiers (Marzabadi et al., 2021), and one study looked at veteran-partner dyads (Starkey, 2019 – Study 3). The remaining studies utilized community samples (Heckendorf et al., 2019; Wood et al., 2009), app users (Newman et al., 2021) and patient samples, including primary care patients (Altier, 2020), patients with anxiety and/or depression (Southwell & Gould, 2017), chronic pain (Ng & Wong, 2013), fibromyalgia (Hirsch et al., 2021), heart failure (Mills et al., 2015), neuromuscular disease (Emmons & McCullough, 2003 – Study 3), and women undergoing IVF in China (Bai et al., 2019). To this point, there do not seem to be any systematic differences in significant results between age-groups or sample characteristics.

Intervention Characteristics

All 11 gratitude interventions involved asking participants to write about things they were grateful for. Two interventions also incorporated workshops on the benefits of gratitude (Bai et al., 2019; Heckendorf et al., 2021). Gratitude writing took the form of journaling (Digdon & Koble, 2011) or asking participants to list the things they were thankful for – one study involved listing an unspecified number of things (Hyland et al., 2007), four studies required individuals to list three things (Bai et al., 2019; Czyzowska & Gurba, 2021; Jackowska et al., 2016a; Mitchell, 2010 – Study 2) and three studies required individuals to list five things (Emmons & McCullough – Study 2 and Study 3; Martinez-Marti et al., 2010; Southwell & Gould, 2017). One study provided participants with an app where they were asked to record moments of gratitude in the form of writing and/or photos (Heckendorf et al., 2021).

Of the 11 intervention studies, three compared experimental gratitude conditions to alternative–activity controls where participants were asked to write about everyday things (Jackowska et al., 2016a; Martinez-Marti et al., 2010; Mitchell, 2010 – Study 2), daily hassles (Emmons & McCullough, 2003 – Study 2; Martinez-Marti et al., 2010) or make downward social comparisons (Emmons & McCullough, 2003 – Study 2). The study by Jackowska et al., (2016a) also had a waitlist control condition. Other intervention studies had measurement-only control conditions where individuals simply carried out questionnaire assessments while they were on a waitlist or underwent treatment as usual (Bai et al., 2019; Czyzowska & Gurba, 2021; Emmons & McCullough, 2003 – Study 3; Heckendorf et al., 2021; Southwell & Gould, 2017). A Randomised Control Trial by Bai et al., (2019) compared the efficacy of both a gratitude intervention and a mindfulness intervention to a waitlist control group. Two intervention studies had no comparative control conditions (Hyland et al., 2007; Digdon & Koble, 2011).

Intervention durations varied, and ranged from one-day (Hyland et al., 2007) to five-weeks (Heckendorf et al., 2021). A duration of one-week/seven-days was used in three studies (Czyzowska & Gurba, 2021; Digdon & Koble, 2011; Mitchell, 2010 – Study 2) – the modal intervention length. While the majority of interventions explored differences in outcomes at baseline versus immediately post-intervention, four studies also included follow-up assessments (three–months and six-months, Heckendorf et al., 2019; two-weeks, Martinez-Marti et al., 2010; one-month, Mitchell, 2010 – Study 2; three–weeks, Southwell & Gould, 2017).

Outcome Measures

The measures used to assess gratitude and sleep across studies are summarised in Table 10. It can be seen that all studies used subjective self-report measures to assess both gratitude and sleep. Two studies did not assess trait gratitude directly (Digdon & Koble, 2011; Jackowska et al., 2016a), but explored the effects of a gratitude intervention on a sleep outcome(s).

Gratitude. The Gratitude Questionnaire 6-item (GQ-6; McCullough et al., 2002) was the most common method used to assess gratitude and was used in 15 out of 22 studies. Other assessment methods included the Gratitude Adjective Checklist (GAC; McCullough et al., 2002), which was used in three studies, and the Gratitude Resentment and Appreciation Test (GRAT 44-items; Watkins et al., 2003), which was used in one study. One study created an Expressing Gratitude Index (Czyzowska & Gurba, 2021) to capture changes in gratitude as part of an intervention and one study used a single-item measure.

Sleep. Sleep measures were more varied; however, the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989) was the most frequent method used to assess overall sleep quality and quantity and was used in eight out of 22 studies. One study also used selected items (quality and duration) from the PSQI. Other sleep outcomes measures included the Insomnia Severity Index (ISI; Morin et al., 2011), which was used in two studies, and the Sleep Impairment Index (SII; Morin et al., 1993) – an older version of the ISI, which was used in one study. The Sleep Problems Index 2 (SPI2) of the Medical Outcomes Survey – Sleep Scale (MOS-Sleep; Hays & Stewart, 1992) was used to assess sleep disturbances in one study. The Sleep Condition Indicator (Espie et al., 2014), The Sleep Quality Scale (SQS; Yi et al., 2006) and the anxiety–insomnia subscale from the General Health Questionnaire (GHQ-28; Goldberg & Hillier, 1978) were each used in one study. Other studies used single-item assessments of sleep quality or duration, and the remaining studies used multiple items to assess different components of sleep (i.e., duration, quality, difficulty falling asleep, depth of sleep, feeling refreshed upon awakening), one of which created an overall sleep score.

Significant Effects

Of the 22 studies extracted in this review, 18 reported some statistically significant association between levels of gratitude and sleep *or* a significant effect of a gratitude intervention on a sleep outcome. All four non-significant findings came from intervention studies (Bai et al., 2019; Digdon & Koble, 2011; Emmons & McCullough, 2003 – Study 2; Martinez-Marti, 2010) – one of which had insufficient power (< 50%) by the authors' own admission and only reported significant effects when combining three non-comparable intervention conditions (Digdon & Koble, 2011). Another intervention had questionable levels of acceptability in a sample of Chinese women undergoing IVF (Bai et al., 2019).

Of the 18 studies that reported some statistically significant effect or relationship between gratitude and sleep, four also exhibited non-significant effects, and thus had mixed findings. First, in a cross-sectional study by Alkozei et al., (2019), while levels of gratitude were significantly higher in those who rated their sleep quality as 'good/fairly good' vs. 'bad/fairly bad', GRAT scores did not significantly correlate with overall PSQI scores. Second, in a study by Marzabardi et al., (2021), while there were significant differences in insomnia severity between those scoring low, medium and high on gratitude, and while low levels of gratitude were related to high levels of insomnia, *high* levels of gratitude were unrelated to insomnia scores. Then, in a study by Starkey (2019), while the PSQI item for sleep duration correlated with a single-item assessment of gratitude, the PSQI item for sleep quality did not. Last, in an intervention study by Jackowska et al., (2016a), while those in the gratitude condition showed significant improvement in *daily* sleep quality ratings versus controls (but not versus those in the alternative-activity condition), there was no improvement in PSQI scores.

To this point, it seems that associations between gratitude and sleep may be more variable if gratitude is treated as a categorical variable (Marzabadi et al., 2021), or assessed via a single-item measure (Starkey, 2019 – Study 3), the GRAT (Alkozei et al., 2019) or the GAC (Emmons & McCullough – Study 2; Martinez-Marti et al., 2010), rather than assessed as a continuous variable via the GQ-6. Further, the PSQI may be less sensitive than daily sleep reports when it comes to detecting changes in sleep within shorter intervention studies (i.e., 2-weeks; Jackowska et al., 2016a) – indeed, the original wording of the PSQI asks about sleep over the last month (Buysse et al., 1989).

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Alkozei et al., (2019)	Cross-sectional	88 undergraduate students	19.06	46.6	GRAT; PSQI	No correlation between GRAT and total PSQI scores (*r* = -.11, p = .3). Sig. correlation between GRAT and sleep duration (*r* = .29, p = .006). GRAT scores significantly higher in those who rated their sleep quality as 'good/fairly good' vs. 'bad/fairly bad'	*r* = -.11 *r* = .29 NR/not enough data to calculate effect size for difference.
Altier (2020) – Dissertation	Prospective – T1 (baseline) and T2 (1-year follow-up)	223 primary care patients	44.07	61.2	GQ-6; MOS-Sleep	T2 gratitude was significantly related to sleep disturbances at T1 (*r* = -.42, *p* < .001) and T2 (*r* = -.46, *p* < .001).	*r* = -.42 *r* = -.46
Bai et al., (2019)	Intervention – **1hr x 4-week workshop + 20-mins daily listing 3 things in a gratitude diary** vs. 20-mins mindful body scan vs. routine care controls (T1 baseline day 1; T2 ~day 30; T3 ~day 40)	234 women undergoing IVF in a Chinese fertility clinic	30.29	100	GQ-6; PSQI	No effect of the gratitude intervention on sleep when compared to controls between the three time-points.	*d* =.03
Coleman et al., (2016)	Cross-sectional	748 female college students	19.25	100	GQ-6; Single-item assessing sleep duration	Sleep duration and gratitude were significantly correlated (*r* = .07, *p* < .05)	*r* = .07
Czyzowska & Gurba (2021)	Intervention – list **1-week of listing 3 things in a gratitude diary every night** vs. control (pre- vs. post-intervention assessment)	80 young adults from Poland	20.6	72.5	Gratitude intervention effect; Expressing gratitude index; GHQ-28 anxiety/insomnia subscale	Expressing gratitude was correlated with anxiety/insomnia (*r* = -.44, *p* < .05) and decreased for those in the gratitude condition (*p* < .05).	*r* = -.44 *d* = .20

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Digdon & Koble (2011)	Intervention – **1-week** x **15-mins writing about positive events before bed** vs. constructive worry vs. imagery distraction (pre- vs. post intervention assessment).	41 university students with disruptive sleep and/or worry	23.22	78.05	Gratitude intervention effect; SQS; daily sleep log/sleep onset; total sleep time; refreshed upon awakening	No significant effect of the gratitude intervention on sleep measures to low power (only significant when pooling non-comparable conditions).	Not appropriate to calculate, (power = <50%; n < 10)
Emmons & McCullough (2003) Study 2	Intervention – **16-days of listing 5 things in a gratitude diary** vs. daily hassles vs. downward social comparison (pre- vs. post-intervention assessment)	166 undergraduate students	NR	75.3	GAC; Single-items to assess sleep duration and sleep quality.	No differences between the conditions in sleep quality or duration.	NR/ Not enough data to calculate effect sizes
Emmons & McCullough (2003) Study 3	Intervention – **21-days of listing 5 things in a gratitude diary** vs. control (pre vs. post-intervention assessment)	65 patients with congenital adult-onset neuromuscular disease	49	67.7	GAC; health measures (including 3 sleep questions – duration, difficulties, refreshed upon awakening)	Gratitude condition reported significantly more hours of sleep and felt more refreshed upon awakening (p < .05), but not fewer sleep difficulties.	NR/ Not enough data to calculate effect size
Heckendorf et al., (2019)	RCT – **1hr x 5-weeks online gratitude training + daily gratitude app** vs. waitlist controls (pre- vs. post- vs. 3-month vs. 6-month assessment).	262 German community sample	42.2	58.8	GQ-6; ISI	Gratitude intervention significantly improved insomnia post-intervention (p < .05) and at 3-months (p < .01) vs. controls. Within-group improvements reported at 6-months, were also significant (p < .001).	Gratitude vs. controls: Post: d = .34 3-month: d = .39 Within gratitude group 6-month: d = .40
Hirsch et al., (2021)	Cross-sectional	1,218 patients with fibromyalgia	58	52	GQ-6; Sleep Condition Indicator	Gratitude and sleep were significantly correlated (r = .07, p < .01).	r = .07

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Hyland et al., (2007) – Study 2	Intervention **– 1 evening of gratitude listing**. No comparison group.	90 students	NR	58.90	GQ-6; 5-items to provide a measure of sleep quality	Gratitude and sleep quality were significantly correlated, independent of expectancy (r = .27, p < .01).	r = .27
Jackowska et al., (2016a)	RCT – **2-weeks of listing 3 things in a gratitude diary** vs. everyday things vs. WC (pre- vs. post-assessment)	119 young women working and/or studying at UCL	26.3	100	Gratitude intervention effect; PSQI; daily sleep quality ratings	No change in PSQI, but daily sleep quality ratings significantly improved to a greater extent in the gratitude group vs. no treatment (p < .05), but not to a greater extent than the everyday things group (NR).	PSQI: d = NR Daily sleep quality: d = -.26
Martinez-Marti et al., (2010)	Intervention – **2-weeks listing 5 things in a gratitude diary** vs. hassles vs. everyday things (pre- vs. post- vs. 2-week follow-up)	159 Spanish UG psychology students	20.7	89.3	GAC; GQ-6; 4-items to assess sleep (quality, duration, difficulty, depth).	No differences in sleep were found as a result of the intervention.	NR/ Not enough data to calculate effect size
Marzabadi et al., (2021) – Study 1	Cross-sectional	315 male soldiers	23.85	0	GQ-6; ISI	Significant difference between high, medium, low gratitude and insomnia severity (p < .001). Low gratitude had the worst insomnia (r = -.31, p < .05). No significant relationship between high gratitude and insomnia (r = -.03).	f = .34 r = -.31 r = -.03
Mills et al., (2015)	Cross-sectional	186 individuals with Stage B symptomatic heart failure	66.5	4.7	GQ-6; PSQI	Significant relationship between gratitude and overall sleep quality and quantity (r = -.25, p < .001).	r = -.25

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Mitchell (2010) – Dissertation Study 1	Cross-sectional	300 university students and staff	18-67	76.7	GQ-6; Sleep impairment index	Significant correlation between gratitude and sleep impairment ($r = -.25$, $p < .001$)	$r = -.25$
Mitchell (2010) – Dissertation Study 2	Intervention – **7-days listing 3 things in a gratitude diary** vs. daily events (pre- vs. post-assessment vs. 1-month follow-up).	51 university students and staff	18-61	82.4	GQ-6; PSQI; Sleep diary;	Significant interaction effect ($p < .05$). Gratitude condition had improved sleep vs. controls post-intervention and 1 month follow-up.	Post: $d = .65$ 1-month follow-up: $d = .15$
Newman et al., (2021)	Ecological Momentary Assessment (21-days)	1,923 App users across the globe who filled out at least 3 sleep entries per week	42.79	34.46	GQ-6; Single-item to assess sleep quality	Trait gratitude significantly predicted better daily sleep quality ($p < .001$).	$r = .24$
Ng & Wong (2013)	Cross-sectional	224 patients with chronic pain	45.7	56.9	GQ-6; PSQI	Significant contribution of gratitude to overall sleep quality and quantity ($p < .05$).	$\beta = .09$
Southwell & Gould (2017)	RCT – **3-weeks listing 5 things in a gratitude diary** vs. WC (pre- vs. post- vs. 3-week follow-up).	109 over 18s with a diagnosis of anxiety and depression	34	88	GQ-6; PSQI	Gratitude intervention significantly improved sleep T1 to T2 ($p < .05$). Effect not held to follow up.	T1 to T2, $\eta_p^2 = .14$ T1 to T3, $\eta_p^2 = .09$
Starkey (2019) – Dissertation Study 3	Cross-sectional	159 veteran/spouse dyads	37	50	2-items from PSQI (duration and quality); 1-item assessing gratitude.	Gratitude was significantly related to sleep quality ($r = .30$, $p < .01$) but not duration ($r = .07$, $p = .40$).	$r = .30$ $r = .07$

Author (Date)	Design	Sample	Mean Age	% Female	Key Measures	Significance	Effect Size
Wood et al., (2009)	Cross-sectional	401 community sample	24.89	53.6	GQ-6; PSQI	Significant relationship between gratitude and overall sleep quality and quantity (r = -.29, p < .001)	r = -.29

Key: GRAT = Gratitude 44-item checklist; PSQI = Pittsburgh Sleep Quality Index; MOS-Sleep = Medical Outcomes Study Sleep Scale; GQ-6 = Gratitude Questionnaire 6-items; GHQ-28 = General Health Questionnaire; ISI = Insomnia Severity Index; SQS = Sleep Quality Scale; GAC = Gratitude Adjective Checklist. WC = Waitlist Controls. NR = not reported.

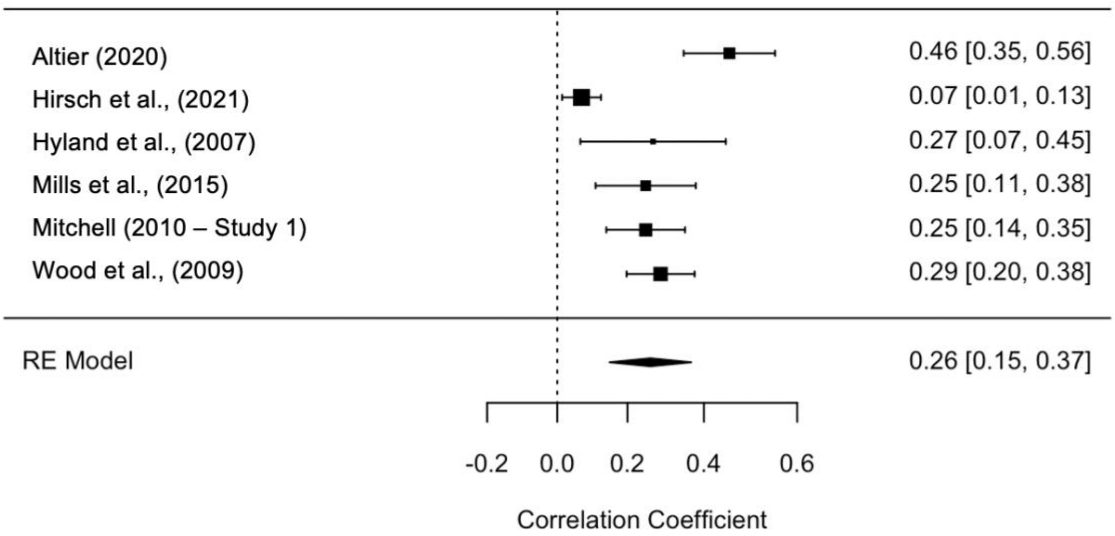
Note: Some correlations in Table 10 are reported as negative as per the reporting in the original study. The majority of negative correlations are the result of *high* scores on sleep outcomes measures such as the ISI and PSQI indicating *poor* sleep quality, whereas high gratitude scores indicate higher levels of gratitude in all instances.

Quantitative Synthesis of Results

For the six studies that reported a cross-sectional correlation between trait gratitude (assessed as a continuous variable via the GQ-6) and some indicator of overall sleep quality (Altier, 2020; Hirsch et al., 2021; Hyland et al., 2007; Mills et al., 2015; Mitchell, 2010 – Study 1; Wood et al., 2009), a random effects meta-analysis revealed a significant association, whereby higher levels of gratitude indicated better sleep (*r* = .26, 95%CI[.15, .37])[13]. See Figure 6 for a forest plot. For the two studies that reported on the cross-sectional correlation between the GQ-6 and overall PSQI scores (Mills et al., 2015; Wood et al., 2009), the mean effect size was *r* = .27, suggesting similar effect sizes may be found when the sleep measure is held constant.

Figure 6

Forest plot of observed associations between trait gratitude and sleep quality in the included studies.



[13] In the original studies, some correlations were reported as negative due to *high* scores on sleep outcomes measures such as the ISI and PSQI indicating *poorer* sleep quality, while high gratitude scores indicate higher levels of gratitude in all instances. For ease, correlations have been reported as positive to reflect the positive relationships between these two variables (i.e., higher levels of gratitude are associated with better sleep outcomes).

Cochrane's Q was significant, suggesting the included studies may not share a common effect size: $q(5) = 45.63$, $p < .0001$. The I^2 statistic was 85.15 (95%CI: [57.79, 98.00]), meaning 85.15% of the observed variation in effect sizes could be due to heterogeneity. Inspection of the Baujat plot revealed that the studies by Altier (2020) and Hirsch et al., (2021) contributed most to heterogeneity and fulfilled the criteria for influential cases. Examining study attributes, the study by Hirsch et al., (2021) had by far the largest sample ($N = 1{,}218$) and the smallest effect size. Further, despite reporting the smallest (Hirsch et al., 2021) and largest (Altier, 2020) effect sizes, these studies also overlapped in terms of author and institution. Thus, heterogeneity could be influenced by sample size, research-group and/or location-specific factors. When assessing for publication bias, inspection of the funnel plot suggested symmetry, while the Egger regression test ($Z = 1.20$, $p = .231$) and rank correlation test (Kendall $\tau = -.07$, $p = 1.00$) were non-significant, suggesting no evidence of publication bias.

Discussion

While previous reviews have collated the effects of gratitude *interventions* on health and wellbeing outcomes more generally (Boggiss et al., 2020; Dickens, 2017), this paper is the first to provide a systematic review and meta-analysis of the wider gratitude-sleep literature to date. Overall, 22 independent study samples from 20 articles investigated associations between levels of trait gratitude and sleep *or* explored the effects of a gratitude intervention on a sleep outcome(s), 18 of which reported some significant association between the two variables *or* an improvement in sleep as a result of a gratitude intervention. Findings demonstrated consistent positive associations between trait gratitude and sleep in all nine cross-sectional studies, while seven out of 11 intervention studies reported some significant effect of a gratitude intervention on a sleep outcome(s). Both prospective and ecological momentary assessment studies also revealed significant relationships between trait gratitude and sleep.

Upon reviewing the studies included in this systematic review, it became apparent that a subset of studies offered the opportunity for further quantitative analysis. Consequently, for the six studies that reported a cross-sectional correlation between trait gratitude (as assessed via the GQ-6) and some overall sleep quality measure, a random effects meta-analysis was run. Findings revealed a significant medium-sized positive correlation between gratitude and overall sleep (r = .26 95%CI[.15, .37]), further supporting associations between gratitude and sleep. Interestingly, a similar mean effect size was found for the two studies that used the PSQI to assess overall sleep quality and quantity (r = .27), suggesting that sleep outcome measure may not introduce too much variability into this relationship.

Here, it is important to note that a considerable level of heterogeneity was observed within the six studies extracted for meta-analysis, with sample size and research-group specific factors potentially influencing the size of relationships. Indeed, one study identified as an influential case had by far the largest sample size and reported the smallest effect amongst the eligible studies (Hirsch et al., 2021). Additionally, despite reporting the largest (Altier, 2020) and smallest (Hirsch et al., 2021) effect sizes, the two studies identified as being influential cases also stood out in that they had overlapping authors and institutions, suggesting that nuances in research group and/or population-specific factors may have also contributed to heterogeneity. When it came to other biases, inspection of the funnel plot, Egger's regression and rank correlation tests revealed no evidence of publication bias across the six studies included in the meta-analysis, suggesting that the high prevalence of significant findings could reflect a true relationship between trait gratitude and sleep, rather than a bias towards the publication of significant results. Efforts to include the findings of unpublished dissertations and extract all reported statistical relationships between gratitude and sleep as part of the current review may have helped to address this; however, publication bias could be present in those studies not included in the quantitative synthesis.

Here, it should also be noted that of the 18 studies that reported some significant effect or relationship between gratitude and sleep, four also reported non-significant findings, wherein gratitude related to sleep measures in some instances but not others (Alkozei et al., 2019; Jackowska et al., 2016a; Marzabadi et al., 2021; Starkey, 2019 – Study 3). To this point, trait gratitude assessed via the GQ-6 and treated as a continuous variable seems to provide the most consistent relationships with sleep, regardless of sleep outcome measure. Future cross-sectional studies may wish to use the GQ-6 in combination with the PSQI – a gold standard self-report sleep assessment measure incorporating seven different components of sleep (Buysse et al., 1989) – in order to provide additional insight as to which components may be most strongly related to gratitude and enable reviews to better consolidate effects. Indeed, the study by Wood et al., (2009) demonstrated significant relationships between trait gratitude and each of the sleep components (with the exception of sleep medication use). Additionally, when it comes to intervention studies, it seems that daily sleep reports may be better at capturing short-term changes in sleep versus the PSQI, which was unable to capture changes in sleep over a two-week intervention by Jackowska et al., (2016a) – potentially as the original measure asks about sleep over the last month (Buysse et al., 1989). Thus, intervention studies may wish to utilise daily sleep reports in order to capture changes occurring in the shorter term.

In addition to providing evidence for positive associations between trait gratitude and sleep, this review also found three cross-sectional studies that had explored mediators of effect, thus providing additional insight as to potential underlying mechanisms. Indeed, depressive mood (Alkozei et al., 2019), anxiety, stress and depression (Hirsch et al., 2021) and positive/negative pre-sleep cognitions (Wood et al., 2009) were all implicated as potential mediators of the gratitude–sleep link, thus demonstrating both direct and indirect effects of gratitude on sleep. In accordance with these findings, it seems that gratitude could help to decrease negative cognitions and levels of stress, anxiety and depression, which in turn may help to reduce levels of physiological arousal known to impair sleep (Harvey, 2002; Nelson & Harvey, 2003). The resulting good sleep could then afford an ‘upward spiral’ of additional benefits for health and wellbeing, thus helping to explain links between gratitude and health found previously (Boggiss et al., 2020; Fredrickson, 2001; 2004). Building up a theoretical model to better understand the direct and indirect relationships between gratitude and sleep is therefore an important step for future research and will help to move studies on from replicating correlational relationships, to explaining *why* such relationships might occur. Indeed, the above findings all came from cross-sectional research designs, emphasising the need for research to begin examining relationships via prospective methods in order to address assumptions of temporal order.

Interestingly, this review only identified one prospective examination of the relationship between gratitude and sleep to date as part of a recent dissertation project by Altier (2020), wherein the reverse direction of effect – that is, the possibility that good sleep also lends itself to higher levels of gratitude – was also examined. Interestingly, sleep disturbances at baseline were related to levels of gratitude one-year later, highlighting the need for further prospective investigation and the need to consider reverse causality. Certainly, better sleep quality and quantity has been shown to benefit emotional wellbeing and increase the intensity and duration of positive emotions and the use of adaptive emotion regulation strategies (Palmer & Alfano et al., 2017; Parsons et al., 2021). Accordingly, good sleep and gratitude may have a mutually reinforcing effect, reflecting current theoretical ideas, wherein positive traits and emotions are suggested to foster an upward spiral of personal resources that contribute to overall wellbeing (Fredrickson, 2001; Bono et al., 2004). Further research examining prospective relationships between sleep and gratitude is therefore needed to elucidate direction(s) of effect; although, the fact that gratitude interventions improve sleep in some instances does imply a causal pathway in this direction.

When it came to intervention studies, listing the things that one is grateful for in life appeared to be largely effective, with seven out of 11 interventions reporting significant effects of a gratitude intervention on a sleep outcome(s). Despite this, further exploration is needed to determine whether increasing gratitude provides a reliable way of improving sleep, with multiple sources of variation making it difficult to collate intervention effects in meaningful ways. Indeed, intervention studies were considered too variable to provide any meaningful average effect size as part of a meta-analysis in the current study, with sources of variance including: intervention length (e.g., one–day vs. two-weeks vs. five–weeks); intervention content (e.g., gratitude journaling vs. three good things vs. gratitude app); the type, number and valence of comparison conditions, or lack thereof (e.g., negative, neutral and/or positive alternative activity controls vs. measurement-only controls vs. no controls); the type of sleep outcome measure used (e.g., PSQI vs. daily sleep diaries vs. unvalidated multiple-item assessments); the sample population (e.g., undergraduate students vs. pregnant women undergoing IVF in China vs. individuals with congenital adult-onset neuromuscular disease); and the type of reported effect size or lack thereof (e.g., Cohen's *d* vs. partial eta-squared vs. insufficient data to calculate an effect size).

One problematic source of intervention variability observed in the current review relates to the content of comparison conditions, or lack thereof. For instance, across the intervention studies extracted in the current review, experimental gratitude conditions have been compared to alternative-activity controls – some neutral (listing everyday events), some negative (listing daily hassles) and some positive (making downward social comparisons) – to measurement-only controls, and in some cases, to no controls at all. Consequently, it remains unclear whether gratitude interventions are a) better than nothing, b) (in)effective compared to alternative activities, or c) 'effective' in comparison to interventions that actively reduce positive outcomes. Indeed, when it comes to claiming the effectiveness of gratitude interventions more widely, Wood and colleagues (2010) have rightly asked: in comparison to what? Accordingly, future interventions should endeavour to compare experimental gratitude conditions to alternative-activity controls with different valences as well as measurement-only controls in order to elucidate the specificity of gratitude interventions and enable more meaningful conclusions. Indeed, previous reviews and meta-analyses exploring the effectiveness of gratitude interventions on physical health more widely have not always considered the valence of comparison conditions (Davis et al., 2016), and thus may be confounded when it comes to conclusions of effect size (Dickens, 2017).

Clarifying whether gratitude interventions provide an effective way of improving sleep may be important when it comes to answering the recent call for integrative, positive-psychology informed approaches to sleep medicine (Wickwire et al., 2021). Certainly, the cheap, easy and self-administrable nature of gratitude listing could make it fairly accessible to the majority of the population, including those who report poor sleep, and may also have utility within clinical settings (Wood et al., 2010). Thus, in order to further inform best practices, future research should attempt to determine the optimum delivery method and duration of gratitude interventions, and further explore whether they work best in combination with, and/or in comparison to, current approaches to sleep health such as sleep hygiene and cognitive behavioural therapy for insomnia (CBT-I). Follow-up studies are also necessary to clarify whether any benefits to sleep persist beyond the short-term, and therefore provide a longer-term solution to sleep complaints. In addition, examining whether intervention effects are moderated by baseline levels of gratitude, demographic features or psychological traits could help to provide further insight as to *who* gratitude interventions are most (in)effective for, and enable a more tailored, case-by-case approach to intervention. For instance, Wood et al., (2016) have acknowledged that gratitude can have negative effects on individuals who put the needs of others above their own, lack autonomy, and/or believe their needs should not be expressed. Indeed, gratitude listing had low acceptability in a sample of Chinese women undergoing IVF – potentially due to lower education, lack of familial support, and domestic violence (Bai et al., 2019) – thus highlighting the limited generality of positive interventions when it comes to those from other backgrounds (Seligman et al., 2005).

Here, it is important to note that the majority of studies identified by the current review were conducted within White, Educated, Industrialized, Rich and Democratic populations – a criticism of positive psychology-based interventions more widely, although efforts to tackle this are slowly being made (WEIRD; Hendriks et al., 2019). Interestingly, however, cross-cultural differences in gratitude have also been shown to exist *within* predominantly WEIRD populations. For example, in a series of studies that compared responses to gratitude in the United Kingdom (UK) and Australia, individuals from the UK were more likely to associate gratitude with feelings of guilt, obligation/indebtedness and embarrassment, and further recognise ulterior motives behind benevolent acts (Morgan et al., 2022). Thus, it is important to consider that gratitude interventions may not have equivalent effects across cultures and countries, and in some instances, could even cause discomfort (Titova et al., 2017).

Lastly, in addition to the scarcity of prospective research, the findings of this review demonstrate that studies to date have not yet examined the relationship between trait gratitude and *objective* assessments of sleep (such as wristwatch actigraphy and/or polysomnography). Thus, determining whether gratitude relates to sleep beyond self-reported quality and quantity provides a valuable next step for research and could help to clarify whether objective sleep is also a correlate of this positive trait – although it should be noted that subjective assessments tend to be more closely linked to psychological traits (Jackowska et al., 2016b). Indeed, self-reported measures of sleep are still valuable and valid measures within themselves, the importance of which should not be negated considering that self-referral to a doctor or sleep clinic is the predominant means by which individuals raise sleep concerns (Wood et al., 2009).

Overall, the findings of this systematic review have demonstrated that higher levels of gratitude are consistently linked to better subjective sleep quality and that gratitude interventions hold promise as a positive solution to sleep problems. However, sleep outcome measures remain varied and associations with objective sleep assessments have not yet been explored. Further efforts are also needed to investigate prospective associations, build-up an understanding of underlying mechanisms, and determine when, and for who, gratitude interventions might be most effective for.

Appendix B – Tout. A. F., Jessop, D. C., & Miles, E. (2023b). Investigating the combined and unique contributions of positive psychological traits to sleep and exploring emotion regulation as a common mediator.

Abstract

Objective. Research to date investigating links between positive psychological traits and sleep has typically focused on single traits, limiting understanding of their collective and independent associations. The present studies addressed this gap by exploring the combined and unique contributions of mindfulness, self-compassion, gratitude and optimism to sleep outcomes; Study 2 further investigated emotion regulation as a common underlying mechanism. *Design.* Both studies employed a cross-sectional correlational design. (Study 1 N = 268; Study 2 N = 333). *Main Outcome Measures.* The main outcome measure was overall sleep quality and quantity assessed using the Pittsburgh Sleep Quality Index. *Results.* Multiple regression analyses revealed that mindfulness, self-compassion, gratitude and optimism collectively accounted for 24.96% (Study 1) and 15.81% (Study 2) of the variance in sleep quality and quantity. Across both studies, mindfulness and optimism emerged as significant linear predictors. Study 2 further identified maladaptive emotion regulation as a common mediating mechanism. *Conclusion.* Findings highlight the importance of positive psychological traits in relation to sleep and indicate that optimism and mindfulness might make unique contributions to the prediction of sleep outcomes. Findings also flag emotion regulation as a potential common mediator of associations between positive psychological traits and sleep.

Introduction

The importance of sleep for health is increasingly being recognised. Poor quality and quantity sleep has been identified as a risk factor for a wide range of adverse physical health outcomes, including coronary heart disease, stroke, diabetes, obesity, high blood pressure and – ultimately – all cause mortality (Cappuccio et al., 2010a; 2010b; 2011; Ferrie et al., 2007; Guo et al., 2013; Miller et al., 2018). In addition, lack of sleep renders individuals more susceptible to mental health outcomes such as depression and anxiety (Cox & Olatunji, 2020; Zhai et al., 2015), exacerbates negative mood (Kahn et al., 2013; Konjarski et al., 2018) and increases the likelihood of developing neurodegenerative diseases (Shi et al., 2018; Xu et al., 2020).

Despite the overwhelming body of evidence documenting harmful consequences of inadequate sleep, many individuals obtain fewer than the recommended seven to nine hours a night (Chattu et al., 2019; Hafner et al., 2017; Sheehan et al., 2019). For example, a recent sleep survey in the UK indicated that 74% of individuals were getting less than seven hours sleep per night (The Sleep Council, 2017). Indeed, poor quality and quantity sleep is sufficiently prevalent throughout both developed and developing nations that researchers working in the field now consider it to be a global epidemic (e.g., Chattu et al., 2019; Stranges et al., 2012).

Identifying variables that facilitate good quality and quantity sleep has the potential to help address this sleep loss epidemic. One set of variables which shows promise in this regard relates to positive psychology, with existing research documenting links between higher levels of mindfulness, self-compassion, gratitude and optimism respectively and better sleep outcomes (e.g., Alkozei et al., 2019; Brown et al., 2021; Hernandez et al., 2020; Sala et al., 2020).

In the context of mindfulness, a recent meta-analysis supports the relationship between trait mindfulness and sleep, finding that higher levels of mindfulness were associated with better sleep outcomes (Sala et al., 2020). Moreover, further meta-analyses and reviews of experimental research indicate that mindfulness might play a causal role in impacting sleep, with results indicating that mindfulness interventions can lead to improvements in sleep (Ong & Moore, 2020; Rusch et al., 2019).

Similarly, recent meta-analyses have concluded that self-compassion is associated with sleep. These analyses demonstrated both that higher levels of trait self-compassion were associated with better quality and quantity sleep (Brown et al., 2021; Butz & Stahlberg, 2020) and that experimentally manipulated self-compassion led to better sleep outcomes (Butz & Stahlberg, 2020), albeit only three experimental studies were included in this latter analysis.

While the research evidence linking dispositional gratitude and optimism respectively with sleep has yet to be subject to meta-analysis, there is also promising evidence that these traits might have important implications for sleep outcomes. With regard to gratitude, several studies have reported links between trait gratitude and sleep, with individuals higher in gratitude experiencing better sleep (e.g., Alkozei et al., 2019; Wood et al., 2009). Furthermore, gratitude interventions have been shown to precipitate better quality and quantity sleep, strengthening the position that gratitude might play a causal role in influencing sleep outcomes (Boggiss et al., 2020; Emmons & McCullough, 2003, Study 3).

The literature is perhaps less clear-cut when considering the evidence that optimism influences sleep. Multiple studies have identified links between higher levels of dispositional optimism and better sleep outcomes, both cross-sectionally and prospectively (e.g., Hernandez et al., 2020; Lau et al., 2017; Uchino et al., 2017). Moreover, there is some evidence that these relationships hold for objective measures of sleep (e.g., Lemola et al., 2011; but see also Hernandez et al., 2020), helping allay concerns that those higher in optimism might simply report or perceive better sleep irrespective of actual sleep quality and quantity. However, to the best of the authors' knowledge, no published experimental studies to date have investigated the effects of optimism interventions on sleep outcomes, making it harder to ascertain whether optimism plays a causal role in this relationship. Nevertheless, there would seem to be sufficient evidence to consider trait optimism as a further plausible predictor of sleep.

In summary, a significant body of evidence associates each of mindfulness, self-compassion, gratitude and optimism with sleep. Critically, however, the research presented above has typically focused on links between one positive psychology-related variable and sleep outcomes. Hence, there is little understanding of how the four positive psychological traits of mindfulness, self-compassion, gratitude and optimism collectively impact sleep and/or which trait(s) make significant independent contribution(s) to the prediction of sleep over and above their combined impact. Addressing these unresolved research questions has the potential to advance the positive psychology literature, by furthering our understanding of the combined and unique contributions of positive psychological traits to sleep outcomes. Moreover, ultimately, such knowledge could help guide the development of effective interventions, by identifying those positive psychology constructs most likely to make the largest unique contribution to sleep quality and quantity. Accordingly, the first aim of the studies reported in this paper was to investigate the combined and unique contributions of mindfulness, self-compassion, gratitude and optimism to overall sleep quality and quantity.

A further consequence of the tendency to focus on single positive psychological traits in sleep research is that little attention has been paid to investigating whether there might exist common underlying mechanisms linking these traits to sleep outcomes. Indeed, to date, research has primarily explored and established mediators specific to individual traits. For example, in the context of mindfulness, findings indicate that higher levels of mindfulness may benefit sleep because they are associated with lower levels of stress (Simione et al., 2020), less ruminative thinking (Liu et al., 2018), and a reduced likelihood of depressive symptoms and anxiety (Bogusch et al., 2016). In relation to self-compassion, it has been shown that this trait may facilitate good quality and quantity sleep via reductions in rumination (Butz & Stahlberg, 2018) and perceived stress (Hu et al., 2018). With regard to gratitude, findings suggest that higher levels of dispositional gratitude may exert positive effects on sleep by increasing positive (and decreasing negative) pre-sleep cognitions, which in turn reduces sleep-impairing thoughts and worries (Wood et al., 2009), and by lessening depressive mood state (Alkozei et al., 2019). Lastly, focusing on optimism, it has been shown that higher levels of this trait are associated with lower levels of anxiety and stress, which subsequently benefit sleep outcomes (Lau et al., 2017); furthermore, studies suggest that depressive symptoms and life satisfaction might also mediate the relationship between optimism and sleep (Lau et al., 2015; Uchino et al., 2017; but see also Lau et al., 2017).

We contend that a more thorough understanding of the associations between positive psychological traits and sleep may be gained by positioning them within a broader positive psychology – sleep framework, which unifies the literature on positive psychology and sleep by considering whether the same mediating mechanisms might explain links between the various traits and sleep outcomes. Specifically, we propose that emotion regulation represents a plausible common mechanism.

Emotion regulation refers to a level of awareness, understanding and acceptance of one's emotions, as well as the ability to control and modulate behaviours in accordance with desired goals when experiencing negative emotions by using situationally appropriate strategies (Gratz and Roemer, 2004). Emotion regulation strategies can be considered as adaptive (e.g., acceptance, positive reappraisal) or maladaptive (e.g., rumination, catastrophising) in nature due to their differential relationships with health and wellbeing outcomes (Garnefski et al., 2001). When it comes to sleep more specifically, adaptive strategies such as acceptance and positive reappraisal are generally linked to better sleep outcomes, whereas maladaptive strategies such as rumination and catastrophizing are related to higher levels of sleep-impairing arousal, insomnia and worse overall sleep quality and quantity (Palmer et al., 2018; Cheng et al., 2020).

Furthermore, previous research has demonstrated that constructs such as mindfulness, self-compassion and gratitude are linked to increased levels of engagement in adaptive emotion regulation and deceased levels of engagement in maladaptive emotion regulation (e.g., Boggio et al., 2020; Inwood and Ferrari, 2018; Roemer et al., 2015). In addition, many of the mediators previously implicated as underpinning relationships between the various positive psychological traits and sleep arguably relate to an individual's (in)ability to regulate their emotions, for example: rumination (Butz & Stahlberg, 2018; Liu et al., 2018), stress (Hu et al., 2018; Lau et al., 2017; Simione et al., 2020), anxiety (Bogusch et al., 2016; Lau et al., 2017), depressive symptoms (Bogusch et al., 2016; Alkozei et al., 2019; Lau et al., 2015; Uchino et al., 2017) and pre-sleep thoughts and worries (Wood et al., 2009).

Indeed, researchers have recently started to investigate specific emotion regulation strategies as possible mediators of the associations between positive psychological traits and sleep. Thus, Semenchuck et al. (2022) demonstrated that self-blame (but no other emotion regulation strategy) mediated the association between self-compassion and sleep quality. However, to date, research has not explored whether adaptive and/or maladaptive emotion regulation might present a common mediator unifying associations between positive psychological traits and sleep.

In light of the above, we propose that emotion regulation represents a viable mediator which might underpin associations between these positive psychology-related constructs and sleep. Specifically, we contend that individuals with higher levels of trait mindfulness, self-compassion, gratitude and optimism will be more likely to engage in adaptive emotion regulation and less likely to engage in maladaptive emotion regulation which, in turn, will be associated with better quality and quantity sleep. Accordingly, as a second aim of the present research, in Study 2 we explore whether adaptive and /or maladaptive emotion regulation might mediate any associations between each of these positive psychological traits and sleep.

Study 1

In line with the first aim of the present research, Study 1 investigated the combined and unique contributions of mindfulness, self-compassion, gratitude and optimism to sleep quality and quantity as assessed by the Pittsburgh Sleep Quality Index's Global Sleep Score. It was hypothesised that, collectively, these positive psychological traits would account for a significant proportion of the variance in this sleep outcome. In addition, the opportunity was taken to investigate which (if any) of these positive psychological traits would make significant unique contributions to the prediction of sleep quality and quantity. No specific hypotheses were made regarding this more exploratory angle of the research, as – as described above - research to date has yet to consider the relative impact of these traits on sleep.

Materials and Methods

Participants

Two hundred and sixty-eight participants completed the study and met the inclusion criteria that they did not work night shifts and did not have a diagnosed sleep disorder. Ages ranged from 18 to 72 years (*M* = 32.63; *SD* = 14.45); 205 (76.49%) participants identified as female and 63 (23.51%) identified as male. The majority of the sample indicated that their nationality was British (82.46%), that their ethnicity could best be described as White (90.30%) and that their occupation could be categorised as either student (45.15%) or employed (41.42%).

Design and Procedure

The study employed a cross-sectional, correlational design. Participants were recruited opportunistically, using social media and email, and invited to take part in a study about their thoughts, feelings and sleep. UK university departments were also contacted and asked to forward the information about the study to their students. The recruitment message contained the web-link to the questionnaire, which was hosted by the online survey platform Qualtrics. In order to encourage participation, participants were given the opportunity to provide their contact details in a separate questionnaire if they wished to be entered into a prize draw with a chance to win one of two £25 vouchers. Participants provided informed consent before filling in the questionnaire and additionally gave permission for their data to be analysed upon its completion. The study was granted ethical approval by the appropriate body at the hosting university.

Materials

The questionnaire included measures of the following constructs[14]:

Demographic Information. Participants were asked to indicate their age, gender, nationality, ethnicity and current occupation.

Mindfulness. The 15 item Five-Facet Mindfulness Questionnaire (Baer et al., 2008) was used to assess mindfulness is the present study. Participants were asked to indicate how true each of the 15 statements was of them (e.g., “When I take a shower or bath, I stay alert to the

[14] The questionnaires included a number of additional measures. Only those measures relevant to the present research hypotheses are described here. The full study materials are given in the online supplemental materials. No other papers have been published from this data set and we have no current plans to publish any further papers from it.

sensations of water on my body") on a 5-point Likert scale, ranging from *never or very rarely true* (1) to *very often or always true* (5). This measure had an acceptable level of internal consistency, α = .80, and a mean score was computed for each participant, with higher scores indicating higher levels of mindfulness.

Self-Compassion. Self-compassion was assessed with the Self-Compassion Scale (Neff, 2003a), which comprises 26 items, e.g., "I try to be loving towards myself when I am feeling emotional pain" (*almost never* [1] to *almost always* [5]). This scale had an acceptable level of internal consistency, α = .94, and a mean score was calculated for each participant, with higher scores indicating higher levels of self-compassion.

Gratitude. The Gratitude Questionnaire Six-Item Form (GQ-6; McCullough et al., 2002) was employed to assess participants' tendency to experience gratitude in their daily lives. The GQ-6 comprises six items, for example "I have so much in life to be thankful for" (*strongly disagree* [1] to *strongly agree* [7]). This measure was found to have acceptable internal consistency, α = .79, and a mean gratitude scores was computed for each participant, with higher scores indicating higher levels of gratitude.

Optimism. Optimism was assessed using the Life Orientation Test – Revised (LOT-R; Scheier et al., 1994), which includes six items assessing overall levels of optimism; e.g., "In uncertain times I usually expect the best" (*strongly disagree* [1] to *strongly agree* [5]). This measure was found to have an acceptable level of internal consistency, α = .88, and a mean score was calculated for each participant, with higher scores indicating higher levels of optimism.

Sleep Quality and Quantity. Sleep quality and quantity were assessed via the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989). This scale includes 19-items assessing the following seven components of sleep quality and quantity over the previous month: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Some of these items are open-ended questions (e.g. "During the past month, what time have you usually gone to bed at night?"), whereas others have fixed response scales (e.g. "During the past month how often have you had trouble sleeping because you cannot get to sleep within 30 minutes?"; *not during the past month* [0] to *three of more times a week* [3]). Responses to all items were scored in accordance with the PSQI manual to provide summary scores for each sleep component; possible component scores range from 0 to 3, with higher scores representing *worse* sleep in relation to each component. A global sleep score was subsequently calculated for each individual by summing their scores across the seven sleep components (internal consistency across the seven component scores was $\alpha = .77$). Possible scores on the resultant global sleep score thus ranged from 0 to 21, with higher scores representing *worse* overall sleep quality and quantity.

Results

Preliminary Analyses

Descriptive statistics for each of the positive psychological traits and sleep quality and quantity are summarised in Table 11, alongside bivariate correlations between these variables.

Exploring Associations Between Positive Traits and Sleep Quality and Quantity

In order (a) to determine whether mindfulness, self-compassion, gratitude and optimism were collectively associated with sleep quality and quantity and (b) to explore which (if any) of these positive psychological traits made significant unique contributions to the prediction of this sleep outcome, a multiple regression analysis was conducted. Global sleep scores were regressed onto the four positive psychological traits. The resultant multiple regression analysis is summarised in Table 12. Collectively, the positive psychological traits accounted for 24.96% of the variance in global sleep scores, $F(4, 253) = 21.04$, $p < .001$. Optimism and mindfulness emerged as significant linear predictors, with higher levels of optimism ($\beta = -.32$, $p < .001$) and mindfulness ($\beta = -.19$, $p = .008$) being associated with better sleep quality and quantity[15].

Discussion

Results support the hypothesis that collectively the four positive psychological traits of mindfulness, self-compassion, gratitude and optimism would account for a significant proportion of the variance in sleep quality and quantity. These variables together accounted for almost 25% of the variance in this sleep outcome. In addition, the findings of Study 1 identified optimism and mindfulness as making significant unique contributions to the

[15]The scoring of the PSQI results in lower scores representing better sleep.

prediction of sleep quality and quantity, with higher levels of dispositional optimism and mindfulness being associated with better sleep.

Table 11. *Descriptive statistics and bivariate correlations for each of the positive traits and sleep quality and quantity, Study 1.*

	2.	3.	4.	5.	Min.	Max.	*M*	*SD*	*n*
1. Mindfulness	$.65^{***}$	$.37^{***}$	$.53^{***}$	$-.38^{***}$	1.00	4.73	3.10	0.56	268
2. Self-compassion		$.43^{***}$	$.68^{***}$	$-.38^{***}$	1.31	4.65	2.91	0.73	268
3. Gratitude			$.60^{***}$	$-.33^{***}$	2.00	7.00	5.73	0.89	268
4. Optimism				$-.46^{***}$	1.00	5.00	3.22	0.82	268
5. Global sleep score					1.00	19.00	6.24	3.56	258

Note: In accordance with the PSQI, lower scores are indicative of better sleep, hence negative correlations with positive psychological traits.

*** $p < .001$

Table 12. *Summary of multiple regression analysis predicting overall sleep quality and quantity from the positive traits, Studies 1 and 2.*

	Study 1 Global Sleep Scores	Study 2 Global Sleep Scores
Mindfulness (β)	-.19**	-.18**
Self-compassion (β)	-.01	-.08
Gratitude (β)	-.07	-.10
Optimism (β)	-.32***	-.16*
Model *F*	21.04***	15.40***
Model R^2	.25***	.16***

*** $p < .001$; ** $p < .01$; * $p < .05$.

Note. Total *df* Study 1 = 257, Study 2 = 332

Study 2

Study 2 presents a pre-registered replication and extension of Study 1. As with Study 1, the first aim of this study was to test the pre-registered hypothesis that, collectively, mindfulness, self-compassion, gratitude and optimism would account for a significant amount of the variance in sleep quality and quantity. To supplement this first aim, we again explored which (if any) of these positive psychological traits would make a significant unique contribution to this sleep outcome.

The second aim of Study 2 was to test the pre-registered hypothesis that emotion regulation would significantly mediate the relationships between each of mindfulness, self-compassion, gratitude and optimism and sleep quality and quantity. In light of the theory and research suggesting that adaptive and maladaptive emotion regulation strategies are likely to be orthogonal in nature (e.g., Garnefski, 2001), and thus could potentially have different implications for sleep, we elected to explore adaptive and maladaptive emotion regulation as independent constructs. Accordingly, the corresponding hypothesis was refined to specify that each of the positive psychological traits would be associated with greater engagement in adaptive emotion regulation strategies and less engagement in maladaptive emotion regulation strategies which, in turn, would be associated with better sleep.

Materials and Methods

The current study was pre-registered with the Open Science Framework (OSF; Link to pre-registration) where associated sample size calculations can also be found.

Participants

A total of 333 psychology undergraduate students recruited from a university in the South of England took part in the present study and met the inclusion criteria that they did not work night shifts or have a diagnosed sleep disorder. Ages ranged from 18 to 49 years (M = 19.92; SD = 2.71); 282 (84.68%) participants identified as female, 49 (14.71%) identified as male, one (0.30%) identified as another gender and one (0.30%) elected not to report their gender. The majority of participants indicated that their nationality was British (78.98%) and identified their ethnicity as White (80.18%).

Design and Procedure

The current study employed a cross-sectional, correlational design. Participants were recruited via SONA – an online participant recruitment tool in which students sign up to studies in exchange for course credits – and invited to take part in a study about their thoughts, feelings and sleep. Participants who signed up to the study were given a link to the online questionnaire, which was hosted by the online survey platform Qualtrics. All participants provided informed consent electronically on the first page of the questionnaire and additionally gave permission for their data to be analysed upon completion; participants were compensated for their time with course credits. The study was granted ethical approval by the appropriate body at the hosting university.

Materials

The questionnaire included measures of the following constructs[16]. Unless otherwise indicated, mean scores were computed for scales, with higher scores indicating higher levels of the construct in question.

Demographic information. Participants were asked to provide their age, gender, nationality and ethnicity.

Mindfulness. Mindfulness was again assessed with the FFMQ-15 (Baer et al., 2008), α = .73.

Self-Compassion. Self-compassion was assessed using the Self-Compassion Scale Short-Form (SCS-SF; Raes et al., 2011), comprising 12 items (e.g., "I try to be understanding and patient towards those aspects of my personality I don't like"; *almost never* [1] to *almost always* [5]); α = .84.

Gratitude. Gratitude was again assessed with the GQ-6 (McCullough et al., 2002), α = .73.

Optimism. Optimism was again assessed using the LOT-R (Scheier et al., 1994), α = .80.

Sleep Quality and Quantity. Sleep quality and quantity was again assessed via the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989); internal consistency across the seven component scores in the present study was α = .67.

[16] The questionnaire included a number of additional measures. Only those measures relevant to the present research hypotheses are described here. Details of additional measures are available via the Open Science Framework (Link to pre-registration). No other papers have been published from this data set and we have no current plans to publish any further papers from it.

Emotion Regulation. Emotion regulation was assessed with the Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski and Kraaij, 2007). This scale includes a total of thirty-six items assessing nine emotion regulation strategies (five adaptive: acceptance, positive refocusing, refocus on planning, positive reappraisal, putting into perspective, and four maladaptive: self-blame, rumination, catastrophizing and other-blame). Participants were asked to indicate how they generally think in response to the negative or unpleasant events they experience (example positive refocusing item: “I think that I can become a stronger person as a result of the experience”; example catastrophizing item: “I keep thinking about how terrible my experience was”). Responses to all items were given on a 5-point Likert scale, ranging from *almost never* (1) to *almost always* (5). An overall adaptive emotion regulation score was computed for each participant by calculating the mean of the twenty adaptive emotion regulation items, $\alpha = .89$. An overall maladaptive emotion regulation score was also computed for each participant by calculating the mean of the sixteen maladaptive emotion regulation items, $\alpha = .78$.

Data Sharing Statement

Data files are available via the OSF (Link to OSF Project Files)

Results

Preliminary Analyses

Descriptive statistics and bivariate correlations between the measures of the four positive psychological traits, sleep quality and quantity and emotion regulation are given in Table 13. It can be seen that each of the positive psychological traits was significantly associated with adaptive emotion regulation, maladaptive emotion regulation and overall sleep quality and quantity. Furthermore, the measures of adaptive and maladaptive emotion regulation were significantly associated with overall sleep. It is also noteworthy that the correlation between adaptive emotion regulation and maladaptive emotion regulation was relatively low, thus justifying their treatment as orthogonal variables in our analyses.

Exploring Associations Between Positive Psychological Traits and Sleep Quality and Quantity

In order to address our first pre-registered hypothesis that, collectively, mindfulness, self-compassion, gratitude and optimism would account for a significant proportion of variance in sleep quality and quantity, global sleep scores were regressed onto the four positive psychological traits (please see Table 12). The resultant regression model indicated that mindfulness, self-compassion, gratitude and optimism together accounted for 15.81% of the variation in global sleep scores: $F(4, 328) = 15.40$, $p < .001$. Mindfulness ($\beta = -.18$, $p = .004$) and optimism ($\beta = -.16$, $p = .022$) again both emerged as significant linear predictors, with higher levels of mindfulness and optimism being related to better sleep quality and quantity.

Exploring Emotional Regulation as a Mediator of Associations Between Positive Psychological Traits and Sleep Quality and Quantity

To assess our second pre-registered hypothesis, that emotion regulation would significantly mediate the relationships between the four positive psychological traits (mindfulness, self-compassion, gratitude and optimism) and overall sleep quality and quantity, a series of mediation analyses were conducted using Hayes PROCESS for SPSS v3.5, taking 5,000 bootstrap samples to compute bias corrected confidence intervals, and adjusting for potential violations of heteroscedasticity (heteroscedasticity-consistent inference: HC2). For each of the four models, the positive psychological trait in question was entered as the predictor variable, global sleep scores were entered as the outcome variable, and adaptive emotion regulation and maladaptive emotion regulation scores were entered as the mediating variables. The resultant models are depicted in Figure 7.

Analyses revealed that there was no significant[17] indirect effect of mindfulness, self-compassion, gratitude or optimism on global sleep scores via adaptive emotion regulation (mindfulness: b = -0.02, BCBCI [-.33, .26]; self-compassion: b = 0.17, BCBCI [-.35, .39]; gratitude: b = -0.76, BCBCI [-.23, .06]; optimism: b = -0.03, BCBCI [-.20, .14]). By contrast, there were significant indirect effects of mindfulness, self-compassion, gratitude and optimism on global sleep scores via maladaptive emotion regulation (mindfulness (b = -0.47, 95% BCBCI [-.75, -.24]), self-compassion (b = -0.48, 95% BCBCI [-.74, -.24]), gratitude (b = -0.32, 95% BCBCI[-.48, -.17]), and optimism (b = -0.31, 95% BCBCI [-.49, -.15]). Thus, the impacts of mindfulness, self-compassion, gratitude and optimism on sleep quality and quantity were each partially mediated through maladaptive emotion regulation. In

[17] The assessment of whether or not each indirect effect is statistically significant is based on inspection of the confidence intervals; where these do not cross zero the effect is considered to be significant. Please note, this approach was used to test for mediation as opposed to Sobel tests (which were specified in the pre-registration) in line with best recommended practices (Preacher & Hayes, 2008).

each case, higher levels of the positive psychological trait in question were associated with lower levels of maladaptive emotion regulation, which in turn was associated with better quality and quantity sleep.

Discussion

The results of Study 2 provide further support for the hypothesis that the positive psychological traits would together account for a significant proportion of the variance in sleep quality and quantity, and again highlight optimism and mindfulness as making significant unique contributions to the prediction of this sleep outcome. Findings also identify maladaptive (but not adaptive) emotion regulation as a possible common mediator of the associations between these traits and sleep.

Table 13. *Descriptive statistics and bivariate correlations between each of the positive traits, emotion regulation and sleep quality and quantity, Study 2 (N = 333).*

	2.	3.	4.	5.	6.	7.	*Min.*	*Max.*	*M*	*SD*
1. Mindfulness	$.52^{***}$	$.30^{***}$	$.45^{***}$	$.42^{***}$	$-.30^{***}$	$-.32^{***}$	1.80	4.40	3.03	0.44
2. Self-compassion		$.33^{***}$	$.57^{***}$	$.61^{***}$	$-.45^{***}$	$-.29^{***}$	1.25	4.33	2.73	0.62
3. Gratitude			$.49^{***}$	$.34^{***}$	$-.34^{***}$	$-.26^{***}$	2.83	7.00	5.72	0.77
4. Optimism				$.39^{***}$	$-.37^{***}$	$-.33^{***}$	1.17	5.00	2.99	0.76
5. Adaptive emotion regulation					$-.25^{***}$	$-.17^{**}$	1.35	4.90	3.21	0.57
6. Maladaptive emotion regulation						$.31^{***}$	1.75	4.50	2.99	0.48
7. Global sleep score							0.00	18.00	7.15	3.03

Note: In accordance with the PSQI, lower scores are indicative of better sleep, hence negative correlations with positive psychological traits and adaptive emotion regulation.

*** $p \leq .001$ ** $p \leq .01$

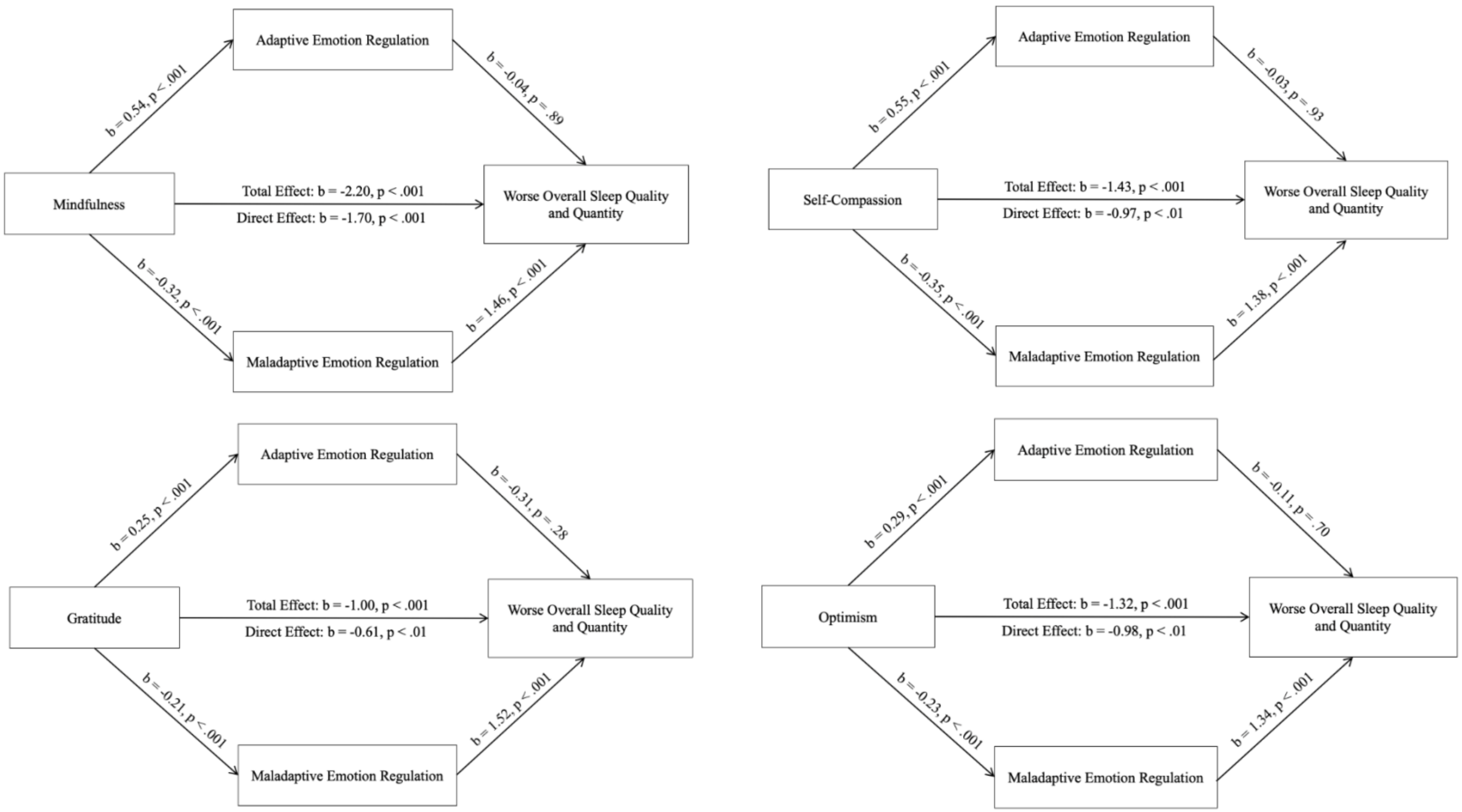


Figure 7. *Mediation analyses displaying the associations between the four positive traits and sleep quality and quantity through adaptive and maladaptive emotion regulation.*

General Discussion

Results from both studies support the hypothesis that collectively the four positive psychological traits of mindfulness, self-compassion, gratitude and optimism would be significantly associated with sleep outcomes, accounting for a significant and sizeable proportion of the variance in sleep quality and quantity in both studies (approximately 25% and 16% respectively). These findings highlight the importance of positive psychological traits in relation to sleep and suggest that mindfulness, self-compassion, gratitude and optimism may collectively help facilitate good quality and quantity sleep. They also support, and start to integrate, the bodies of literature which have previously identified each of these traits as being independently associated with sleep outcomes (e.g., Alkozei et al., 2019; Brown et al., 2021; Hernandez et al., 2020; Sala et al., 2020).

The study results also provide some insight into which of these positive psychological traits might make the largest independent contribution to the prediction of sleep outcomes. Specifically, optimism and mindfulness emerged as significant linear predictors of overall sleep quality and quantity in their own right, such that greater levels of optimism and mindfulness were associated with better sleep.

These findings thus suggest that optimism and mindfulness might make a unique contribution to sleep. It is noteworthy that the tables of correlations for both studies showed significant bi-variate correlations between each of the positive psychological traits and overall sleep quality and quantity. Given this, the findings of the regression analyses should not be interpreted to imply that optimism and mindfulness are the only two variables to be significantly associated with sleep outcomes or that they are the most important variables in this regard. Rather, these findings indicate that optimism and mindfulness make a significant unique contribution to the prediction of sleep over and above any shared variance between the various traits and sleep. It is perhaps unsurprising that some of the variability in sleep outcomes may be predicted by shared variance between the positive psychological traits, given that there are likely to be degrees of overlap and similarity between constructs such as - for example - mindfulness and self-compassion, where definitions of the latter include a mindfulness subcomponent (Neff, 2003a, 2003b). Future research would benefit from trying to disentangle further the relative contributions of the different positive psychological traits (and perhaps their various subdimensions, where applicable) to sleep.

It is interesting that optimism emerged as significant linear predictor in its own right, given the relative lack of research attention this individual difference variable has received as a potential target for intervention in the context of sleep. Indeed, this finding suggests that there may be some merit in experimentally manipulating individuals' levels of optimism (e.g. Carrillo et al., 2019; Meevissen et al., 2011) and observing whether there are any attendant benefits for sleep. Such intervention studies would also help consolidate evidence suggesting that optimism may play a causal role in impacting sleep outcomes.

The present research also provides insight into *how* these positive psychological traits might impact sleep outcomes. Specifically, the findings of Study 2 indicate that maladaptive emotion regulation might represent a common mechanism underpinning the relationships between these traits and sleep. Mediation analyses thus indicated that there was a significant indirect association between each of mindfulness, self-compassion, gratitude and optimism and sleep via maladaptive emotion regulation. In each instance, higher levels of the positive psychological trait in question were associated with lower levels of maladaptive emotion regulation which in turn was associated with better quality and quantity sleep.

Although the bivariate correlations indicated that the positive psychology traits were similarly associated with greater levels of adaptive emotion regulation and also that adaptive emotion regulation was associated with better sleep, the mediation analyses revealed no indirect impact of any of the four traits on sleep via this mechanism.

Although various mediators have previously been put forward and – on occasion – empirically tested for each of mindfulness, self-compassion, gratitude and optimism (e.g., Alkozei et al., 2019; Butz & Stahlberg, 2018; Simione et al., 2020; Uchino et al., 2017), studies have not previously attempted to establish whether there might be common mechanisms underpinning the impact of these four traits on sleep. The present research goes some way towards addressing this gap in the literature by identifying maladaptive emotion regulation as a potential underlying mediator between each of these traits and sleep. The identification of such common pathways between positive psychology-related constructs and sleep should ultimately allow for the development of common theories and frameworks which will help to unify the disparate strands of research on each of these traits and sleep outcomes.

It is noteworthy that, although there were significant indirect effects of mindfulness, self-compassion, gratitude, and optimism on sleep via maladaptive emotion regulation, the direct effects of each of these traits on sleep also remained significant. One explanation for this finding could be that there are additional underlying mechanisms linking these traits to sleep. Future research may thus wish to explore further common mediators, in order to better situate current findings within a broader framework.

The design of the present study is, of course, subject to limitations. The cross-sectional correlational design precludes us from drawing conclusions regarding causality, albeit previous experimental research in the domains of mindfulness, self-compassion and gratitude suggests probable causal paths from these traits to sleep (Boggiss et al., 2020; Butz & Stahlberg, 2018; Ong & Moore, 2020). Furthermore, the reliance on self-report measures of sleep is subject to inaccuracies introduced by, for example, the inability of individuals to accurately recall their sleep patterns over the previous month and/or social desirability biases. Although the PSQI is a reliable and validated measure (Buysse et al., 1989; Mollayeva et al., 2016), which has been widely used in studies exploring links between positive psychology constructs and sleep (e.g., Bogusch et al., 2016; Hu et al., 2018; Wood et al., 2009; Uchino et al., 2017), future research would nevertheless benefit from exploring whether the patterns of findings reported here hold for more objective measures of sleep outcomes (e.g., polysomnography or actigraphy; Marino et al., 2013). In addition, the samples for both studies were recruited opportunistically and hence are unlikely to be representative of the general population; for example, it is evident that females are over-represented throughout. It would be worthwhile establishing whether the current findings hold across a larger stratified sample.

In summary, the findings of both studies highlight the potential for the positive psychological traits of mindfulness, self-compassion, gratitude and optimism to collectively explain a significant amount of the variability in sleep quality and quantity. Future research should continue to explore their combined impact on sleep in order to more fully understand their shared and unique contributions to this fundamental health behaviour and to establish whether optimism and mindfulness consistently make independent contributions to the prediction of sleep outcomes. Such understanding has the potential to guide the development of more effective interventions to optimise sleep quality and quantity and – ultimately - help tackle the global sleep loss epidemic. The findings of Study 2 also identify maladaptive emotion regulation as a possible common mediator of the relationships between positive psychological traits and sleep. Establishing such shared pathways has the potential to help integrate research exploring associations between positive psychology-related constructs and sleep into one overarching theoretical framework, and future research would benefit from investigating further such common mechanisms.

Appendix C – Optimism Intervention Instructions

Best Possible Self Instructions (optimism condition)

Hello and thank you very much for taking part in this study! My name is Amber, and I am the lead researcher on this project.

You are now going to spend some time thinking about your best possible self.

Your best possible self means imagining yourself in a future in which everything has turned out as well as it possibly could. You have worked hard and accomplished all of your life's goals. You have satisfied all of your dreams and achieved your full potential.

In a moment, you are going to think of the best possible ways in which your life could develop. These developments can be within your personal life (skills, hobbies, personality, health and lifestyle, accomplishments), your professional life (career, education, qualifications, skills, income, retirement) and your social life (social activities, romantic relationships, relationships with friends, colleagues or family members).

You have probably never thought about yourself in this way, but research has indicated that this method may have a positive influence.

For the next week, we would like you to spend 5 minutes per day imagining your best possible self.

To help you do this, you are going to spend some time thinking about all of the goals, skills and desires you would like to achieve in the future. After taking a moment to think, you will have 15 minutes to write about your best possible self in as much detail as you can, using the goals you have just been thinking about as a guide.

Please do not worry about spelling or grammar, just try and keep writing. If you run out of things to say, you can repeat the things you have already written.

After you have spent 15 minutes writing, you will be asked to spend 5 minutes imagining the things you have written about, trying to imagine them as vividly as possible and in as much detail as you can.

The things you write are for yourself and yourself alone. You will receive a copy of your writing activity after the study is complete so that you can keep imagining your best possible self over the next week.

The instructions for the exercise will be at the top of the next page in case you forget what to do.

Thank you very much for taking part!

Daily Activities Instructions (active control condition)

Hello and thank you very much for taking part in this study! My name is Amber, and I am the lead researcher on this project.

You are now going to spend some time thinking about your daily activities.

This means you are going to give more thought to the usual day-to-day activities of your life, such as the specific meetings, lectures, conversations and thoughts you have during a typical day. Think of this as moving through your typical day, hour after hour. You may use your schedule of the past 24 hours as guidance.

You have probably never thought about your daily activities in this way, but research has indicated that this method may have a positive influence.

For the next week, we would like you to spend five minutes per day imagining your daily activities.

To help you do this, you are first going to spend some time thinking about your typical day-to-day schedule. Think during this process of your realistic daily activities from the moment *you wake up to the moment you go to bed, going more deeply into the conversations, discussions, thoughts, or feelings that you tend to have.*

After taking a moment to think, you will have 15 minutes to write about your typical daily activities in as much detail as you can, using the things you have just been thinking about as a guide.

Please do not worry about spelling or grammar, just try and keep writing. If you run out of things to say, you can repeat the things you have already written.

After you have spent 15 minutes writing, you will be asked to spend 5 minutes imagining the things you have written about, trying to imagine them as vividly as possible and in as much detail as you can.

The things you write are for yourself and yourself alone. You will receive a copy of your writing activity after the study is complete so that you can keep imagining your typical daily activities over the next week.

The instructions for the exercise will be at the top of the next page in case you forget what to do.

Thank you very much for taking part!

Appendix D – Supplementary Analysis 1

Table 14. Bivariate correlations between optimism and sleep quality and quantity scores pre- vs. post-intervention, separated by condition.

		Sleep T1	Sleep T2
BPS	Optimism T1	-.411*	-.676**
	Optimism T2	-.470*	-.767**
DA	Optimism T1	-.456*	-.427*
	Optimism T2	-.544**	-.486**

*$p < .05$; **$p < .01$

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