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Circadian rhythm and mental health relationships among nurses working night shifts in the era of COVID-19 pandemic

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ABSTRACT

Worldwide, many nurses work during the night on a rotational or permanent basis. To enhance nursing staff allocation, reduce nurses' workload, improve job performance, and promote mental wellbeing among nurses in the coronavirus disease era of 2019, shift patterns should be organized systematically, and workers should be assigned coherently. Sleep is a vital physiological process largely controlled by the circadian clock in the suprachiasmatic nucleus of the anterior hypothalamus. Shift work may promote the desynchronization of circadian rhythms and increase the risk of cognitive impairment among night-shift nurses over the course of time. Night shift intolerance may reflect individual differences in responsiveness to internal desynchronization. The purpose of this study was to determine the prevalence of nicotine, caffeine, cannabis, sleep-promoting medication, and alcohol use in a sample of nurses working night shifts in the province of Saskatchewan, Canada. In addition, the association between sleep quality, anxiety, and depression among Canadian nurses working night shifts in the COVID-19 era. Subsequently, a systematic review and meta-analysis were conducted to systematically summarize and quantitatively evaluate some selected cross-sectional, case-control, and cohort studies in order to determine the relationship between night shift work and the risk of depression in nurses. However, regarding the biological relationships between night shift work and circadian rhythm among nurses, a thorough narrative review was conducted alongside experts in the field. Lastly, to test the efficacy of some interventions to improve the working conditions of nurses, a

systematic review was conducted to evaluate the effectiveness of bright light exposure, modafinil, and armodafinil for improving alertness during working time among nurses on the night shift.

In the pilot study, twenty-two registered nurses ranging in age from 25 to 65 who work permanent or rotating night shifts participated in an online survey from April 11th to July 15th, 2022. subsequently a systematic search was carried out across the electronic databases PubMed, Scopus, and Web of Science from inception to September 30, 2022, for studies that reported a relationship between estimated night shift work and depression in nurses. The outcomes were measured using the odds ratio (OR) and matching 95% confidence interval (CI). The I^2 statistic was used to assess heterogeneity. The Grading of Recommendations Assessment, Development, and Evaluation technique was used to evaluate the quality of the evidence, and the Newcastle-Ottawa Scale was utilized to assess the methodological quality of each of the included studies. We determined the overall relationship between working nights and the onset of depression. A literature search was conducted using the PubMed and Scopus electronic databases. Selection criteria include studies published in English between 1997 and 2021 that examined the impact of night-shift work on the mental health of nurses. A literature search was conducted using the PubMed, Scopus, and Web of Science electronic databases regarding articles pertaining to workplace interventions for improving wakefulness among nurses working the night shift using the following medical subject headings: ((((Bright light exposure) OR wakefulness medications) AND Nurses AND Night Shift-

work)). The literature searches were completed on January 5, 2021. Only articles published in English were included.

The results of the pilot study conducted in Canada showed a strong positive association between sleep disturbance and depression: r (19) = 0.50 [p = 0.029, 95% CI, 0.06, 0.78]. A positive correlation was found between higher levels of reported anxiety and sleep disturbance, r (19) = 0.69 [p = 0.001, 95% CI, 0.34, 0.87]. There was a positive correlation between depression and occupational exhaustion: r (17) = 0.56 [p = 0.021, 95% CI, 0.10, 0.82]. Anxiety was significantly related to occupational exhaustion r (17) = 0.65 [p = 0.005, 95% CI, 0.24, 0.86] and depersonalization r (17) = 0.52 [p = 0.005, 95% CI, 0.06, 0.80], but not significantly related to personal accomplishment r (17) = -0.34 [p = 0.185, 95% CI, -0.70, 0.17]. In conclusion, a sample of Canadian nurses working night shifts in the province of Saskatchewan during the COVID-19 pandemic showed a significant positive relationship among sleep disturbance, anxiety, and depression. Furthermore, most nurses reported using at least one or more of the following substances: sleep-promoting medication, nicotine, alcohol, and cannabis. Regarding the outcome of the systematic review and meta-analysis. A total of 20 studies were included in the systematic review. Furthermore, eight studies were included in the meta-analysis due to their common use of the OR as an effect measure. The 8 studies gave an overall estimate indicating a statistically significant association between night shift work and depression among nurses (OR =1.49 95% CI: 1.26, 1.76). The literature study on circadian misalignment among night shift nurses showed that disrupted circadian rhythms

and poor sleep quality and quantity have been identified as two of the most significant elements in the long-term effects of night-shift work on nurses' mental health. The study on nurses' vigilance showed that bright light exposure is beneficial for improving alertness during the night shift. Armodafinil or modafinil taken prior to the start of night shift work, on the other hand, is effective in the treatment of excessive sleepiness associated with shift work sleep disorder. Furthermore, armodafinil, the R-enantiomer of modafinil, appears to have longer-lasting effects compared to modafinil.

In conclusion, there is a significant relationship between working night shifts, the disturbance of sleep and circadian rhythm linked to night work, and the risk of depression and anxiety in nurses. This indicates that nurses who work night shifts are more likely to experience depression, anxiety, or both.

RIASSUNTO

In tutto il mondo, molti infermieri lavorano durante la notte a rotazione o tempo indeterminato. Per migliorare l'allocazione del personale infermieristico, ridurre il carico di lavoro degli infermieri, migliorare le prestazioni lavorative e promuovere il benessere mentale tra gli infermieri nell'era della malattia da coronavirus del 2019, i turni dovrebbero essere organizzati sistematicamente e i lavoratori dovrebbero essere assegnati in modo coerente. Il sonno è un processo fisiologico vitale ampiamente controllato dall'orologio circadiano nel nucleo soprachiasmatico dell'ipotalamo anteriore. Il lavoro a turni può promuovere la desincronizzazione dei ritmi circadiani e aumentare il rischio di deterioramento cognitivo tra gli infermieri del turno di notte nel corso del tempo. L'intolleranza al turno di notte può riflettere differenze individuali nella reattività alla desincronizzazione interna. Lo scopo di questo studio era determinare la prevalenza di nicotina, caffeina, cannabis, farmaci che favoriscono il sonno e consumo di alcol in un campione di infermiere che lavoravano nei turni notturni nella provincia di Saskatchewan, in Canada. Inoltre, l'associazione tra qualità del sonno, ansia e depressione tra gli infermieri canadesi che lavoravano nei turni notturni nell'era COVID-19 Successivamente, sono state condotte una revisione sistematica e una meta-analisi per riassumere sistematicamente e valutare quantitativamente alcuni controllo e studi di coorte per determinare la relazione tra il lavoro notturno e il rischio di depressione negli infermieri. Tuttavia, per quanto riguarda le relazioni biologiche tra il lavoro notturno e il ritmo circadiano tra gli infermieri, è stata

condotta un'approfondita revisione narrativa insieme a esperti del settore. Infine, per testare l'efficacia di alcuni interventi per migliorare le condizioni di lavoro degli infermieri, è stata condotta una revisione sistematica per valutare l'efficacia dell'esposizione alla luce intensa, modafinil e armodafinil per migliorare la vigilanza durante l'orario di lavoro tra gli infermieri del turno di notte.

Nello studio pilota, ventidue infermieri registrati di età compresa tra 25 e 65 anni che lavorano turni notturni permanenti o a rotazione hanno partecipato a un sondaggio online dall'11 aprile al 15 luglio 2022. Successivamente è stata effettuata una ricerca sistematica attraverso i database elettronici PubMed, Scopus e Web of Science dall'inizio al 30 settembre 2022, per gli studi che hanno riportato una relazione tra il lavoro notturno stimato e la depressione negli infermieri. I risultati sono stati misurati utilizzando l'odds ratio (OR) e il corrispondente intervallo di confidenza al 95% (CI). La statistica I^2 è stata utilizzata per valutare l'eterogeneità. La tecnica Grading of Recommendations Assessment, Development, and Evaluation è stata utilizzata per valutare la qualità delle prove e la scala Newcastle-Ottawa è stata utilizzata per valutare la qualità metodologica di ciascuno degli studi inclusi. Abbiamo determinato la relazione complessiva tra le notti lavorative e l'insorgenza della depressione. È stata condotta una ricerca bibliografica utilizzando i database elettronici PubMed e Scopus. I criteri di selezione includono studi pubblicati in inglese tra il 1997 e il 2021 che hanno esaminato l'impatto del lavoro notturno sulla salute mentale degli infermieri. È stata condotta una ricerca bibliografica utilizzando i database elettronici PubMed, Scopus e

Web of Science riguardanti gli articoli relativi agli interventi sul posto di lavoro per migliorare lo stato di veglia tra gli infermieri che lavorano nel turno di notte utilizzando i seguenti titoli di argomenti medici: ((((Esposizione alla luce intensa) O farmaci per la veglia) E Infermieri E Turni notturni)). Le ricerche bibliografiche sono state completate il 5 gennaio 2021. Sono stati inclusi solo gli articoli pubblicati in inglese.

I risultati dello studio pilota condotto in Canada hanno mostrato una forte associazione positiva tra disturbi del sonno e depressione: r (19) = 0,50 [p = 0,029, 95% CI, 0,06, 0,78]. È stata trovata una correlazione positiva tra livelli più elevati di ansia segnalata e disturbi del sonno, r (19) = 0,69 [p = 0,001, 95% CI, 0,34, 0,87]. C'era una correlazione positiva tra la depressione e l'esaurimento professionale: r (17) = 0,56 [p = 0,021, 95% CI, 0,10, 0,82]. L'ansia era significativamente correlata all'esaurimento professionale r (17) = 0,65 [p = 0,005, 95% CI, 0,24, 0,86] e alla depersonalizzazione r (17) = 0,52 [p = 0,005, 95% CI, 0,06, 0,80], ma non significativamente correlato alla realizzazione personale r (17) = -0,34 [p = 0,185, 95% CI, -0,70, 0,17]. In conclusione, un campione di infermiere canadesi che lavoravano nei turni notturni nella provincia di Saskatchewan durante la pandemia di COVID-19 ha mostrato una significativa relazione positiva tra disturbi del sonno, ansia e depressione. Inoltre, la maggior parte degli infermieri ha riferito di utilizzare almeno una o più delle seguenti sostanze: farmaci che favoriscono il sonno, nicotina, alcol e cannabis. Per quanto riguarda l'esito della revisione sistematica e della meta-analisi Un totale di 20 studi sono stati inclusi nella revisione sistematica. Inoltre, otto studi sono stati inclusi nella meta-analisi a causa del

loro uso comune dell'OR come misura dell'effetto. Gli 8 studi hanno fornito una stima complessiva che indica un'associazione statisticamente significativa tra il lavoro notturno e la depressione tra gli infermieri (OR = 1,49 95% CI: 1,26, 1,76). Lo studio della letteratura sul disallineamento circadiano tra gli infermieri del turno di notte ha mostrato che i ritmi circadiani interrotti e la scarsa qualità e quantità del sonno sono stati identificati come due degli elementi più significativi negli effetti a lungo termine del lavoro del turno di notte sulla salute mentale degli infermieri. Lo studio sulla vigilanza degli infermieri ha mostrato che l'esposizione alla luce intensa è utile per migliorare la vigilanza durante il turno di notte. L'armodafinil o il modafinil assunto prima dell'inizio del lavoro notturno, invece, è efficace nel trattamento dell'eccessiva sonnolenza associata al disturbo del sonno da lavoro a turni. Inoltre, armodafinil, l'enantiomero R di modafinil, sembra avere effetti più duraturi rispetto a modafinil.

In conclusione, esiste una relazione significativa tra il lavoro notturno, i disturbi del sonno e del ritmo circadiano legati al lavoro notturno e il rischio di depressione e ansia negli infermieri. Ciò indica che gli infermieri che lavorano nei turni notturni hanno maggiori probabilità di soffrire di depressione, ansia o entrambi.

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LIST OF ABBREVIATIONS

AUDIT-C	Alcohol Use Disorder Identification Test-Concise
BMAL1	Brain and muscle ARNT-like 1
BMI	Body mass index
CaffEQ	Caffeine Expectancy Questionnaire
CLOCK	Circadian locomotor output cycles protein kaput
COVID-19	Coronavirus disease 2019
CRY	Cryptochrome proteins
DLMO	Dim light melatonin onset
E-box	Proteins act via enhancer box
FDA	Food and drug administration
GRADE	Grading of Recommendations, Assessment, Development and Evaluations
HADS	Hospital Anxiety and Depressive Disorders Rating Scale
MBI	Maslach Burnout Inventory
NREM	Non–rapid eye movement
PER	Regulatory sequences to drive daytime expression of period
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta Analyses
PSQI	Pittsburgh Sleep Quality Index
REM	Rapid eye movement
RHT	Retinohypothalamic tract
SCN	Suprachiasmatic nucleus
SDS	Severity of dependence scale
SPSS	Statistical Package for the Social Sciences
SWSD	Shift work sleep disorder
VLPO	Ventrolateral preoptic region

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1. INTRODUCTION

1.1 Background

The 24-hour internal clock in human brain that regulates cycles of alertness and sleepiness by responding to light variations in the surroundings is known as the circadian rhythm (Peng *et al.,* 2022). Melatonin is a hormone produced mostly during the dark period in the pineal gland and inhibited by light exposure. Melatonin affects circadian rhythms and the sleep-wake cycle (Vasey *et al.,* 2021). Non-rapid eye movement and rapid eye movement sleep are the two main phases of sleep (Borbély *et al.,* 2016). When triggered by circadian input from the anterior hypothalamus and sleep–wake homeostatic information from endogenous chemical signals (example, adenosine), the ventrolateral preoptic nucleus initiates the onset of sleep (Rosenwasser & Turek, 2015). Arousal in which there is a conscious monitoring of the surroundings and the ability to respond to external stimuli is known as wakefulness. It contrasts the state of sleep, in which receptivity to external stimuli is reduced (Sollars & Pickard, 2015). The higher the synchronous firing rates of cerebral cortex neurons, the longer the brain has been awake. Sleep-wake disturbances induced by endogenous circadian system disruptions or desynchronization between internal and external sleep-wake cycles are known as circadian rhythm sleep-wake disorders (Steele *et al.,* 2021). Whenever the circadian rhythm is disrupted or distorted because of sleeplessness, rotating shifts, or other lifestyle

variables, negative health repercussions emerge, and the risk of mental diseases rises (Kirlioglu & Balcioglu 2020).

Nurses working night shift are more likely to experience fatigue and sleepiness than those working day shift (Brzozowski *et al.,* 2021). Sleepiness contributes to car accidents by impairing aspects of physical and mental health that are critical for safe driving (Mulhall *et al.,* 2019). Sleepiness also reduces optimal reaction time and people who are drowsy have been found to have trouble with braking in time to avoid a collision (Mulhall *et al.,* 2019). Nurses who work double shifts (≥ 16 hours) are more likely to be involved in sleep-related crashes and should avoid driving after the night shift (Westwell *et al.,* 2021). Being awake ≥ 16 hours and, possibly, working > 12 hours daily are associated with increases in road traffic accidents (Valent *et al.,* 2010). According to the outcome of one study, nearly all frontline nurses surveyed on social media during the Coronavirus disease 2019 (COVID-19) pandemic who work 12-hour shifts reported poor sleep, over one-third reported insomnia, and over half indicated burnout (Stewart *et al.,* 2021). Many nurses also reported hallucinations and sleep disturbances because of the frequent equipment use (Stewart *et al.,* 2021).

A survey of 987 frontline nurses in Oman revealed that 58.8% of them had poor sleep quality (Al Maqbali, 2021). Age, marital status, years of experience, comorbidity, and whether family members or relatives were suspected or proven to have COVID-19 all played a role in sleep disturbances (Al Maqbali, 2021). Sleep disorders were found to be substantially linked to stress, anxiety, and depressive symptoms (Al Maqbali, 2021). One study in Wuhan, China,

found that 60% of frontline nurses had poor sleep quality, 46% had depression symptoms, and 40% had anxiety symptoms (Tu *et al.*,2020). Depressive symptoms were found to be linked to poor sleep quality and anxiety symptoms (Tu *et al.,* 2020). According to one study conducted in the United States, sleep quality was influenced by nurses' work status, non-day shift, poor reported physical health, a low degree of self-care self-regulation, and a high level of work stress (Kim-Godwin *et al.,* 2021). Studies across various jurisdictions have persistently highlighted the high prevalence of shift work sleep disorder among nurses and the resultant effect on their health. In Africa, a study that was conducted in a Nigerian teaching hospital before the COVID-19 pandemic showed a 43.2% prevalence of shift work sleep disorder among night shift nurses, as well as an increased level of sleep impairment, health complaints, and physiological indices of stress such as fatigue, menstrual irregularities, and lack of concentration, attributed to the changes in circadian rhythm associated with shift work (Fadeyi *et al.,* 2018). In a study in India, as many as 83.3% of nurses were found to have mild shift work sleep disorder (Joseph *et al.,* 2018). In Australia, nurses were shown to have increased odds of developing a shift work sleep disorder, which impacted negatively on daily health habits, just as in Europe, where some studies in Italian hospitals indicated the high prevalence of shift work sleep disorder and related symptoms among nurses, with the resultant low performance at work (Booker *et al.,* 2020; d'Ettorre & Pellicani, 2020; Galasso *et al.,* 2021). Night shift work has been associated with an increase in cardiovascular, gastrointestinal, metabolic, reproductive, and mental health complications with a resultant

increase in total and cause-specific mortality for night shift nurses (Gu *et al.,* 2015; Wickwire *et al.,* 2017). Of great significance is the fact that working night shifts does not only affect the physical and mental health of nurses, but also their social and family lives (Huang *et al.,* 2021). Changes in the sleep-wake cycle from inconsistencies between work schedules and an individual's circadian rhythm could result to shift work sleep disorder (Booker *et al.,* 2020). Excessive sleepiness is one of the conditions vital to making a diagnosis of shift work sleep disorder according to the third edition of the international classification of sleep disorders (Sateia, 2014). The diagnosis is made when the diagnosing criteria are met over a period of at least 3 months (Drake *et al.,* 2004). When compared to the workforce in other professions, a higher number of nurses reported symptoms of shift work sleep disorder (Flo *et al.,* 2012; Pallesen et al., 2021; Martyn *et al;* 2021). Among the nursing population on different shift schedules, 44.2% of nurses working the night shift indicated shift work sleep disorder symptoms, compared to 23.6% of nurses working daytime only (Pallesen *et al.*, 2021). This indicates that shift work sleep disorder tends to occur more frequently in nurses and night shift workers compared to community dwellers and those working daytime only. During the COVID-19 pandemic, the rate of drowsiness among Polish nurses rose after each night shift because of the accumulation of sleepiness and exhaustion, which leads to a decline in alertness and level of concentration throughout the following days of work (Martyn *et al;* 2021). There was a high prevalence of insomnia among Italian night-shift nurses working during the COVID-19 pandemic, and most of them attributed the insomnia to the pandemic

(Ielapi *et al.*, 2021). Gender, work history, chronic diseases, daytime sleep duration, direct participation in COVID-19 patient rescue, frequency of night shifts, professional psychological assistance during the pandemic, negative experiences such as family, friends, or colleagues becoming seriously ill or dying due to COVID-19, COVID-19 fear, fatigue, and burn-out were all linked to insomnia among Chinese front-line nurses fighting COVID-19 in Wuhan (Zhan *et al.*, 2021). According to a study, one-third of Chinese frontline nurses in Wuhan during the COVID-19 epidemic suffered from anxiety, which was linked to perceived stress and insomnia. Anxiety, perceived stress, insomnia, working four-night shifts per week, and fear of COVID-19 were all found to have significant relationships (Shen *et al.*, 2021). Nurses on the frontline of the COVID-19 outbreak may develop sleep problems because of the tensions they experience. Psychological, occupational, and environmental health risks have been linked to sleep deprivation, and insomnia among hospital workers. An increased risk of depression altered immunological responses, medical errors, drowsy driving, and burnout are factors associated with working the night shift among nurses. As a result, effective interventions to tackle sleep deprivation, insomnia, and shift work disorder among nurses on the front lines of the COVID-19 outbreak are required (Ballesio *et al.*, 2021). Insomnia at night, significant sleep issues, and a high level of burnout may worsen in the COVID-19 era among frontline nurses, emphasizing the necessity of their well-being (Kim *et al.*, 2021). Exogenous melatonin use among Norwegian nurses in the COVID-19 era was caused by poor sleep quality, shift work sleep disorder symptoms, insomnia, anxiety, and

depression (Forthun *et al.,* 2022). The use of sleep medication without a prescription could have serious consequences for nurses' health, well-being, and performance. Emotion dysregulation and COVID-19-related psychological distress are key factors associated with insomnia among frontline nurses during COVID-19 (Nazari *et al.,* 2022). Short sleep was associated with a higher prevalence of psychological distress among New York City healthcare workers during the COVID-19 pandemic (Diaz *et al.*,2022).

1.2 Statement of the problem

Patients' safety is jeopardized by sleep disorders such as shift work sleep disorders, which affect several nurses as a result of circadian misalignment, especially those working rotating shifts, and this has been associated with increasing adverse mental health conditions (example, depression and anxiety) among nurses and increased rates of medical errors (examples include medication administration errors, needle stick injuries, and equipment operational errors), which jeopardize patients' safety. An increase in stress, anxiety, and depression are all associated with sleep disruptions among nurses in the era of the COVID-19 pandemic. Having adequate sleep is beneficial for nurses' physical and mental wellbeing and job performance. Frontline nurses working various shifts may suffer from sleep deprivation and physical and mental fatigue because of the COVID-19 pandemic's burden. Nurses may find night shifts and long shifts tough during the COVID-19 crisis. Even frontline nurses who previously tolerated night shifts and long shifts may find it difficult to adapt because of anxiety and stress. Sleep deprivation over an extended period might result in decreased

alertness and attention on the following working days, thus compromising patient care and safety.

1.3 Purpose of the study

The objectives of this research are twofold. First, to determine the prevalence of problematic nicotine, caffeine, sleep-promoting medication, and alcohol use in a sample of registered nurses working night shifts in the era of COVID-19 pandemic. Secondly, to determine the association between job stress, sleep quality, anxiety and depression among Canadian nurses working night shifts in the COVID-19 era.

1.4 Relevance and significance

Sleep disorders such as shift work sleep disorder can impair nurses' vigilance, putting patients' safety at risk. As a result, determining the prevalence of problematic nicotine, caffeine, sleep-aid drugs, and alcohol use among nurses working night shifts during the COVID-19 period is crucial. Furthermore, there may be a relationship between job stress, sleep quality, anxiety, and depression among nurses working night shifts in the COVID-19 era. Therefore, there is a need for developing effective health promotion strategies and workplace interventions to improve nurses' mental health, vigilance at work and sleep quality and duration after work.

1.5 Research questions

This study focuses on the following research question:

I. What are the health impacts of COVID-19 pandemic on mental wellbeing in a sample of registered nurses working night shifts in the Canadian province of Saskatchewan?

II. What is the prevalence of problematic nicotine, caffeine, sleep-promoting medication, and alcohol use in a sample of registered nurses working night shifts in the Canadian province of Saskatchewan?

III. Is there an association between job stress, sleep quality, anxiety and depression among nurses working night shifts in the COVID-19 era?

IV. Is there an association between working night shifts and problematic substance use among nurses in the COVID-19 era?

V. Is there a correlation between problematic nicotine and caffeine use among nurses in the COVID-19 era?

2. LITERATURE REVIEW

2.1 Neurobiology of circadian rhythm regulation

In humans, the circadian pacemaker is in the suprachiasmatic nucleus (SCN), a small structure in the anterior hypothalamus, above the optic chiasma on either side of the third ventricle (Welsh *et al.,* 2010). The SCN generates the endogenous rhythm with a period length (or time taken to complete a full cycle) of approximately 24 h (Hu *et al.,* 2008). Entrainment of the circadian pacemaker (setting the clock time) is by photoperiodic information of the light/dark cycle that is relayed to the SCN via the optic nerve (retinohypothalamic tract, RHT). The human circadian pacemaker system is composed of photoreceptors and input pathways (RHT) that receive and transmit light cues, the SCN itself, and output pathways from the SCN. Light/dark information is converted into action potentials by the photoreceptors in the retina and transmitted to the SCN via the RHT (Pittman-Polletta *et al.,* 2010). From the SCN, rhythmic information reaches the pineal gland, a small pea-sized structure located close to the 3rd ventricle and ventrally to the splenium, and results in the synthesis and secretion of melatonin. The role of melatonin is to convey information about the daily light and dark cycle to every tissue in the body. Melatonin has been described as the hand of the clock, as it not only responds to signals from the SCN, but the endogenous melatonin rhythm can indicate the phase or time of the clock (Welsh *et al.,* 2010; Pittman-Polletta *et al.,* 2010; Hu *et al.,* 2008). In humans, putative melatonin receptors have been in the SCN and have been found to provide a feedback loop to the SCN. By way of this

feedback loop, the circulating melatonin influences the SCN, which in turn controls the timing of the secretion of melatonin from the pineal gland (Touitou *et al.*, 2017).

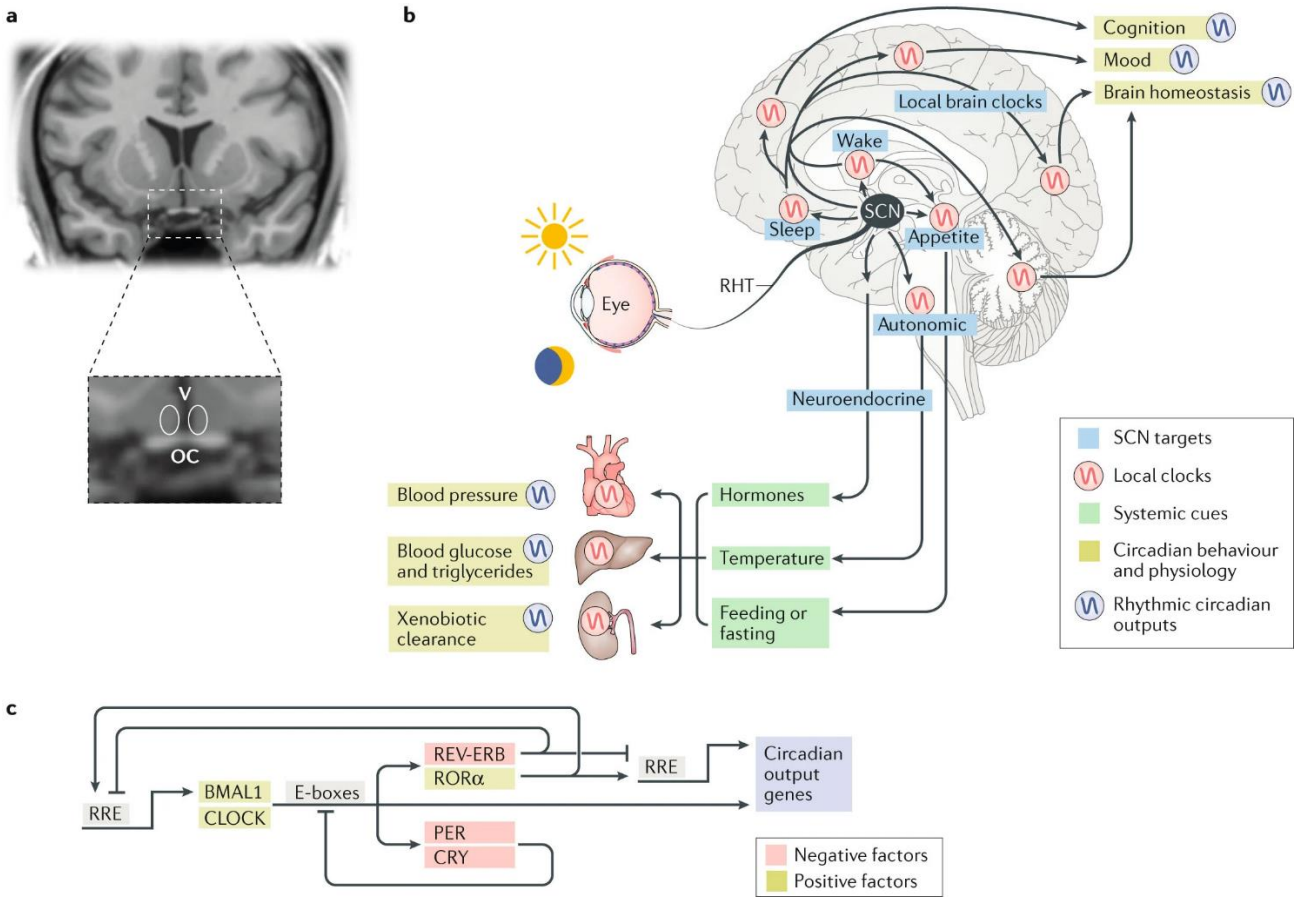


Figure 1: Role of the suprachiasmatic nucleus (SCN) in producing the circadian rhythms. a) The principal circadian clock, the **SCN,** is in the hypothalamus. b) The SCN receives direct retinal innervation via the retinohypothalamic tract (RHT) to ensure its synchronization to day–night cycles. c) Simplified schematic of the molecular transcriptional–translational feedback loops of the mammalian circadian clock, in which heterodimeric complexes of circadian locomotor output cycles protein kaput (CLOCK) and brain and muscle ARNT-like 1 (BMAL1) proteins act via enhancer box (E-box) regulatory sequences to drive daytime expression of period (PER) and cryptochrome proteins (CRY),

which in turn combine to suppress CLOCK–BMAL1 activity at their own E-boxes.

(Copyright © 2018 Nature Reviews Neuroscience (Nat Rev Neurosci). All rights reserved. Hastings, M. H., Maywood, E. S., & Brancaccio, M. (2018). Generation of circadian rhythms in the suprachiasmatic nucleus. Nature reviews. Neuroscience, 19(8), 453–469. https://doi.org/10.1038/s41583-018-0026-z)

In summary, the SCN promotes sleep by mediating circadian (Process C) and homeostatic (Process S) activity (Pandi-Perumal *et al.,* 2022). Melatonin controls sleep by acting as a chemical signal on the body's natural clock. Light serves as a cue for sleep/wake management by stimulating retino-recipient cells in the SCN and suppressing melatonin. Clock genes are the molecular timekeepers that keep the 24-hour cycle in place (Pandi-Perumal *et al.,* 2022). Entraining signals, or so-called zeitgebers, that determine or regulate the phase or period of the circadian rhythm are easily detected by clocks. Other external (such as feeding and exercise) or intracellular (temperature) cues can reset, or entrain, the endogenous rhythms, in addition to light, which is the major zeitgeber for photosensitive clocks. The human body is designed to cope with daily demands with the least amount of effort. This is achieved by precisely scheduling and combining all components of sleep and waking (Pandi-Perumal *et al.,* 2022). The SCN have an influence on the hypothalamus, thalamus, and limbic system through projections (Hofstra & de Weerd, 2008). The pineal body is one of the SCN's primary targets. Melatonin synthesis from tryptophan is a crucial function of this tiny brain region. In

all mammals studied thus far, this production is very rhythmic (Gentry *et al.,* 2021). It has a modest production during the day, which rises after the advent of darkness to a high output during the night, peaking between 11 PM and 3 AM, and then drops quickly before the onset of light. The release of melatonin and the activity of the SCN are two of the few circadian rhythms that occur in both nocturnal and diurnal species (Hofstra & de Weerd 2008; Gentry *et al.,* 2021).

2.2 Sleep physiology and circadian misalignment

Sleep is an actively regulated process that is strongly impacted by homeostatic influences that develop throughout continuous awake and dissipate during sleep, as well as by circadian effects that are entrained to the 24-hour day (Schwartz & Roth, 2008). The transitions between sleep and wake states are regulated by a well-defined subcortical network of brain areas, and sleep has a typical underlying architecture characterised by a regular alternating between non–rapid eye movement (NREM) and Rapid eye movement (REM) stages (Saper *et al.,* 2005). Different hormonal patterns distinguish sleep and wake states, which may have major effects on metabolism and glucose balance. The inhibition of activity in the ascending arousal systems is required for the initiation and maintenance of sleep. The inhibitory neurons of the ventrolateral preoptic region (VLPO), which are active during sleep, do this. The molecular initiates that activate the VLPO and induce sleep onset have yet to be fully characterised, however extracellular adenosine has been suggested as a possible candidate. During alertness, adenosine accumulates in the basal forebrain, which then decreases with continued sleep (Schwartz & Roth, 2008). The VLPO contains adenosine receptors, and adenosine activates VLPO neurons in vivo, therefore it's a good candidate for the sleep switch. Despite this data, additional molecules are almost certain to perform essential signalling functions in the beginning and maintenance of sleep. The VLPO may be inhibited by the monoaminergic arousal centres, which project to it (Troynikov *et al.,* 2018). This gives rise to the concept of flip-flop behavioural regulation, in which activity of one arousal-

producing or sleep-producing neurons dominates and suppresses the other at any given time. In addition, the suprachiasmatic nucleus which is the core circadian clock provides considerable circadian modulation to the VLPO (Schwartz & Roth, 2008). Sleep isn't a one-size-fits-all procedure. REM sleep, which is associated with active dreaming, and NREM sleep are two fundamentally different types of sleep. Switches between NREM and REM sleep appear to be regulated by reciprocal inhibition between monoaminergic neurons and a subgroup of cholinergic neurons in the brainstem, which becomes surprisingly quiet. Most hormones have significant 24-hour cycles in their plasma levels, indicating the relevance of both the circadian clock and sleep-related impacts on their release and/or metabolism (Schwartz & Roth, 2008). Some hormones, such as adrenocorticotropic hormone, cortisol, and melatonin, are unaffected by sleep versus awake; others, such as thyroid-stimulating hormone and prolactin, are highly influenced by sleep; and still others, such as growth hormone, are affected by specific sleep stages. Prolactin levels are low during the day and high during sleep in typical circumstances. Sleep onset, regardless of time of day, is related with a boost of prolactin, according to studies employing daytime naps or abrupt changes in sleep schedule. It's been proposed that EEG delta activity and pulsatile prolactin release have a negative relationship (Murillo-Rodriguez *et al.,* 2012).

Circadian misalignment refers to a range of situations, including improperly scheduled sleep and wake, sleep/wake misalignment with eating rhythms, and misaligned central and peripheral rhythms (Schwartz & Roth, 2008). Most of the early research centred on sleep

misalignment with the biological night (Baron & Reid, 2014). Circadian rhythm disruption, whether caused by external causes like shift work or intrinsic variables like circadian disorders, has been linked to medical and mental repercussions. Misalignment of the sleep-wake cycle regarding the biological night is one of the most common types of misalignments examined (Okechukwu *et al.,* 2022). Misalignment of feeding rhythms to the sleep-wake or light-dark cycle, as well as internal misalignment of central and peripheral rhythms, are examples of other types of misalignments. The core body temperature minimum and the timing of melatonin onset under dim light conditions known as dim light melatonin onset (DLMO) are frequently utilised as markers of circadian timing. Phase angle refers to the timing of these circadian markers in connection to sleep-wake activities, and it has also been employed as a measure of circadian alignment (Schwartz & Roth, 2008). The time interval between circadian indicators (DLMO or core body temperature minimum) and sleep timing (onset, midpoint, or wake time), for example, has been studied. Some researchers have found that those with an evening chronotype (a preference for later sleep and activity) had a smaller phase angle between circadian markers and sleep, indicating that they sleep and wake earlier in their circadian phase (Montaruli *et al.,* 2021). Sleep disturbance and/or daytime sleepiness are two of the most serious and immediate consequences of misaligning the sleep-wake cycle to the biological night. Insomnia, difficulty waking up in the morning, and tiredness are common symptoms that motivate patients to seek treatment for circadian disorders in sleep clinics (Okechukwu *et al.,* 2022). The physiological and psychological implications,

however, go far beyond sleep-wake disruption. Changes in eating habits, metabolic function, and the likelihood of developing mood disorders are among them. Internal rhythm misalignment, such as the timing of central vs. peripheral clocks, is another sort of disturbance (Montaruli *et al.*, 2021).

2.3 Epidemiology of sleep problems among nurses in the frontline against COVID-19

Proserpio and colleagues investigated sleep interruptions, anxiety, and depression among healthcare and non-healthcare employees at three hospitals in Milan, Italy, during the COVID-19 pandemic. In Italy, they identified a higher incidence of sleep and mental disorders among healthcare personnel. Conditions that suggested a significant shift in personal or work routines were the ones that were most strongly associated to insomnia or mood disorders (Proserpio *et al.,* 2022). According to one study, COVID-19-induced psychological distress among Iranian nurses predicted insomnia. Psychopathology vulnerabilities, emotion dysregulation, dysfunctional sleep habits, and neuroticism all play a role in the relationship. Female nurses also had greater rates of sleeplessness, neuroticism, psychopathology vulnerability, and COVID-19-related psychological distress than male nurses (Nazari *et al.,* 2022). During the COVID-19 epidemic, most intensive care nurses in Turkey experienced moderate to extremely severe depression, anxiety, and stress, according to one research (Kandemir *et al.,* 2022). Furthermore, some of the nurses suffered from moderate to severe insomnia. The effects of stress, anxiety, and sleeplessness on depression,

the dependent variable, were found to be statistically significant within the context of a conceptual framework. Furthermore, it was discovered that stress, anxiety, sleeplessness, and depression all have a strong correlation among Turkish nurses during the COVID-19 pandemic (Kandemir *et al.,* 2022). Suicidal ideation is associated to traumatic experiences, and very little is established about the psychological mechanisms that underpin this connection. COVID-19-related traumatic event exposure was significantly associated with insomnia severity, nightmare frequency, and suicidal ideation, according to a study that aimed to examine the relationship between COVID-19-related traumatic event exposure and suicidal ideation among 16,220 Chinese hospital workers and identify mediating roles of sleep disturbances in this relationship (Que *et al.,* 2022). After adjusting for relevant confounders, nightmares were found to be an independent risk factor for suicide ideation, but not insomnia, depression, or anxiety.

Sleep quality deteriorated among 61.4% of 4,384 evaluated Brazilian health professionals who were assisting patients with COVID-19 and those who had a previous COVID-19 infection, while 43.5% and 22.8% reported ≥ 1-hour sleep duration reduction and worsening or new-onset nightmares, respectively (Drager *et al.,* 2022). Age, gender, weight change, prevalent anxiety, new-onset burnout, family income drops, and supporting patients with COVID-19 were all found to be independently linked with the development or severity of past insomnia episodes in multivariate model (Drager *et al.*, 2022). During the COVID-19 outbreak in China, a study involving 562 frontline nurses found a significant high prevalence

of anxiety in frontline nurses, and identified five risk factors: poor sleep quality, experienced major COVID events, lower resilience and motivation, and no visiting friends on a routine basis (Wang *et al.,* 2021).

2.4 Night shift work and shift work sleep disorder

Shift work is defined as work that takes place between 7:00 p.m. and 6:00 a.m. for at least a portion of the shift (Jang, 2021). Shift work, which includes night shifts, is a regular occupational characteristic in roughly 20% of the global workforce (Gupta *et al.,* 2019). As a result of night shift work, a significant percentage of night shift workers in both developed and developing countries develop shift work sleep disorder, a circadian rhythm sleep disorder characterised by excessive drowsiness, sleeplessness, or both (Wright *et al.,* 2013). In addition to negative health repercussions and a reduced quality of life for individuals, shift work disorder cost employers a lot of money due to decreased job performance and an increase in accidents and errors (Gupta *et al.,* 2019). The two key components of night shift work that have been demonstrated to disrupt mental functioning are a reduction in night sleep duration and a desynchronization of circadian rhythm. The most immediate negative implications of night shift employment include reduced neurocognitive performance and a higher chance of accidents and errors as a result (Savarese & Di Perri, 2020). With 24 hours of sustained wakefulness, sleep loss significantly decreases neurobehavioral performance and job performance. Long-term exposure to night work may disrupt the body's natural circadian

rhythm and have a negative impact on mental health. Permanent or rotating night shifts may be linked to an increased risk of sleep and mental health disorders, and these links may be mediated through sleep disruption. Furthermore, night work disrupts social life, negatively affecting work performance, physical health, and social connections (Drake *et al.*, 2004). Furthermore, psychological stress may be stronger at night than during the day. In the situation where the timing of the external environment doesn't match the human internal clock, biological time begins to regulate, so the inner clock meets the environmental time. The mismatch between the human internal clock and the environmental time is called "external desynchronization," and therefore, the adjustment of the inner clock to fulfil the environmental time is called "re-entrainment (Vanttola *et al.*, 2020)." During re-entrainment, human circadian rhythms of assorted physiological processes change and befit the environmental time, thus deviating from the inner clock. However, the circadian rhythms of every physiological process don't coordinate at the identical rate; some rhythms with large exogenous components, like the sleep–wake cycle and eating, adjust rapidly, whereas rhythms with large exogenous components, like hormone secretion and vital signs, adjust more slowly (Reynolds *et al.*, 2021). It takes a long time for all rhythms to become completely attuned to the environmental time; until that time, biological time re-entrainment is incomplete, and the biological time system is inefficient. During this period, the individual processes governed by biological time don't match each other; this state is called internal desynchronization, or circadian disruption. Internal desynchronization is the most

influential reason for shift work intolerance (Lee *et al.,* 2021). Some of the signs and symptoms of intolerance to night shift work that can lead to shift work sleep disorder include: problematic use of wakefulness promoting medications and/or sleeping promoting pills, sleep disturbances (poor sleep quality, difficulty falling asleep, and frequent awakenings), chronic fatigue during the night shift even after getting enough sleep during the day, Changes in behaviour (unusual irritation, malaise, and a sense of inadequacy), loss in cognitive performance during the night shift, rise in work-related errors Problems with the digestive system (dyspepsia, epigastric pain, and gastric ulcers) (Vanttola *et al.,* 2019; Reynolds *et al.,* 2021).

2.5 The effects of night shift work on nurses' sleep quality and circadian rhythm

Nurses' job performance can be affected by sleep disorders and fatigue in terms of performance, output, activity response time, and management (Giorgi *et al.,* 2018). Rotating shift nurses and permanent night shift nurses frequently experience disruptions of the circadian rhythm and sleep disturbance. According to one study night-shift nurses had less effective circadian activity rhythm compared with nurses who worked day shifts (Kang *et al.,* 2015). According to Min and colleagues' nurses who worked night shifts reported lower average alertness scores than those who worked day and evening hours. Overall, attentiveness was on the decline, albeit the patterns of reduction varied between shifts (Min *et al.,* 2021). The decrease in alertness at work among fixed night shift nurses is mediated by sleep parameters. According to one study, fixed night shift nurses' attention lowers drastically

during regular hours and remains poor during overtime. Every working hour, the alertness scores of fixed night shift nurses decreased. After 4 hours, the scores had plummeted below 20%, and after 6 hours, they had dropped below 30%. Increased bedtime, sleep time, and sleep efficiency all lowered the likelihood of alertness scores below 70. Sleep delay was reported to be correlated to a higher likelihood of alertness ratings falling below 70 (Seong *et al.*, 2022). Moreover, night shift nurses also experience a substantial decline in cognitive functioning throughout their shifts compared to day shift nurses (James *et al.*, 2020).

2.5.1 Medical errors related to sleepiness in night shift nurses

According to the outcome of one study, more than half of the night shift nurses who participated in a survey reported being sleep deprived (Johnson *et al.*, 2014). The nurses who were sleep-deprived nurses made more patient care errors (Johnson *et al.*, 2014). According to Arakawa and colleagues, when night shift break durations are increased by 1 min, the number of incidents/errors increases considerably. Furthermore, being under treatment, absence due to illness in the previous 6 months, night shift break times, bodily pain, and role were all linked to medical errors and events among female hospital nurses (Arakawa *et al.*, 2011). According to a logistic regression analysis, nurses undergoing treatment had 1.20 times more medical errors than healthy nurses, while nurses reporting a sickness absence in the previous 6 months had 1.50 times more medical errors than healthy nurses (Arakawa *et al.*, 2011). Medical error involving nurses is a serious problem since nurses' activities have a direct and often major impact on their patients' prognosis. Arimura and colleagues confirmed

that hospital nurses' sleep and mental health were both poor, and that shift work and poor mental health were both important contributors to medical errors (Arimura *et al.*, 2010). According to one study, most sleep deprived night shift nurses got 5 hours or less of sleep during the day, for a total mean average of 4.3 hours per day, while many non-sleep deprived night shift nurses got 8 hours or less of sleep per day, for a total mean average of 6.4 hours per day (Ramadan & Al-Saleh, 2014). Furthermore, the research showed that the incidence of medical errors increased among nurses as the number of working hours in a week increased.

2.5.2 Motor vehicle accidents related to early-morning sleepiness among night shift nurses

As a result of circadian disruption and sleep limitation, night-shift nurses are at a higher risk of drowsiness-related motor vehicle collisions. Driver drowsiness is exacerbated by night-shift work, resulting in poor driving performance and an increased chance of near-crash occurrences (Lee *et al.*, 2016). Despite the significant occurrence of drowsy driving and sleep-related crashes, little is known about the characteristics of driver impairment before or during a critical driving incident caused by tiredness. Driving time increases drowsiness and the danger of crashing. With increasing drive duration, sleep-deprived drivers exhibit increased subjective tiredness, reaction delay, and erroneous lane crossings during simulated driving (Lee *et al.*, 2016). Corrective steering wheel movements, automobile speed, and lateral position all degrade over time, with severe driving impairment after 2 hrs drive on a highway. According to Scott and colleagues, nurses who worked night shifts were nearly 4

times more likely than nurses who did not work at night to have trouble remaining awake when driving home. Because sleep propensity/circadian drive for sleep is highest in the early morning hours, it's no surprise that nurses who left work between 02:00 and 06:00 reported struggle to stay awake about half of the time on the way home (Scott *et al.,* 2007). Given the difficulties of both shift duration and shift time, the combination of long work hours and working at night makes driving home particularly dangerous. Lastly, shorter sleep lengths were linked to a higher likelihood of having trouble staying awake when driving home.

2.6 Circadian rhythm disturbance and mental health

The mechanism of circadian rhythm disturbance and its relationship to mental health and biological factors are still unknown. However, mood disorders and circadian rhythms may have a reciprocal association (Walker *et al.,* 2020). Mood disorders are frequently linked to disrupted circadian clock-controlled responses like sleep and cortisol secretion, whereas disruption of circadian rhythms caused by night-shift work, or exposure to artificial light at night can induce or exacerbate anxiety and depression in those who are susceptible (Ahmad *et al.,* 2020). Although evidence implies strong links between circadian rhythms and mental health, studies on the direct interactions between the circadian system and mood regulation have just recently started. According to an Italian study, night shift work has an impact on mental health by causing the onset of neuropsychiatric disorders such as mood disorders, anxiety, nervousness, major depression, anxiety syndromes, chronic fatigue and chronic insomnia, irritability, sleep disturbances, attention deficits, cognitive impairments, and

changes in circadian rhythm (Sancini *et al.*, 2012). Night shifts impair social life and create severe desynchronization of chronobiological cycles, resulting in negative consequences on work performance, health, and social relationships (Sancini *et al.*, 2012; Torquati *et al.*, 2019). Shift workers, particularly women, are at an increased risk for poor mental health, particularly depressive symptoms, according to the findings of one meta-analysis study. This is likely due to circadian rhythm interruption (Torquati *et al.*, 2019).

2.7 Association between sleep deprivation and depression

Depression is the most prevalent mood disorder associated with insomnia. Most patients with depression, it is thought, have poor sleep quality (Choi *et al.*, 2021). Insomnia and depression are common illnesses among shift workers, and they frequently co-occur (Choi *et al.*, 2021). However, a recent Japanese study suggests that in a working population in Japan, depressed symptoms are linked to longer sleep latency and lower rapid eye movement latency (Omichi *et al.*, 2022). According to one study, the overall heritability of insomnia symptoms is moderate, with genetic variables accounting for around 37% of the variance based on combined youth and parental reports (Gehrman *et al.*,2011). By way of reference, the heritability of anxiety disorder was 30% for males and 46% for females, while the heritability of depression was 11% for males and 19% for females, according to youth reports (Gehrman *et al.*,2011). In adults, women have a higher prevalence of insomnia than males, but the causes for this disparity are unknown. According to one study individuals with sleep-wake

related disturbances and who had severe insomnia presented also had had severe depressive and anxiety symptoms (Chen *et al.,* 2021). Patients with co-occurring insomnia and hypersomnia symptoms experienced greater depressive symptoms, a higher rate of suicide ideation, and more severe impairment in physical, economic, job, and family relationships, according to one investigation (Zhao *et al.,* 2021). Patients with both sleep problems were more likely to have excessive sleep anxiety, suicide ideation, social disharmony discomfort, more somatic symptoms, lack of energy, hyperphagia, loss of mood reactivity, and diurnal change (Zhao *et al.,* 2021). A Transdiagnostic Intervention for Sleep and Circadian Dysfunction will improve functional impairment, disorder-focused symptoms and sleep and circadian functioning (Harvey, 2022). The Transdiagnostic Intervention for Sleep and Circadian Dysfunction was associated with psychosocial and sleep and circadian improvements for specific sleep and circadian problems (insomnia, hypersomnia, parasomnias, periodic limb movement/restless leg syndrome, circadian rhythm disorders) because it tackles impairment associated with quantity of sleep and type of circadian problems and the comorbidity and sub-diagnostic indicators (Sarfan *et al.,* 2021).

2.8 Pathophysiology of shift work sleep disorder

Despite enough time in bed (7 to 8 hours), consistent sleep cycles, and the absence of other sleep disorders, nurses diagnosed with shift work sleep disorder are unable to withstand the impacts of a shift work schedule and may present with excessive sleepiness or insomnia (Okechukwu *et al.,* 2022). Although few research directly address shift work sleep disorder in

night shift nurses. Sleep disruption, periodic awakenings, and an inability to stay alert during early morning after work or commuting hours are all possible symptoms of shift work sleep disorder among nurses working night shifts (Rosa *et al.,* 2019). Job performance, driving safety, quality of life, work satisfaction, and health are all affected by these deficits in nurses working night shifts or rotating shifts (Cappadona *et al.,* 2021). Circadian preference as regards morningness or eveningness, a heritable trait linked to a length polymorphism in the PER3 gene and the intrinsic period of the circadian clock, is one predictor of shift tolerance. Individuals who are more morning-type have a lower tolerance for shift work than those who are more evening-type (Cheng *et al.,* 2018). Furthermore, the fact that older people are more morning people may help to explain why they have a harder time coping with shift work. Older people's lowered ability to adapt their endogenous circadian rhythms in response to moderate light levels could also be a role in shift work intolerance in that population (Abel *et al.,* 2020). The circadian system stimulates brain arousal throughout the day, and sleep is normally stimulated at night. The suprachiasmatic nucleus, located in the anterior hypothalamus of the brain, keeps the rhythms aligned with the day-night cycle (Keijzer *et al.,* 2017). The molecular basis of biological timekeeping is gene-transcription feedback loops in individual suprachiasmatic nucleus cells. Light exposure schedules, intensity, and previous exposure to light all influence circadian phase shifts population (Abel *et al.,* 2020). Exposure changes might speed up or slow down these oscillations. Light exposure at night, for example, can cause the rhythms to be delayed. The retinohypothalamic tract sends

information about environmental light from photoreceptors in the retina to the suprachiasmatic nucleus. The pineal gland, which secretes the hormone melatonin, is regulated by the suprachiasmatic nuclei. Melatonin secretion usually starts two hours before night and ends two hours before waking up (Cable *et al.,* 2021). Melatonin binding to the MT1 and MT2 melatonin receptors causes a decrease in neuronal firing in the suprachiasmatic nuclues. Sleep is thought to be stimulated by a decrease in suprachiamatic activity. While daytime nurses produce melatonin at night, night shift nurses' melatonin production is reduced owing to light exposure (Mohd *et al.,* 2022). In summary, the most common cause of shift work sleep disorder among nurses working night shift is maladaptation to the schedule (Okechukwu *et al.,* 2022). Cortisol and melatonin are essential hormones in the circadian cycle. Cortisol and melatonin do not entrain to a night-oriented rhythm and remain on a daytime schedule in circadian misalignment. Melatonin levels continue to rise at night throughout a night shift nurse's awake period and fall during sleep time. Cortisol levels are lower when night shift nurses are awake and greater when they are sleeping (Okechukwu *et al.,* 2022).

2.9 Diagnostic criteria and assessment of shift work sleep disorder

Regarding the second edition of the International Classification of Sleep Disorders, shift work sleep disorder is diagnosed on four essential points: The following: (1) a complaint of insomnia or excessive sleepiness that is temporally associated with a recurring work schedule that overlaps the usual time for sleep; (2) the symptoms are associated with the shift work

schedule over a period of one month; (3) sleep log or actigraphy monitoring for at least seven days demonstrates disturbed circadian and sleep-time misalignment; and (4) the sleep disturbance is not better explained by another current sleep disorder, medical or neurological (American Sleep Disorders Association, 1990). When the third edition of the diagnostic system was released in 2014, three notable amendments to the diagnostic criteria for shift work sleep disorder were made: At least three criteria must be met: (1) the insomnia/sleepiness complaint must be accompanied by a reduction of total sleep time; (2) the duration of the symptoms must be at least 3 months; and (3) sleep log or actigraphy monitoring has to be conducted for at least 14 days and needs to include both work and free days. According to the third edition of the International Classification of Sleep Disorders, physicians are more strongly encouraged to consider the use of actigraphy and biomarkers such as dim-light melatonin onset in establishing a shift work disorder diagnosis, although these are not required to meet the criteria for any diagnosis (Sateia, 2014). The use of questionnaires such as the Morningness-Eveningness Questionnaire to identify chronotype is also encouraged. A set of criteria applies to identifying shift work sleep disorders. These include (1) a chronic or recurrent pattern of sleep-wake rhythm disruption primarily caused by an alteration in the endogenous circadian timing system or misalignment between the endogenous circadian rhythm and the sleep-wake schedule desired or required, (2) a sleep-wake disturbance (i.e., insomnia or excessive sleepiness), and (3) associated distress or impairment (Sateia, 2014). A duration criterion of at least 3 months is considered before

establishing the incidence of shift work sleep disorder. However, additional tests can be carried out. Examples are (I) polysomnography: In order to diagnose shift work disorder, a night shift worker must undergo a polysomnogram, or sleep study, during the day. During non-rapid eye movement and rapid eye movement stages, an electroencephalograph monitors the patient's vital signs and behaviours while they sleep (Rundo & Downey, 2019). (II) Multiple Sleep Latency Test: The test, which consists of four to five 20-minute naps interspersed with two-hour breaks, determines how long it takes the patient to fall asleep during the day. Sensors will be worn by the patient to track their sleep-wake cycle. After 15 minutes of sleep, the patient will be woken up, and the nap session will cease if they are unable to fall asleep after 20 minutes (Arand & Bonnet, 2019).

2.10 Treatments for shift work sleep disorder

Shift work sleep disorder is remarkably complex. Perfectly timed bright and dim light exposures relative to the period of the sleep window can help the internal clock adapt to the night (van Maanen *et al.*, 2016). For example, if a person's shift ends in the morning and they plan to go home and sleep, they should limit their exposure to light between then and bedtime (e.g., wear a sunshade, have blackout shades). Shift work is frequently combined with a work schedule that is longer than eight hours. As a result, shift workers sleep less than day employees and become increasingly sleep deprived over time. Modafinil and armodafinil, two wakefulness-promoting drugs, have been approved by the Food and Drug Administration

for the treatment of shift work sleep disorder (Tembe *et al.,* 2011). These medications, taken one hour before work, may assist enhance alertness during the shift. Furthermore, bright light increases alertness while suppressing melatonin production (van Maanen *et al.,* 2016). Naps scheduled before or during the night shift are critical for recovery. Napping can help night shift workers stay awake (Dutheil *et al.,* 2020). Individuals with shift work sleep disorder should be encouraged to avoid rotating shifts on a regular basis as well as decrease the number of night shifts worked in a row. Working rotational shifts is more demanding than working the same shift for a longer period. On their days off, they should obtain enough sleep. Maintaining a health and balanced diet as well as engaging regularly in physical activity is important in improving sleep health (Grundy *et al.,* 2009).

2.10.1 Pharmacological treatments for shift work sleep disorder

According to one study aimed at evaluating the effects of pharmacological interventions to reduce sleepiness or to improve alertness at work and decrease sleep disturbances whilst off work or both, in workers undertaking shift work in their present job, melatonin (1 to 10 mg) after the night shift may increase sleep length during daytime sleep. In one low-quality trial, hypnotic medication zopiclone did not result in significantly longer daytime sleep length compared to placebo in one low-quality trial (Liira *et al.,* 2014). At three months' follow-up in shift work sleep disorder patients, Armodafinil probably reduces sleepiness by one point on the Karolinska Sleepiness Scale and increases alertness by 50 ms in a simple reaction time test. Modafinil probably has similar effects on sleepiness and alertness in the psychomotor

vigilance test in the same patient group. Severe skin reactions have been reported (Liira *et al.*, 2014). Adverse effects reported by trial participants were headaches, nausea, and a rise in blood pressure. There were no trials conducted with non-patient shift workers. Based on one trial, caffeine plus pre-shift naps taken before the night shift decreased sleepiness (Liira *et al.*, 2014). According to one study, Armodafinil (150 mg) taken early during the night shift improves driving simulator performance in individuals with shift work sleep disorder (Drake *et al.*, 2014). The effects of Armodafinil on sleepiness, cognition, and driving were found up to 9.5 h post-ingestion, during the critical time when many night workers are driving home (Drake *et al.*, 2014).

2.10.2 Non-pharmacological treatments for shift work sleep disorder

According to one study, bright light exposure during the night shift caused a mean reduction of 0.83 score points of sleepiness measured via the Stanford Sleepiness Scale (Slanger *et al.*, 2016). However, napping during the night shift resulted in an 11.87 ms reduction of sleepiness among shift workers (Slanger *et al.*, 2016). Moreover, physical exercise and sleep education interventions were really of good help in maintaining sleep health (Slanger *et al.*, 2016). According to one study, behavioural interventions resulted in some improvements in sleep and other health indicators among shift workers. Importantly, behavioural interventions that tailored the information provided to workers were more likely to result in positive changes (Crowther *et al.*, 2021). Examples of such interventions are tailoring educational resources or providing information about fatigue, sleep behaviours or healthy diets among

shift workers. Qualitative analysis indicates that controlled light therapy was beneficial for shift workers, particularly for improving objective sleep parameters (Crowther *et al.*, 2021). However, the intensity and timing of bright light varied greatly between studies. Consequently, there remains limited evidence to date to establish the most suitable timing or intensity of light administration to provide clear guidelines for shift workers (Crowther *et al.*, 2021). It is also important to note that controlled light appeared to be associated with some negative side effects (e.g., headaches or eyestrain), decreased subjective sleep quality, and deterioration in perceived health status (Aemmi *et al.*, 2020).

2.11 Resources for the management of night shift work and shift work sleep disorder among nurses

Shift work disorder is linked to depression and anxiety in nurses, suggesting that it could be a focus for improving mental health among shift nurses (Booker *et al.*, 2020). In turn, depression is a substantial contributor to sick leave. Rotating shift employees have been found to have more depressed symptoms than day workers. Adults who do not work at night have been demonstrated to exhibit depressive symptoms that are linked to chronotype and sleep duration (Togo *et al.*, 2017). According to one study, among female nurses, both rotating night shift work and unhealthy lifestyle were associated with a higher risk of type 2 diabetes. The excess risk of rotating night shift work combined with unhealthy lifestyle was greater than the addition of risk linked with each specific factor (Shan *et al.*, 2018). Night

shift nurses should be advised to eat healthy diet and exercise regularly to reduce the risk of type 2 diabetes. Moreover, mind-body exercises (e.g. Yoga) should be designed by nurse managers to minimize work-related among nurses. According to one study, restorative yoga may be helpful for relieving work-related stress among female nurses working the night shift (Miyoshi, 2019).

Attention deficits among nurses increase the occurrence of devastating consequences such prescription errors, failure to identify life-threatening signs and symptoms, and other critical patient safety concerns. Stress in the nursing profession has also been linked to depression, work satisfaction, psychological suffering, and personal relationship problems, according to research. These stress-related consequences are factors that can lead to patient harm. Burnout, depression, and lateral aggression are the three main impacts of stress on nurses. Burnout is a phenomenon characterised by depersonalization, emotional weariness, and a poor sense of personal accomplishment, and its occurrence has been linked to perceived stress. Nurses have found mindfulness-based programmes to be a promising intervention for lowering stress. Nurse supervisors can customise a mindfulness-based stress reduction programme to promote nurses' mental health (Botha *et al.*, 2015). To help enhance mindfulness, the mindfulness programme combines mindfulness meditation, body awareness, and yoga. By focusing on present-moment awareness, the practise aims to help the body relax and the mind calm down. In healthcare personnel, a mindfulness training has been shown to reduce stress, improve quality of life, and increase consciousness (Santamaría-Peláez *et al.*, 2021). Nurse managers

should also tailor shift schedules to the chronotype and sleep patterns of their staff. By starting the shift earlier in the night, nurses' sleepiness during night shifts with either bright or normal lighting can be considerably reduced (Postnova *et al.,* 2013). Shift response maps can aid nurse managers and occupational physicians in the development of shift schedules with desired circadian characteristics (Postnova *et al.,* 2014).

2.12 The role of nurse leaders and managers in improving the safety of nurses working the night shift

Nurse manager has an impact on the entire health system as well as on the immediate lives of nurses (Mudallal *et al.,* 2017). The day-to-day operations of the workplace are the responsibility and accountability of a nurse manager (Greco *et al.,* 2006). Employee recruitment, hiring, orientation, staff development and assessment, resource allocation and management, risk management, patient safety, and financial responsibility are just a few examples of the task of a nurse manager. Nurse managers are also expected to assist nurses with motivation, direction, and guidance. They supervise and influence the clinical skills of the highest number of frontline nurses in the health system, and thus the largest groups of health care workers. Errors are known to increase late at night, but nurse managers can help nurses adapt to the night shift by providing guidance. Nurse managers can reduce some of the constraints on night shift nurses, which can improve clinical efficacy, increase safety, foster career progression, and promote retention. Night staff retention could be considerably improved with good nursing management. Nurse managers are in a unique position to foster

positive work cultures that improve staff productivity and satisfaction while still upholding patient care standards and ensuring organisational efficiency. It is vital to employ techniques to counteract shift work concerns such as fatigue, and organisational disengagement (Dalky *et al.*, 2018). Night shift nurses who feel appreciated, valued, and involved have higher morale, are more satisfied at work, and are more likely to stay in their positions.

2.13 Role of physical activity in improving physical and mental health among nurses

The rate of overweight and obesity among nurses is a critical topic because nurses play important role in healthy role modelling and health promotion practice in hospitals and clinics (Blake *et al.,* 2021). Therefore, persuading nurses to embrace a healthy lifestyle for their role modelling to patients as health advocates is important (Al-Tannir *et al.,* 2017). Nursing job consists primarily of low-intensity physical activity, which may not be sufficient to improve nurses' overall wellbeing (Chappel *et al.,* 2017). As a result, physical activity and health promotion interventions aimed at improving the physical and mental wellbeing among nurses must be developed (Monnaatsie *et al.,* 2021). There was significant reduction in fat mass among nurses who participated in a workplace physical activity program (Tucker *et al.*, 2018). According to one study, Nurses who engaged in yoga had better sleep quality and lower job stress compared with nurses that don’t engage in yoga (Fang & Li, 2015). There was a 3% increase in job performance among nurses that engaged in Tai Chi compared to control (Palumbo *et al.*, 2012). A review conducted by some researchers affiliated with the Sapienza University of Rome, Italy showed that Tai Chi can reduce work-related stress

among healthcare professionals (Cocchiara *et al.,* 2020). Therapeutic exercises are essential for improving aerobic capacity and reducing musculoskeletal pain among hospital nurses (Oldervoll *et al.,* 2001). Exercise has been shown to improve mood, cognitive function and delay cognitive decline among depressed patients, by maintaining the integrity of hippocampus and white matter volume (Zhao *et al.,* 2020).

2.14 Role of physical activity in improving sleep among nurses

Excessive sleepiness has been linked to car accidents and medical errors in nurses who work long shifts. Exercise, a low-cost, nonpharmacologic strategy that is readily available to the great majority of adults, presents a potential alternative method to improving sleep. Due to the nature of their work, nurses are vulnerable to sleep disorders, emotional stress, anxiety, and depression. Sleep quality can be improved by engaging in moderate-intensity physical exercise, which is a cost-effective health promotion strategy for nurses. By boosting melatonin concentrations, endocrine activity, heart rate, and slow wave sleep in nurses, adherence to a moderate-intensity exercise regimen may improve both sleep quality and duration. According to one study, an 8-week moderate-intensity aerobic exercise program was effective in improving sleep quality among Taiwanese nurses (Niu *et al.*, 2021). According to the outcome of systematic review and meta-analysis study engaging in physical activity as well as mind-body exercise regularly mostly improved subjective sleep quality. Wang and colleagues from their systematic review and meta-analysis found that yoga in women can be beneficial in the management of sleep problems (Wang *et al.*, 2020). A

moderate-intensity aerobic exercise program designed for nurses and nursing aides, which was planned by administering exercise sessions 2-6 days per week for a 4-month period at 60–70% of maximal heart rate, improved both sleep quality and duration (Härmä *et al.*, 1988).

3. METHODS

3.1 Procedure

The data used in this study was obtained from a survey titled "Lifestyle behaviours among Canadian nurses working night shifts in the COVID-19 era: a pilot study," which was conducted among registered nurses working night shifts in the province of Saskatchewan, Canada. The purpose of this study was to determine the prevalence of nicotine, caffeine, cannabis, sleep-promoting medication, and alcohol use in a sample of registered nurses working night shifts in the province of Saskatchewan, Canada. In addition, the association between sleep quality, anxiety, and depression among Canadian nurses working night shifts in the COVID-19 era. Subsequently, a systematic review and meta-analysis was conducted to systematically summarise and quantitatively evaluate some selected cross-sectional, case-control, and cohort studies in order to determine the relationship between night shift work and the risk of depression in nurses. However, regarding the biological relationships between night shift work and circadian rhythm among nurses, a thorough narrative review was conducted alongside experts in the field. Lastly, to test the efficacy of some interventions to improve the working conditions of nurses, a systematic review was conducted to evaluate the effectiveness of bright light exposure, modafinil, and armodafinil for improving alertness during working time among nurses on the night shift.

3.2 Participants

Twenty-two registered nurses between the ages of 25 to 65 years who have been working permanent or rotating night shifts for the past two years in the province of Saskatchewan, with no history of major psychiatric illness, and neurological disorders completed an online survey from April 11th, until July 15th, 2022.

3.3 Instruments

Sociodemographic characteristics such as age, gender, race/ethnicity, level of education, years of working experience as a nurse, marital/relationship status, and hours of work per shift were reported.

3.3.1 Assessment of sleep quality and mood

The Pittsburgh Sleep Quality Index (PSQI) was used to assess the sleep quality of the participants (Buysse *et al.,* 1989), and anxiety and depressive symptoms were assessed using the Hospital Anxiety and Depressive Disorders Rating Scale (HADS) (Herrmann, 1997). The possible association between poor sleep quality and anxiety and depressive symptoms among nurses working night shifts were assessed.

3.3.2 Assessment of nicotine dependence

Nicotine dependence was assessed using the Fagerström test for nicotine dependence, a validated questionnaire for the evaluation of nicotine dependence (Heatherton *et al.,* 1997).

The Fagerström test was designed to provide an ordinal measure of nicotine dependence related to cigarette smoking. It includes six items that evaluate the quantity of cigarette consumption, the compulsion to use, and dependence. In scoring the Fagerstrom test for nicotine dependence, yes/no items are scored from 0 to 1 and multiple-choice items are scored from 0 to 3. The items are summed to yield a total score of 0-10. The higher the total Fagerström score, the more severe the patient's physical dependence on nicotine.

3.3.3 Assessment of caffeine use

Problematic caffeine use was evaluated using the Caffeine Expectancy Questionnaire (CaffEQ) (Huntley *et al.,* 2012). The CaffEQ is a 47-item self-report evaluation which measures a range of expectancies for caffeine including: withdrawal/dependence, energy/work enhancement, anxiety/negative physical effects, social/mood enhancement, appetite suppression, physical performance enhancement, and sleep disturbance.

3.3.4 Assessment of sleep-promoting medication use

The severity of dependence scale (SDS) was used to evaluate the use of sleep medication among the nurses (Ferri *et al.,* 2000). The assessment was based on the use of the following sleep-promoting medications: benzodiazepine receptor agonists (eszopiclone, zaleplon, and zolpidem), Benzodiazepines (estazolam, flurazepam, quazepam, temazepam, and triazolam), dual Orexin receptor antagonists (suvorexant), sedative antidepressants, exogenous melatonin, and melatonin receptor. The SDS is a five-item questionnaire for measuring

psychological components of dependence. The scale has been proved to be valid and reliable in the general population, across substances and settings. In this study, participants answered the items of the SDS which had four options scoring from 0 to 3 and produced a total score of 0–15. The higher the total score, the higher the severity of dependence.

3.3.5 Assessment of cannabis use

The SDS was also used to evaluate the use of cannabis among the nurses (Ferri *et al.,* 2000).

3.3.6 Assessment of alcohol use

The Alcohol Use Disorder Identification Test-Concise (AUDIT-C) was used to collect data on alcohol use among the nurses (Higgins-Biddle *et al.,*2018). The AUDIT-C has three items: (a) How often did you have a drink containing alcohol in the past year? Never (score 0), Monthly or less (1), 2–4 times per month (2), 2–3 times per week (3), 4+ times per week (4); (b) How many drinks did you have on a typical day when you were drinking in the past year? 1–2 (0), 3–4 (score 1), 5–6 (2), 7–9 (3), 10+ (4); (c) How often did you have six or more drinks on one occasion in the past year? Never (0), Less than monthly (1), Monthly (2), Weekly (3), Daily or almost daily (4). The total AUDIT-C score ranges from 0 to 12. Using the AUDIT-C scores, the participants were categorized as low-risk users of alcohol (the total score of <3 (women) and <4 (men), and probable alcohol misuse (hazardous, harmful, or dependent) (the total score of ≥3 (women) and ≥4 (men).

3.3.7 Assessment of occupational burnout among the nurses

Job burnout is a persistent response to chronic emotional and interpersonal stressors on the job. According to Maslach and colleague, job stress is characterized by the three dimensions of exhaustion, cynicism, and inefficacy (Maslach *et al.,* 2001). The Maslach Burnout Inventory (MBI) is one of the leading measures of job burnout and it was used to measure the degree of burnout prevalent among the nurses. It has been validated by extensively through research conducted for more than 30 years. The MBI Is a 22-item survey which uses a 7-point scale for responses, it measures three dimensions of burnout (emotional exhaustion, depersonalization, and personal accomplishment). Cronbach alpha ratings are 0.90 for emotional exhaustion, 0.76 for depersonalization, and 0.76 for personal accomplishment (Maslach *et al.,* 2001).

3.4 Statistical analysis

Statistical analysis was performed using SPSS version 28.0 (SPSS Inc., Armonk, NY: IBM Corp, USA). Sample characteristics were summarised using frequency distributions. A bivariate correlation analysis was conducted among the key variables of interest. The Pearson correlation coefficient, which measures the strength and direction of linear relationships between pairs of continuous variables, was used to reveal the associations among job stress, sleep quality, anxiety, and depression.

3.4 Ethical statement

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the University of Saskatchewan Behavioural Research Ethics Board (ID: 3279). Informed consent was obtained from all subjects involved in the study.

4. RESULTS

4.1 Lifestyle behaviors among Canadian nurses working night shifts in the COVID-19 era

The survey was completed by 22 nurses in total. These respondents were primarily white (86%) and women (91%) while their ages were diverse (25-29=36%; 30-34=23%; 35-39=18%; 40 and above=23%). They also reported having low to normal Body mass index (18.5-29.9=77%), being married or in a relationship (82%), living in a household of three or less (82%) and being born in a prairie province (82%). In terms of their careers as nurses, most had obtained a bachelor's degree (82%). Demographic characteristics are shown in Table 1.

Table 1. Demographic Characteristics of participants

Characteristics	N (%)
Age	
25-29	8 (36.4%)
30-34	5 (22.7%)
35-39	4 (18.2%)
40 and above	5 (22.7%)
Ethnicity	
White	19 (86.4%)
Asian	1 (4.5%)
Black	1 (4.5%)
Gender	
Man	1 (4.5%)
Woman	20 (90.9%)
Non-binary	1 (4.5%)
Body Mass Index	
18.5-24.9	7 (31.8%)
25-29.9	10 (45.5%)
30-34.9	3 (13.6%)
35 and over	1 (4.5%)
Marital Status	
Single	3 (13.6%)
In a relationship	7 (31.8%)
Married	11 (50.0%)
Separated	1 (4.5%)
Number of people in household	
1	3 (13.6%)
2	10 (45.5%)
3	5 (22.7%)
4	2 (9.1%)
More than four	2 (9.1%)
Region of Canada where born	
Central Canada	1 (4.5%)
Prairie provinces	18 (81.8%)
Northern territories	1 (4.5%)
Outside Canada	2 (9.1%)
Level of education	
Diploma	2 (9.1%)
Bachelor's degree	18 (81.8%)
Master's degree	2 (9.1%)
Employed by	
Hospital	18 (81.8%)
Long term care home	1 (4.5%)
Not listed	3 (13.6%)
Type of Hospital unit	
Community nursing	3 (13.6%)
ICU/NICU	2 (9.1%)
Long-term care	1 (4.5%)
Other	15 (68.2%)
Currently working as	
General nurse	19 (86.4%)
Nurse practitioner	1 (4.5%)
Clinical nurse specialist	1 (4.5%)
Not listed	1 (4.5%)
Work Pattern	
Full time	15 (68.2%)
Part time	3 (13.6%)
Casual	4 (18.2%)

Years as a Registered Nurse	
< 2 years	2 (9.1%)
2-5 years	10 (45.5%)
6-10 years	3 (13.6%)
>10 years	7 (31.8)
Years working night shifts	
< 2 years	2 (13.6%)
2-5 years	10 (54.5%)
6-10 years	3 (4.5%)
>10 years	7 (27.3)
Pattern of night shift	
Rotating night shift	20 (90.9%)
Permanent night shift	2 (9.1%)

Many of the scales employed in the survey designated threshold scores that indicated the relative risk associated with participants' responses (see Table 2). In these cases, the data were coded into the scales' respective subcomponents, then totaled and categorized according to the specified threshold values. In terms of the PSQI, three quarters of the participants (77.3%) had scores that pointed to signs of sleep disturbance. The HADS scores suggested that only a few participants (18.2%) surpassed the threshold into borderline depression scores. Regarding anxiety, many participants (63.7%) were borderline anxious. Almost three quarters of the participants (73%) reported using at least one substance when it came to nicotine, alcohol, or cannabis. Of this category, 36.4% had scores considered to be at an elevated risk for alcohol dependence, while a smaller number (9.0%) were at risk for cannabis dependence and the same number (9.0%) were at risk for nicotine dependence. Over half of respondents (59.1%) used sleep promoting medication with roughly half of the individuals who did use the medication (53.8%) having scores below the cut-off for risky behavior. Lastly, the questions in the CaffEQ were slightly different in that an at-risk

threshold score was not specified. Nonetheless, the mean for the questions on the 1-5 scale was 2.69 suggesting that the average response was that participants were “a little likely” to engage in behaviors related to caffeine dependence.

In assessing job stress, the three components of the MBI were independently evaluated**.** In the area of occupational exhaustion, greater than half of participants expressed a high degree of burnout (54.5%). For depersonalization, fewer than half of the participants indicated that they experienced depersonalization to a high degree (45.5%). Whereas personal accomplishment would represent positive aspects of a job and contrast burnout, less than half of the participants (45.5%) felt a low degree of personal accomplishment.

Table 2. Outcomes of health assessment

Pittsburgh Sleep Quality Index score

	N	%
>5 (sleep disturbance)	17	77.3%
5 or less	2	9.1%
**	3	13.6%

Hospital Anxiety and Depressive Disorders - Depression score

0-7 Normal	13	59.1%
8-10 Borderline abnormal	4	18.2%
**	5	22.7%

Hospital Anxiety and Depressive Disorders -Anxiety score

0-7 Normal	5	22.7%
8-10 Borderline abnormal	6	27.3%
11-21 Abnormal	8	36.4%
**	3	13.6%

Fagerström test for nicotine dependence score

1-2 Low dependence	2	9.1%
3-4 Low to moderate dependence	1	4.5%
5-7 Moderate Dependence	1	4.5%
**	18	81.8%

Alcohol Use Disorder Identification Test-Concise score

Not at risk	9	40.9%
Elevated risk	8	36.4%
**	5	22.7%

Severity of dependence scale - Cannabis score

Not at risk	6	27.3%
Very high	1	4.5%
Extremely high	1	4.5%
**	14	63.6%

Severity of dependence scale – sleep promoting medication score

Not at risk	7	31.8%
At risk	3	13.6%
Very high	2	9.1%
Extremely high	1	4.5%
**	9	40.9%

Maslach Burnout Inventory outcome

Occupational exhaustion score

<17 low degree	2	9.1%
18-29 Moderate degree	2	9.1%

>30 high degree	12	54.5%
**	6	27.3%

Depersonalization score

<5 Low degree	1	4.5%
6-11 moderate degree	6	27.3%
>12 high degree	10	45.5%
**	5	22.7%

Personal accomplishment score

<33 low degree	10	45.5%
34-39 Moderate degree	3	13.6%
>40 high degree	4	18.2%
**	5	22.7%

**** Missing data**

With respect to the research questions, see Table 3. there was a strong positive association between sleep disturbance, as measured by the PSQI, and depression *r* (19) = 0.50, [*p* = 0.029, 95% CI, 0.06, 0.78]**.** Similarly, a positive correlation was found between higher levels of reported anxiety and sleep disturbance *r* (19) = 0.69, [*p* = 0.001, 95% CI, 0.34, 0.87]**.** There were no significant relationships between sleep disturbance and occupational exhaustion *r* (17) = 0.43, *[p* = 0.089, 95% CI, -0.07, 0.75], depersonalization *r* (17) = 0.46, [*p* = 0.065, 95% CI, -0.03, 0.77], or personal accomplishment *r* (19) = -0.13, [*p* = 0.631, 95% CI, -0.58, 0.38]. However, there was a positive correlation between depression and occupational exhaustion *r* (17) = 0.56, [*p* = 0.021, 95% CI, 0.10, 0.82], but no relationship with depersonalization *r* (17) = 0.43, (*p* = 0.086, 95% CI, -0.06, 0.75] or personal accomplishment *r* (17) = -0.46, [*p* = 0.062, 95% CI, -0.77, 0.02]. Anxiety, on the other hand, was significantly related to occupational exhaustion *r* (17) = 0.65, [*p* = 0.005, 95% CI, 0.24,

0.86] and depersonalization r (17) = 0.52, [p = 0.005, 95% CI, 0.06, 0.80], but not significantly related to personal accomplishment r (17) = -0.34, [p = 0.185, 95% CI, -0.70, 0.17].

Table 3. Correlations among sleep quality, job stress (burnout), anxiety and depression

	1	2	3	4	5	6
1. PSQI Global	-	0.43 (-0.07, 0.75)	0.46 (-0.03, 0.77)	-0.13 (-0.58, 0.38)	0.69** (0.34, 0.87)	0.50* (0.06, 0.78)
2. Occupational Exhaustion		-	0.32 (-0.20, 0.70)	-0.63** (-0.85, -0.22)	0.65** (0.24, 0.86)	0.56* (0.10, 0.82)
3. Depersonalization			-	-0.01 (-0.48, 0.47)	0.52* (0.06, 0.80)	0.43 (-0.06, 0.75)
4. Personal Accomplishment				-	-0.34 (-0.70, 0.17)	-0.46 (-0.77, 0.02)
5. HADS (Anxiety)					-	0.78** (0.51, 0.91)
6. HADS (depression)						-

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Confidence intervals (95%) are presented below the correlation coefficient.

HADS - Hospital Anxiety and Depressive Disorders.

PSQI - Pittsburgh Sleep Quality Index score

4.2 Biological and practical considerations regarding circadian rhythm and mental health relationships among nurses working night shifts

The searches generated a total of 22 records on the PubMed database, and 9 records on the Scopus database, and a total of 31 studies. 29 papers were identified after removal of duplicates. However, 29 articles were screened based on the review of titles and abstracts. 19 articles were identified for full-test review. 7 papers were eligible for inclusion in this review. The 7 studies were all selected for this narrative review based on their significance to the objectives of this study (Figure 2). The selected studies were mostly cross-sectional studies (n =6), and one experimental study involving gene analysis (See table 4).

Clock gene polymorphisms may influence the adverse effects associated with circadian rhythm disruptions caused by working the night shift among nurses. Gamble *et al.* for example, analysed the role of chronotype on nurses' ability to adjust to night shift work. They compared the effectiveness of typical sleep methods used by nurses on both working days and off days. They used single-locus and multi-locus techniques to analyse common polymorphisms of circadian/circadian-related genes in association with sleep/circadian phenotypes across diverse shift-work contexts in order to uncover gene-environment interactions. According to the findings of their study, night-shift nurses reported significantly lower adaptation to their work schedule than day-shift nurses, and analysis of three categories of adaptability revealed that night-shift nurses reported being significantly less well-adjusted

to their work schedule than day-shift nurses. Caffeine use was substantially associated with age; caffeine consumption did not significantly rise in day-shift nurses over the median age of thirty-six but increased significantly in night-shift nurses over the median age of thirty-six. According to the researchers, there may be a genetic risk for anxiety and mood disorders among night-shift nurses working in stressful settings, according to the analysis of gene-environment relationships. Genetic influences on behavior in night-shift nurses may have been demonstrated by disruption of the circadian system, as evidenced by the significant multi-locus model predicting the number of minutes to get out of bed. Øyane et al. examined the effect of night work on anxiety, depression, insomnia, sleepiness, and fatigue among Norwegian nurses. They discovered that night-shift nurses are more likely than non-night-shift nurses to experience sleeplessness and chronic exhaustion. However, no significant associations were found between working night shifts and anxiety, depression, insomnia, sleepiness, and fatigue after multiple regression for nurses with at least 3 years of night work experience. According to Ferri et al., nurses working rotational night shifts have lower job satisfaction compared to day-shift nurses. This was associated with physical and psychological symptoms related to stress, chronic fatigue, and poor sleep quality, which were more prevalent among night nurses compared to day-shift nurses. According to Jensen et al., intensive care nurses working night shifts experienced significantly greater symptoms of mood swings and headaches than those working evening hours. In order to uncover individual factors associated with cognitive functioning during the night shift among hospital

nurses working on irregular rotating-shift patterns, Zion & Shochat, conducted a study on the impact of night-shift work on cognitive functioning among nurses working night shifts. They discovered that cognitive performance among hospital nurses drops throughout the middle of the night shift and rises towards the end of the shift; lower functioning is linked to increased subjective sleepiness, older age, and longer time awake. According to the findings of a study by Dai et al., 353 nurses (40.8 percent) among 865 day and night shift nurses had depressive symptoms. Nurses working night shifts were younger, had higher Pittsburgh Sleep Quality Index and Hospital Anxiety and Depressive Disorders Rating Scale scores, and worked longer hours than nurses working day shifts only. A positive correlation was also found between the Pittsburgh Sleep Quality Index and the Hospital Anxiety and Depressive Disorders Rating Scale, indicating that a greater incidence of depressive symptoms among nurses working night shifts may be linked to lower sleep quality caused by the night shift. According to Feng et al., night-shift nurses, had poorer sleep quality and more health issues compared to day-shift nurses. Compared to day-shift nurses, night shift nurses have a higher rate of poor subjective sleep quality, sleep latency, sleep efficiency, sleep disruption, and daytime dysfunction. Night-shift nurses may be more vulnerable to sleep disorders, difficulties falling asleep, taking a long time falling asleep, tiredness, and insomnia during the day, than day-shift nurses. The physical health of night shift nurses was worse than day shift nurses, but there was no difference in psychiatric issues between the two groups.

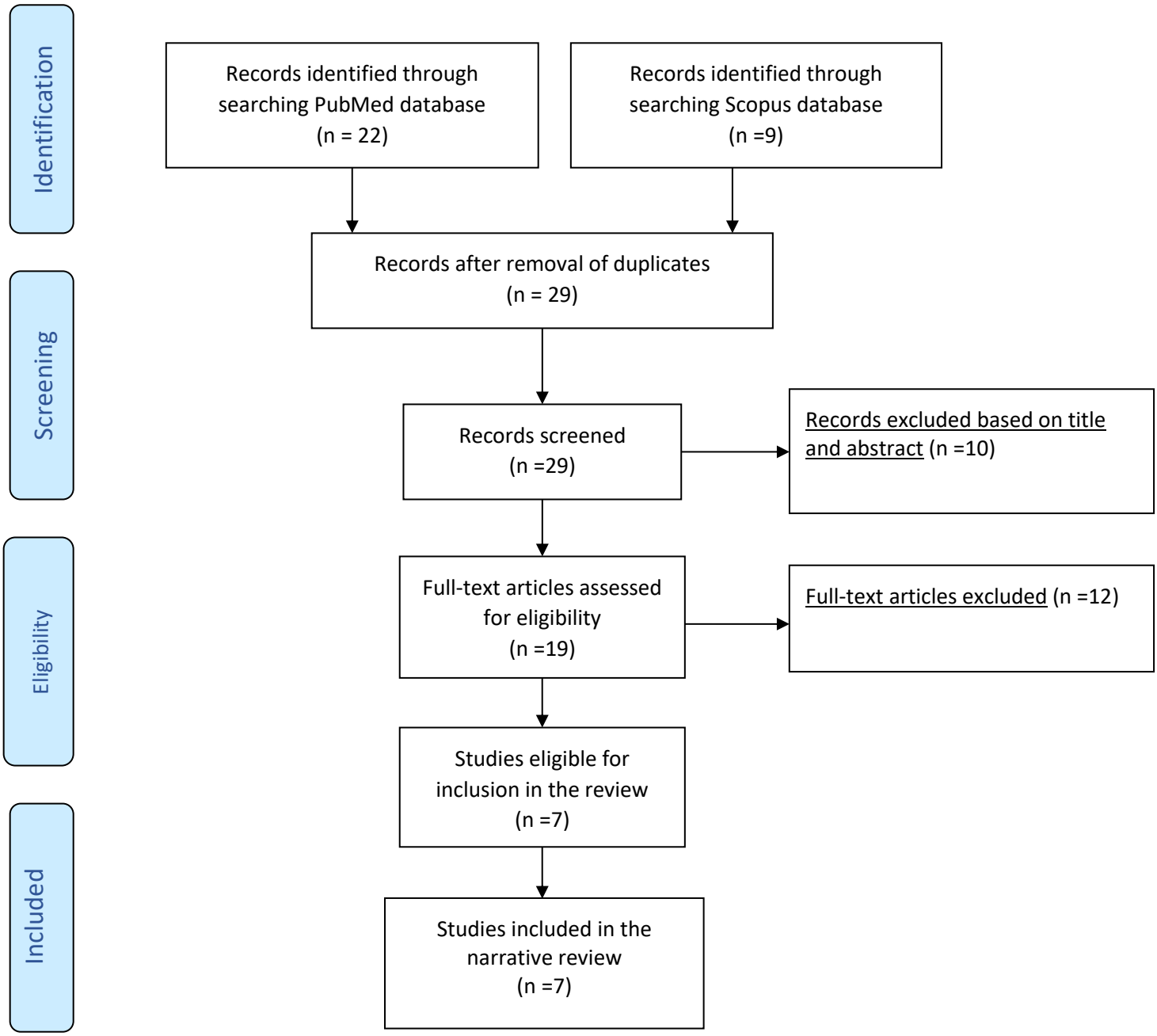


Figure 2. Preferred Reporting Items for Systematic Reviews and Meta Analyses flow diagram

Table 4. Summary of the included studies

Authors	*Country*	*Study Design*	*Year*	*Sample size*	*Objectives*	*Outcomes*	*Quality assessment Score*
Gamble *et al.,* 2011	United States of America	Experimental study	2011	388	The purpose of this study was to investigate frequent polymorphisms of circadian or circadian-related genes in day and night shift nurses, utilizing single locus and multi-locus analyses in relation to sleep/circadian phenotypes in various shift-work environments.	During night shift work, the circadian sleep/wake cycle, hormones, and physiological processes are often misaligned with behavioral patterns, increasing the risk of developing mental disorders such as depression and anxiety. Environmental stress, and the rhythm of physiological processes and metabolic activities, can have behavioral and health implications for nurses working the night shift. Sleep timing, chronotype, and circadian clock gene variation, may play important roles in shift work adaptation. Nurses on the night shift who used sleep deprivation to transition to and from diurnal sleep during the day were the least acclimated to their work schedule. The efficacy of adaptation was similarly influenced by chronotype. Polymorphisms in the genes CLOCK, NPAS2, PER2, and PER3 were also linked to outcomes including alcohol/caffeine use and sleepiness.	10
Øyane *et al.,* 2013	Norway	Cross-sectional study	2013	2059	The purpose of this study was to examine the relationship between night work and anxiety, depression, insomnia, sleepiness, and fatigue among Norwegian nurses.	Nurses who worked at night recently or previously reported more insomnia than nurses who had never worked at night, and current night work was also linked to chronic fatigue. Night work was not linked to anxiety, or depression.	10

Ferri *et al.,* 2016	Italy	Cross-sectional study	2016	213	The aim of this study was to examine whether night shift work, as compared to day shift work, is associated with risk factors that lead to poorer health and lower job satisfaction among nurses.	In comparison to day shift work, night shift work was associated with lower job satisfaction, and quality and quantity of sleep, as well as more frequent chronic fatigue, psychological, and cardiovascular symptoms.	10
Jensen *et al.,* 2018	Denmark	Cross-sectional study	2018	114	The purpose of this study was to examine how shift work affects the lives of intensive care nurses.	Working shifts resulted in social isolation for about 25% of both the evening and night shift groups. When compared to evening-shift workers, night-shift workers showed a larger percentage of physical and mental complaints, with mood swings and headaches being the most common.	10
Zion & Shochat 2018	Israel	Cross-sectional study	2018	92	To determine individual factors that are associated with cognitive performance during the night shift.	Increased subjective sleepiness, older age, and prolonged time awake were associated with decreased cognitive performance among hospital nurses during the middle of the night shift and increases at the end of the shift; decreased functioning is associated with increased subjective sleepiness, older age, and prolonged time awake.	9
Dai *et al.,* 2019	China	Cross-sectional study	2019	865	To compare sleep quality and depressive symptoms among nurses who work night shifts to those who solely work day shifts, and to examine the relationship between sleep quality and depressive symptoms among nurses.	Night shift and poor sleep quality were found to be independent risk factors for depressive symptoms among nurses. The poor sleep quality caused by working night shifts may be associated with higher rates of depression among Chinese nurses working night shifts.	10

Feng *et al.,* 2021	China	Cross-sectional study	2021	3206	The aim of this study was to examine the sleep quality of Chinese nurses and whether there was a connection between night shift, sleep quality and health.	Night shifts were associated with poor sleep quality and health problems among nurses.	9

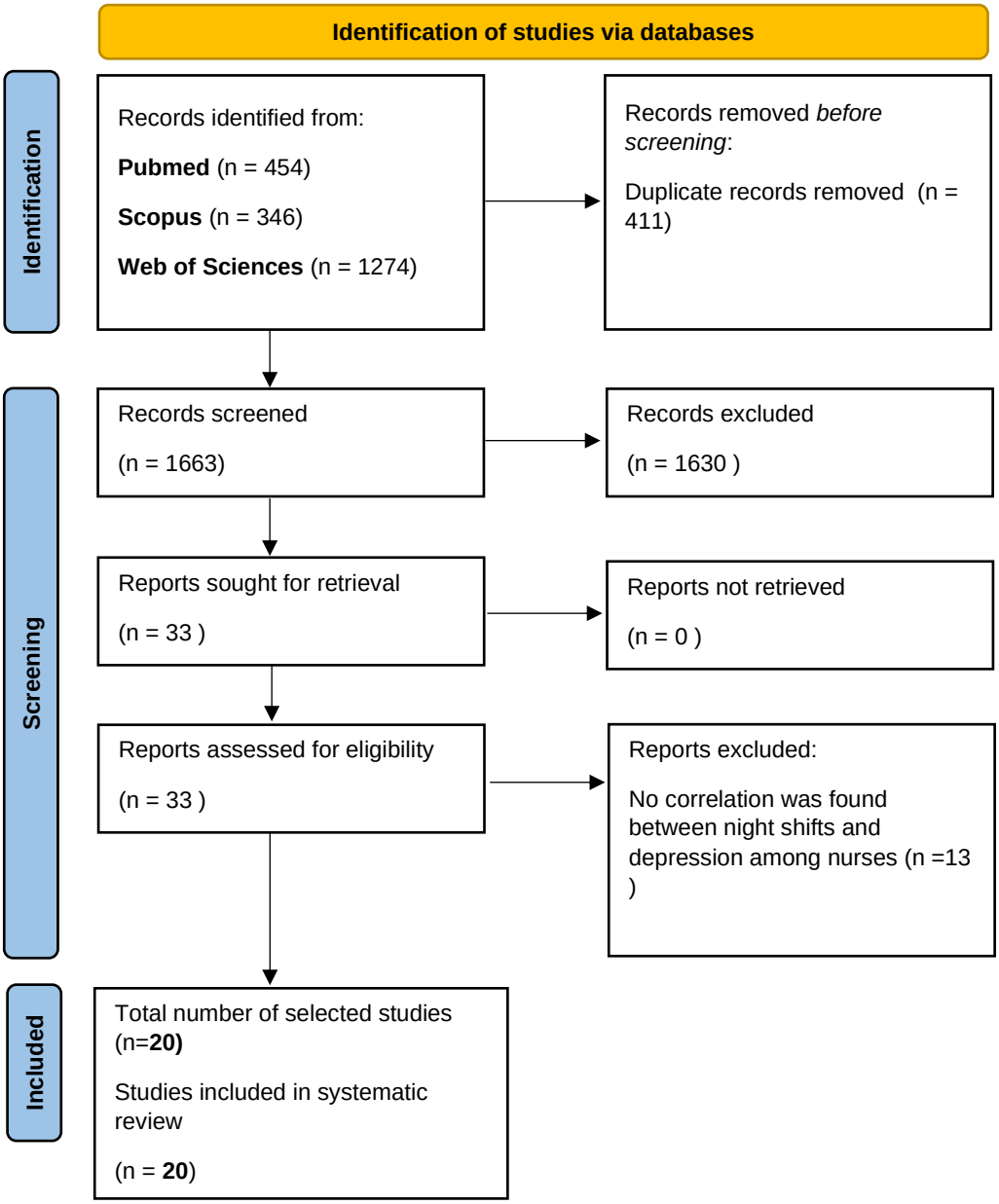
4.3 The relationship between working night shifts and depression among nurses: a systematic review and meta-analysis

4.3.1 Study identification and selection

A total of 2074 studies were identified through a preliminary database search, and 411 duplicates were excluded from Zotero. By browsing the titles and abstracts, 1663 studies were available and entered full-text screening. After reading these documents carefully, 1630 studies were excluded (1020 had data that was not extractable, 328 were reviews or conference abstracts, 49 were editorial letters, 182 were qualitative research studies, and 51 full texts could not be obtained).

Finally, a total of 20 eligible studies were included in the systematic review and 8 studies in this meta-analysis. Figure 3 shows the detailed research identification and selection process.

Figure 3. PRISMA flow diagram of selected studies



4.3.2 Study characteristics

The 20 studies included were published between 1990 and 2022, covering a total of 37,983 participants. There were 18 cross-sectional studies and 2 cohort studies. The sample sizes in each study varied from 39 to 11,450, and most participants were registered nurses working various shifts. The majority of the studies (n = 9) used the Hospital Anxiety and Depression Scale to assess depression among the nurses. This is a self-assessment scale that has been developed and found to be a reliable instrument for detecting states of depression and anxiety. The characteristics of the included studies are shown in Table 5. Table 6 shows the differences in the characteristics of the 20 studies with respect to population, sex and age distribution, exposure and comparator variables, outcome measures, and study design. Except for one study, which sampled firefighters and government workers, all studies recruited nurses. Five studies recruited only female nurses. The mean age of the study population ranged from 25.3 to 50 years. However, three studies did not state the age of their study population. All studies assessed depression as the outcome variable using different tools. Although seven studies had a similar definition of night shift as the exposure of interest, the other studies had varied definitions of shift work, with some incorporating the intensity and frequency of the shifts over time. The comparison group was also defined differently; nine studies used day shift workers, while one used the general population. Table 7 summarizes the statistical output of the studies, including the effect measures, variations in effects, strength of association, and heterogeneity. Eight studies measured the association between night shift work and depression using the odds

ratio; five used the mean difference, and four used the regression coefficient. Eleven studies performed further statistical analysis to adjust for confounding variables; this included five of the eight studies that used the odds ratio as an effect measure. Also, 11 studies reported a statistically significant association between night shift work and the development of depression.

Table 5. Characteristics of included studies

N.	First Author	Year	Country	Study design	Sample size	Assessment tool for depression	Aim of the study	Main outcomes
1	James	1990	United States	Cross-sectional study	463	Hospital anxiety and depression scale	To determine the relationships between physical health and depression among nurses working shifts.	There was no significant correlation between shift work and signs of depression among nurses.
2	Ruggiero	2003	United States	Cross-sectional study	142	Beck Depression Inventory-II	To evaluate shift-related variations in chronic fatigue and the influences of sleep quality, anxiety, and depression among female nurses	Depression and poorer sleep quality were more prevalent in nurses that work night shifts than day shifts.
3	Bjorvantn	2012	Norway	Cross-sectional study	267	Hospital anxiety and depression scale	To investigate sleep, sleepiness, fatigue, subjective health complaints (musculoskeletal, gastrointestinal), anxiety and depression in a sample of Intensive-care unit nurses.	21.5% and 14.8% of the intensive care nurses scored above the cut-off values for anxiety and depression, respectively.
4	Øyane	2013	Norway	Cross-sectional study	2059	Hospital, Anxiety, and Depression Scale	To determine the relationship between working the night shift with sleep problems and psychological wellbeing.	There was a significant positive correlation between insomnia and depression among night shift nurses.
5	Thun	2014	Norway	Cross-sectional study	633	Hospital anxiety and depression scale	To compare the developmental trajectories of anxiety and depressive symptoms among nurses working night shifts (night only, or a three-shift schedule) with	Compared to day workers, nurses who switched from night to day shifts had a significant decline in anxiety and depressive

							those of nurses working shifts that do not include nights (day only, or a two-shift schedule).	symptoms over time.
6	Gong	2014	China	Cross-sectional study	3474	Chinese version of the 20-item Zung Self-Rating Depression Scale	To investigate the association between working conditions and depressive symptoms among nurses using a cross-sectional study.	1320 nurses reported having depressive symptoms, making the prevalence of depressive symptoms around 38% overall. A total of 20.82% of the nurses worked two or more night shifts each week.
7	Berthelsen	2015	Norway	Cohort study	2059	Hospital, Anxiety, and Depression Scale	To investigate factors that may lead to shift work disorder in Norwegian nurses	A reduction in the number of night shifts or cessation of working night shifts was associated with a decrease in depression and shift work disorder.
8	Togo	2017	Japan	Cross-sectional study	2669	The Center for Epidemiologic Studies Depression Scale	To determine the relationships between depressive symptoms, morningness-eveningness, sleep duration and rotating shift work among nurses	Depression was more prevalent in rotating shift nurses compared to nurses who work only day shifts.
9	Hall	2018	Canada	Cross-sectional study	11450	Composite International Diagnostic Interview Short Form, Major Depression section	To investigate the relationships between work rota and depression among Canadian nurses.	There was a strong relationship between work rota and depression, which is very apparent among rotating and regular night shift nurses.
10	Booker	2018	Australia	Cross-sectional study	202	Patient Health Questionnaire	To assess the relationship between shift	Nurses who are at serious risk of shift

							work disorder risk, depression and anxiety using validated tools.	work disorder had higher depression.
11	Tahghighi	2019	Australia	Cross-sectional Study	1,369	Depression, Anxiety and Stress Scale-21 Items	To compare nurses who work shifts with nurses who work regular hours in order to comprehend the effects of shift work on psychological health and resilience.	There was relatively high levels of depression among both shift and non-shift nurses, but there was no significant difference between the two groups.
12	Khade	2019	India	Cross-sectional study	190	Hospital, Anxiety, and Depression Scale	To determine the relationship between working the night shift with sleep problems and psychological wellbeing.	There was a significant positive correlation between insomnia and depression among night shift nurses.
13	Mbanga	2019	Cameroon	Cross-sectional study	143	9-item Patient Health Questionnaire	To determine the prevalence and predictors of depression among nurses in Cameroon.	Nurses who are working night shifts reported more depression and poorer sleep quality than day nurses.
14	Bukhari	2019	Pakistan	Cross-sectional study	250	Agha Khan University Anxiety and Depression Scale	To determine the factors that were associated with depression among Pakistani nurses.	The prevalence of depression in nurses working rotating shifts was significantly higher.
15	Dai	2019	China	Cross-sectional study	865	Hospital Anxiety and Depression Scale	To compare sleep quality as well as depressive symptoms in nurses working night shifts to those working day shifts only.	Among the 865 nurses, 353 (40.8%) were considered to have depressive symptoms. The logistic regression analysis demonstrated that night work was independently associated with the presence of

								depressive symptoms.
16	Bilge	2020	Turkey	Cross-sectional study	163	Beck Depression Inventory	To determine the effect of nurses' way of working on depression indications and their sexual lives.	Nurses who worked night shifts had higher rates of depression and higher rates of sexual dysfunction.
17	Choi	2020	South Korea	Cross-sectional study	77	Hospital Anxiety and Depression Scale	To examine the progression of depressed and anxiety symptoms in nurses working night shifts (night only, or a three-shift schedule) with nurses working shifts without nights	Depressive mood and anxiety symptoms were significantly worse in nurses working 3 shift-schedule.
18	Park	2020	South Korea	Cross-sectional study	39	Hospital Anxiety and Depression Scale	To propose the mediating role of grey matter structure in the relationship between sleep disturbance and depressive symptom.	All day-working nurses reported depressive symptom within the normal range, whereas 39% of the shift-working nurses reported mild depression beyond the normal range.
19	Vitale	2022	Italy	Cohort study	408	Depression, Anxiety and Stress Scale-21 Items	To evaluate variations in body mass index features, shift, work history, and nurses' levels of stress, anxiety, and depression.	There was no significant difference in the rate of depression between night shift nurses and their day shift colleagues.
20	Yuxin li	2022	China	Cross-sectional study	11061	9-item Patient Health Questionnaire	To evaluate and describe the mental health status of Chinese nurses, including symptoms of depression and anxiety, while focusing on the effects of shift work-related characteristics.	Shift work correlated with higher levels of depression among all nurses.

Table 6. Clinical Heterogeneity of included studies

No	Author	Year	Population	Sex	Exposures	Comparator	Outcomes	Study Design	Mean Age (years)
1	James	1990	Nurses	B	Night shift	Other shifts	depression	cross-sectional	35
2	Ruggiero	2003	Nurses	F	Night shift	Day shift	depression	cross-sectional	44.9
3	Bjorvantn	2012	Nurses	B	Shift work	General population	depression	cross-sectional	39.4 (9.1)
4	Øyane	2013	Nurses	B	Current Night shift	No Night shift	depression	cross-sectional	33.1 (8.2)
5	Thun	2014	Nurses	F	Night shifts	Day shift	depression	cross-sectional study	33.1 (8.2)
6	Gong	2014	Nurses	B	Night shift(>=2/week)	Night shift (<2/week)	depression	cross-sectional	31.93 (7.55)
7	Berthelsen	2015	Nurses	B	Night shift (current/previous)	No Night shift	depression	cohort study	30-39
8	Togo	2017	Nurses	B	Rotating shift	Day shift	depression	cross-sectional	Day worker = 41.5 (9.7), Rotating shift = 40.2 (10.4)
9	Hall	2018	Nurses	B	High-precision work schedule (regular days)	High-precision work schedule (Rapid frequency rotating shifts)	depression	cross-sectional	45-54
10	Booker	2018	Nurses	B	High-risk SWD	Low-risk SWD	depression	cross-sectional	35.28 (12.02)
11	Tahghighi	2019	Nurses	B	Shift work	non-Shift work	depression	cross-sectional	Shift work = 46.8 (11.50), non-Shift work = 50.0 (9.99)
12	Khade	2019	Nurses	B	Number of Night Shift in last 1 month	None	depression	cross-sectional	25.3 (5.4)
13	Mbanga	2019	Nurses	B	Number of Night Shift in last 1 week	None	depression	cross-sectional	29.8 (6.55)
14	Bukhari	2019	Nurses	F	Rotating shift	Not stated	depression	cross-sectional	Not stated

15	Dai	2019	Nurses	B	Night shift	Day shift	depression	cross-sectional	Not stated
16	Bilge	2020	Nurses	F	Night shift	Day shift	depression	cross-sectional	36.0 (6.37)
17	Choi	2020	Nurses, Firefighters, Day workers	B	Nurses working 3 shifts schedule	Other Day workers	depression	cross-sectional	Nurses-28.7 (5.13), Firefighter-42.8 (9.38), Day workers-40.1 (8.30)
18	Park	2020	Nurses	F	Shift work	Day shift	depression	cross-sectional	Shift work-28.1 (3.2), Day shift-30.8 (4.6)
19	Vitale	2022	Nurses	B	Night shift	Day shift	depression	cross-sectional	Not stated
20	Yuxin li	2022	Nurses	B	Shift work	No shift work	depression	cross-sectional	33.24 (7.31)

B:both male and female,, F:female only

Table 7. Methodological Heterogeneity of included studies

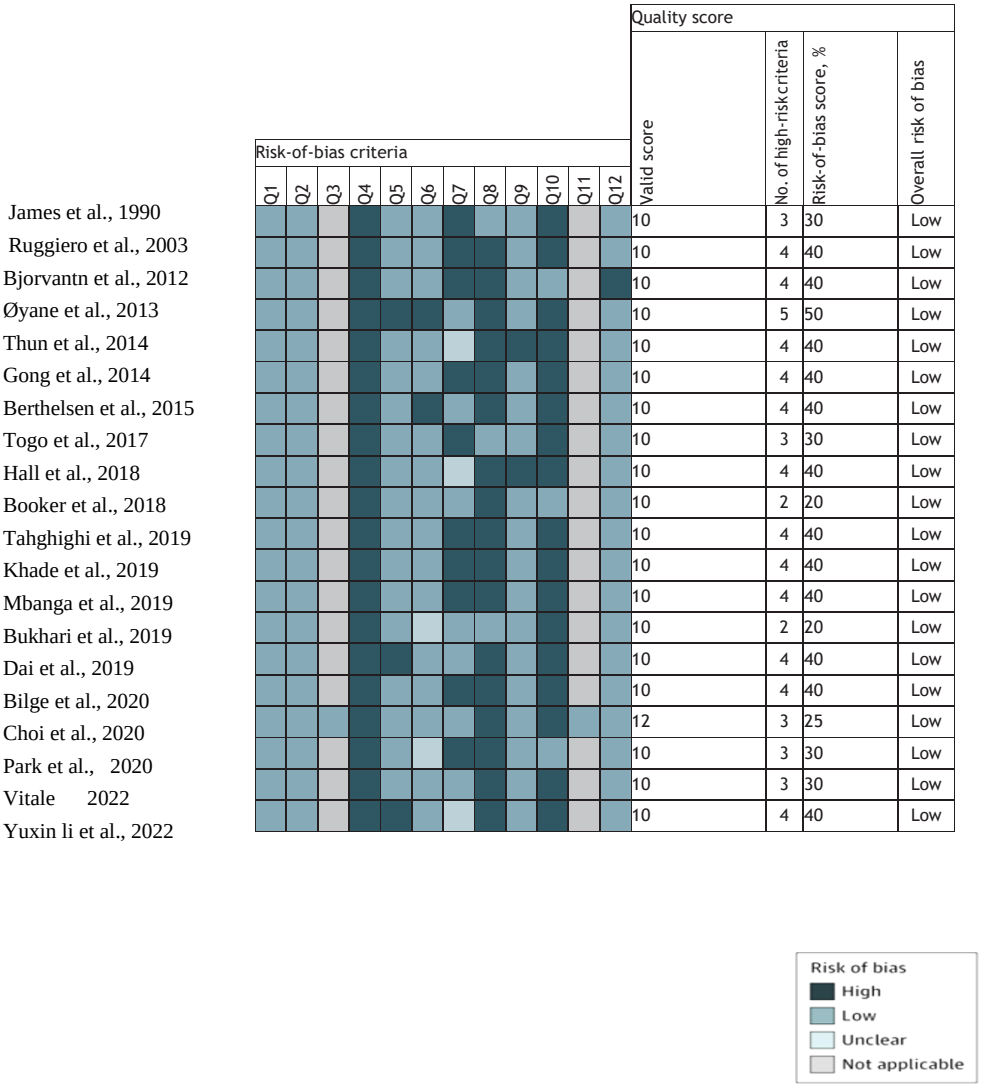
No	Author	Year	Effect Measure	Study group	Comparator Group	OR (95% CI)/B/r/π/p-value	Statistical Adjustment	Direction of effect
1	James	1990	Regression coefficient	NA	NA	B=0.09	not done	negative
2	Ruggiero	2003	Mean difference	10.35 (7.89)	7.18 (6.65)	p<0.01	not done	positive
3	Bjorvantn	2012	Mean difference	5.0 (2.3)	3.5 (3.1)	p<0.001	not done	positive
4	Øyane	2013	Odds ratio	Not stated	Not stated	1.35 (0.75 - 2.42)	done	negative
5	Thun	2014	Regression coefficient	NA	NA	B=-0.05	done	negative
6	Gong	2014	Regression Coefficient	NA	NA	B=1.53	done	positive
7	Berthelsen	2015	Odds ratio	Not stated	Not stated	1.20 (0.71 - 2.03)	not done	negative
8	Togo	2017	Cohen's d /Odds ratio	550/1006	351/762	Cohens'd=0.084	not done	positive
9	Hall	2018	Odds ratio	Not stated	Not stated	1.51 (0.91 - 2.51)	done	negative
10	Booker	2018	Mean difference/R-squared	7.54 (4.28)	3.78 (3.24)	R2 = 0.184	done	positive
11	Tahghighi	2019	Mean difference	Not stated	Not stated	p = 0.514	done	negative
12	Khade	2019	Correlation coefficient	Not stated	Not stated	not stated	not done	negative
13	Mbanga	2019	Odds ratio	Not stated	Not stated	1.58 (1.01 - 2.48)	done	positive
14	Bukhari	2019	Proportional difference	Not stated	Not stated	p=0.012	not done	positive
15	Dai	2019	Odds ratio	Not stated	Not stated	1.83 (1.23 - 2.72)	done	positive
16	Bilge	2020	Mean difference	Not stated	Not stated	p<0.001	done	positive
17	Choi	2020	Mean difference/Odds ratio	7.64 (3.35), 41/36	6.30 (3.64), 41/98	p=0.014	not done	positive
18	Park	2020	Mean difference	43.1 (6.4)	35.3 (4.9)	p=0.0003	not done	positive
19	Vitale	2022	Regression coefficient	NA	NA	B=-0.019	done	negative
20	Yuxin li	2022	Odds ratio	2305/3773	1515/1588	1.54 (1.4 - 1.69)	done	positive

OR (95% CI): odds ratio (95% confidence interval), B: regression coefficient, r: correlation coefficient, π: prevalence/proportion, NA: not applicable

4.3.2 Evaluation of risk of bias and quality assessment

The risk of bias in included studies was evaluated using the 13-item version of the Research Triangle Institute Item Bank tool. The risk-of-bias assessment was performed by two authors (C.O. and G.O.) independently, with discrepancies being resolved by discussion and, if needed, by a third author (DS). Items were scored as having a high, low, unclear, or not applicable risk of bias. Each study received an overall risk of bias score based on the ratio of high and valid items (excluding not applicable items) and an arbitrary cutoff of 50%. The quality of the included articles was assessed using the NOS. Green highlighted articles have 9 stars or more, indicating high quality; yellow highlighted articles have 7 or 8 stars, indicating moderate quality; and red highlighted articles have 6 stars or fewer, indicating low quality. Six of the cross-sectional studies in our review are of high quality, 11 are of moderate quality, and one is of low quality. On the cohort studies One study has high quality and the other has low quality. The outcomes for risk of bias assessment and quality assessment in the overall study and for each study are shown in Figure 4 and Table 8, respectively.

Figure 4 shows the included studies' risk of bias as determined by the Research Triangle Institute Item Bank.



A high risk of bias is indicated by scores of 50 or above.

Table 8. Newcastle-Ottawa quality assessment scale for the cross-sectional and cohort studies included in the systematic review and meta-analysis

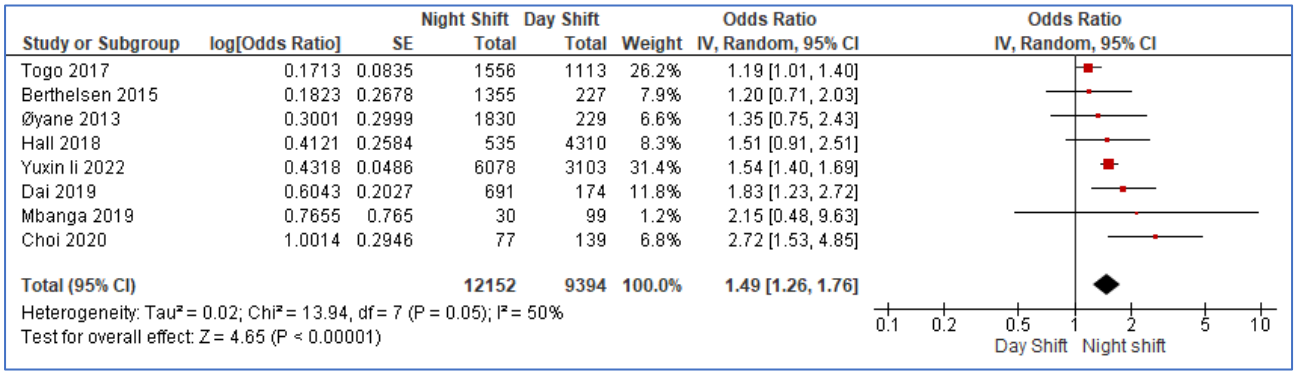
Author (Year)	Selection	Comparability	Exposure/Outcome
Cross-sectional studies (*n* = 18)			
James (1990)	*****	*	***
Bjorvantn (2012)	****	**	***
Øyane (2013)	*****	**	***
Hall (2018)	*****	*	***
Booker (2018)	*****	*	***
Park (2020)	*****	*	***
Ruggiero (2003)	*****	*	**
Gong (2014)	*****	*	**
Thun (2014)	*****	*	**
Togo (2017)	*****	*	**
Dai (2019)	*****	*	**
Khade (2019)	*****	*	**
Mbanga (2019)	*****	*	**
Tahghighi (2019)	*****	*	**
Bilge (2020)	*****	*	**
Choi (2020)	*****	*	**
Yuxin li (2022)	*****	*	**
Bukhari (2019)	**	*	**
Cohort studies (*n* = 2)			
Berthelsen (2015)	*****	**	***
Vitale (2022)	*****	*	**

Green highlight = 9 stars or more. Yellow highlight = 7 or 8 stars. Red highlight = 6 stars or fewer.

4.3.2 Meta-analysis and outcome

Figure 5 shows the Forest plot of the individual and summary estimates of eight studies included in the meta-analysis. These 8 studies were included in the meta-analysis due to their common use of the odds ratio (OR) as an effect measure. The random effect model was used to test for heterogeneity among the 8 studies. Overall, the model was statistically significant ($p<0.00001$). A 50% heterogeneity was estimated using the I^2 at $p=0.05$. This indicates low heterogeneity among the 8 studies. The individual studies' effects range from an odds ratio of 1.19 (1.01, 1.40) to 2.72 (1.53, 4.85). All individual effect estimates were to the right of the line of no effect (OR = 1). However, the confidence interval of 5 studies cuts across the line of no effect. The 7th study had the widest confidence interval and was thus the least precise, while the 5th study had the smallest confidence interval, making it the most precise. The 5th study also contributed the most weight (31.4%) to the summary estimate, while the 7th contributed the least (1.2%). The inverse variance method was used for weighting the studies. We discovered that nurses who work night shifts have a significant risk of depression after combining the ORs reported in the eight studies, yielding an overall estimate of 1.49 (1.26, 1.76).

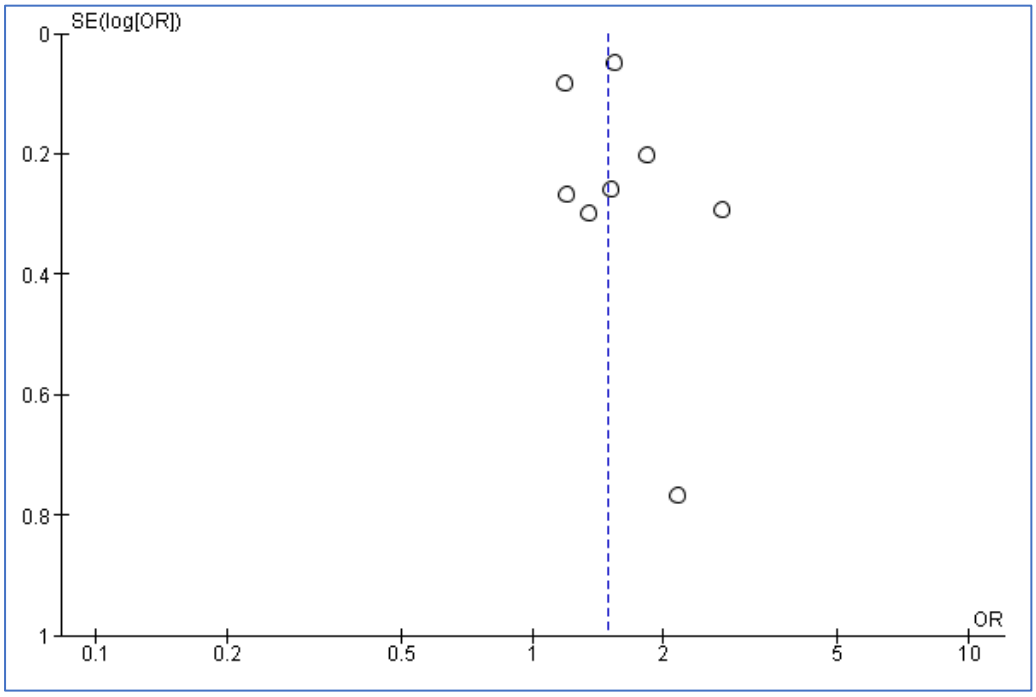
Figure 5. Forest plot of the summary of odds ratio of comparable studies



4.3.4 Publication bias

Given the studies that were included in the meta-analysis, Figure 6 is a funnel plot to investigate publication bias. No signs of publication bias may be seen in the way the included studies were symmetrically dispersed on each side of the overall effect line.

Figure 6: Funnel plot to explore publication bias



4.3.5 GRADE assessment of all included studies

The overall quality of the evidence of all included studies in this review, as shown in Table 9, was graded as moderate for the association between sleep disturbance and depression among nurses working night shifts. Moreover, there is less heterogeneity among selected studies, and no publication bias was discovered.

Table 9. GRADE assessment of evidence quality

Criteria	No of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Other considerations	No of subjects	Relative (95% CI)	Overall quality of evidence	Importance
Nurses, shift work and depression	20	Cross-sectional studies and Cohort studies	Low	Significant	Not significant	Not significant	Not significant	None	37983	-	⨁⨁⨁⨀ Moderate	Critical

4.4 Effectiveness of bright light exposure, modafinil and armodafinil for improving alertness during working time among nurses on the night shift: A systematic review

4.4.1 Search outcomes

A total of one hundred and ninety-six papers were initially identified from various database searches, out of which 101 were duplicates. After thorough screening of 95 papers based on the inclusion and exclusion criteria, 5 papers were finally selected for the systematic review. The PRISMA flowchart for the selection is shown in Figure 7.

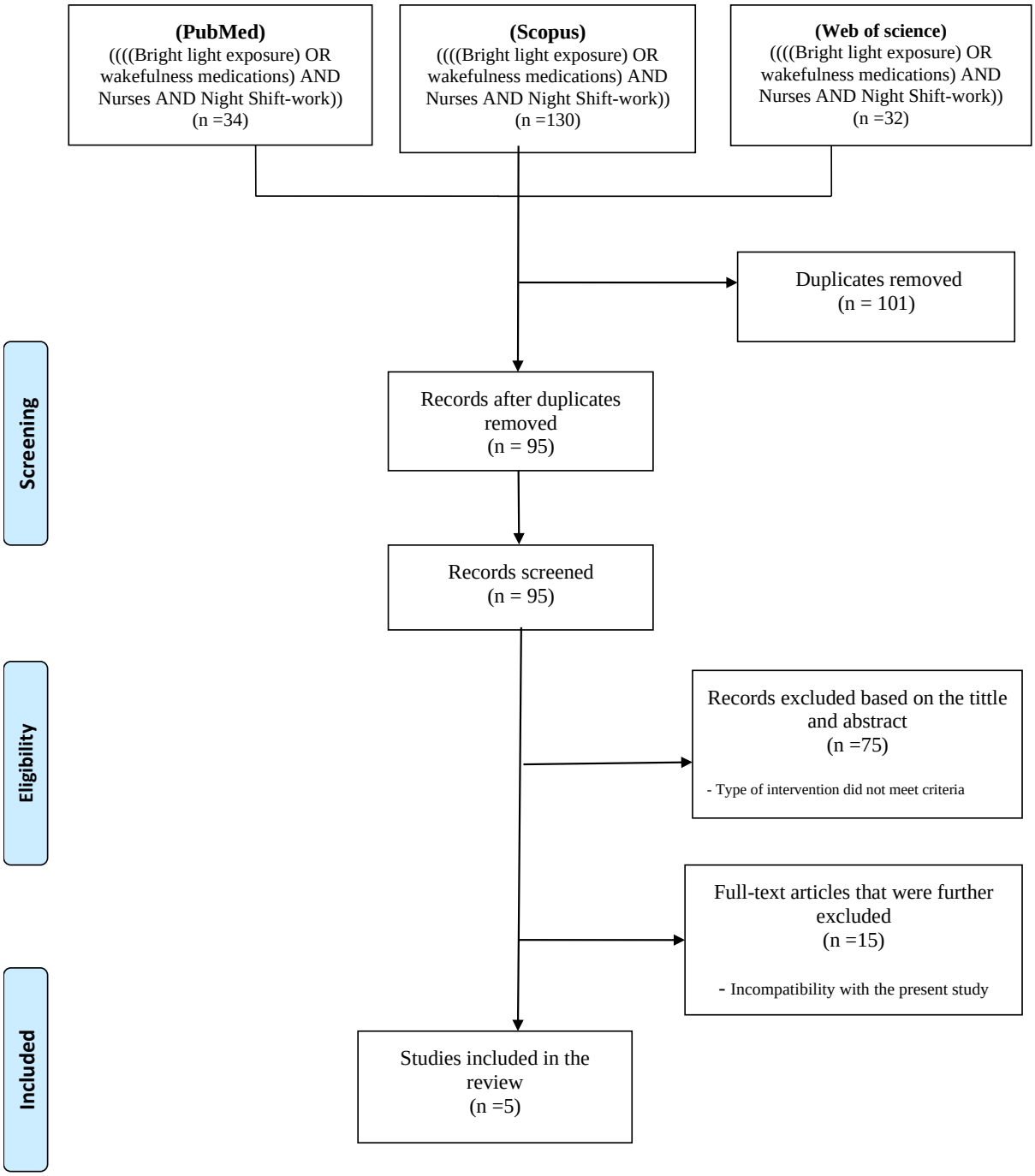


Figure 7. PRISMA flowchart for study selection

4.4.2 Quality appraisal

The quality of the studies was assessed using the study design-specific tool developed by the National Heart, Lung, and Blood Institute and Research Triangle Institute International (NIH National Heart, Lung and Blood Institute, 2021). We gave point values (e.g., No = 0, Yes = 1, Good = 2, Fair = 1, Poor = 0) to each assessment of quality and summed them for the final quality score, so that the higher the total score, the better the quality of study (Table 10). Two authors (CEO & CEO) reviewed the selected papers independently and unanimously approved the five papers for the review. Due to the heterogeneity of the papers which differed in their methods and interventions regarding this topic, we decided to conduct a systematic review to assess the efficacy of bright light exposure, modafinil and armodafinil for improving wakefulness and sleep quality among nurses working night shifts.

Table 10. Quality Scores of studies on workplace interventions for improving wakefulness and sleep quality among nurses working night shifts

Author (Year)	Quality Score
Griepentrog *et al.* (2018)	10
Huang *et al.* (2013)	9
Kakooei *et al.* (2010)	9
Czeisler *et al.* (2009)	10
Czeisler *et al.* (2005)	10

Note. Study design-specific tool developed by the National Heart, Lung, and Blood Institute (NHLBI) and Research Triangle Institute International (NIH National Heart, Lung and Blood Institute, 2021).

4.4.3 Evaluation of study design

The searches generated a total of 34 records on the PubMed database, 130 on the Scopus database, and 32 on the Web of Science database. A total of 95 studies were identified after removal of duplicates. Nevertheless, the 95 articles were screened, 75 studies were excluded based on the review of titles and abstracts, and further 15 full-text articles were excluded because the studies did not meet the selection criteria. A total of 5 studies were selected based on the objective of this systematic review. See Figure 7 for the literature search and selection strategy. A total of 632 subjects from 5 studies were included. There were 3 studies that reported the efficacy of bright light exposure in improving alertness and reducing sleepiness among nurses working night shifts. Two studies reported the efficacy of modafinil and armodafinil in the management of excessive sleepiness during working hours among shift workers with shift work sleep disorder (see Table 11).

Table 11. Characteristics of included studies and summary of some evidence on the effectiveness of bright-light exposure and wakefulness-promoting medications in mitigating sleepiness

Author (Year) Country	Sample size	Aims	Study design	Interventions	Results	Comment
1. Griepentrog et al. United States of America	43	To determine whether prolonged exposure to bright light during a night shift reduces sleepiness and enhances psychomotor performance among nightshift intensive care unit nurses.	A single-center randomized, crossover clinical trial. Nurses working the night shift were exposed to a 10-h period of high illuminance (1500–2000 lx) white light compared to standard ambient fluorescent lighting of the hospital.	**Non-pharmacological intervention** (Bright light exposure).	When exposed to high illuminance lighting, the subjects experienced reduced sleepiness scores based on the Stanford sleepiness scale than when exposed to standard hospital lighting.	A bright lighting environment for intensive care unit nurses working the night shift reduces sleepiness.
2. Huang et al. Taiwan	92	To determine whether bright light exposure during the first half of the evening/night shift combined with light reduction in the morning is effective in reducing sleep problems among nurses.	Female hospital nurses on rotating shifts during the evening or night shift with an Insomnia Severity Index score > 14 were enrolled. Subjects in the treatment group were exposed to bright light at 7,000-10,000 lux for ≥ 30 minutes. Exposure was continued for at least 10 days during the 2-week experiment, and the subjects avoided daytime outdoor sun exposure after work by wearing dark sunglasses.	**Non-pharmacological intervention** (Bright light exposure).	Bright light therapy of 7,000-10,000 lux for at least 30 minutes at night for at least 10 days for 2 weeks significantly attenuated sleep problems in nurses working the evening or night shift.	Bright light exposure decreased anxiety and depression by mitigating insomnia among shift nurses. .
3. Kakooei et al. Iran	34	To evaluate the effects of bright light on the rhythms in body temperature, plasma melatonin, plasma cortisol	The subjects were assessed under 24 h during which their plasma cortisol and plasma melatonin levels were measured at 3 h intervals. The night shift nurses were exposed to bright light (4500 lux)	**Non-pharmacological intervention** (Bright light exposure).	Bright light exposure increases cortisol levels and body temperature and improves alertness	Bright light exposure is a promising strategy to improve alertness and reduce sleepiness

		and subjective alertness among nurses during night shift.	during two break times (21:15 to 22; 00 and 3:15 to 4:00) for four consecutive weeks.		among nurses on the night shift.	among nurses working night shifts.
4. Czeisler et al. United States of America	254	To assess the effect of armodafinil, 150 mg, on the physiologic tendency for sleep and cognitive performance during normal night shift hours among patients with excessive sleepiness associated with chronic shift work sleep disorder.	Patients received armodafinil, 150 mg, or placebo 30 to 60 minutes before each night shift for 12 weeks.	**Pharmacological intervention** (armodafinil).	Armodafinil significantly reduced sleepiness during the night shifts, improved memory performance and attention compared with placebo.	Armodafinil significantly improved wakefulness during scheduled night work. Armodafinil can be an effective treatment for excessive sleepiness associated with shift work sleep disorder among nurses working night shifts.
5. Czeisler et al. United States of America	209	To evaluate the efficacy of modafinil for the treatment of sleepiness among patients with shift work sleep disorder.	This is a double-blind randomized trial. Patients with shift-work sleep disorder received either 200 mg of modafinil or a placebo before the start of each shift.	**Pharmacological intervention** (modafinil).	Treatment with modafinil, as compared with placebo, resulted in a moderate improvement from baseline in mean nighttime sleep latency.	Treatment with 200 mg of modafinil moderately decreased excessive sleepiness among shift workers with shift work sleep disorder.

4.4.4 Bright light exposure's effectiveness in improving alertness and reducing sleepiness during working hours among nurses working the night shift

The efficacy of bright light exposure in resetting the circadian clock is dependent on the dose of the light stimulus applied (light intensity, wavelength spectrum, illumination, and duration), time, and individual circadian rhythms (Schotland, 2007). However, timed bright light exposure may not be sufficient to shift the melatonin rhythm completely into the sleep episode, but it can significantly phase-delay dim light melatonin onset. According to one study conducted by some Finnish researchers, eighty-seven healthy female nurses were actively exposed to brief periods of bright light (5000 lux) at planned intervals during each night shift during a two-week period (Leppämäki *et al.*, 2003). The participants completed self-assessment questionnaires each morning after a night shift, evaluating subjective symptoms and discomfort brought on by night work. The questionnaires were also completed 2 weeks before and after the bright light session. Summer (May-June) and winter (November-December) were the two stages of the research (Leppämäki *et al.*, 2003). A total of thirty-seven nurses participated in the study in both seasons. Bright light exposure, regardless of the age of the participant, significantly reduced the subjective distress associated with nightshift work in both summer and winter. Those who reported seasonal changes on a regular basis had a greater benefit. Moreover, Short pulses of timed bright-light exposure during the night duty may enhance nurses' adaptation to night shift work (Leppämäki *et al.*, 2003). One meta-analysis showed that medium-intensity light therapy for a shorter duration effectively reduced

sleepiness among shift workers on the night shift (Lam & Chung, 2021). On the other hand, the results of another meta-analysis showed that exposure of night shift nurses to bright light could decrease sleepiness and improve alertness during night shifts (Aemmi *et al.,* 2020). Timed bright light exposure significantly phase shifts the circadian system, improves sleep, and performance in a simulated night shift experiment (Dawson *et al.,* 1995). The outcomes of the above-mentioned studies seem to be in accordance with those of our selected studies regarding the efficacy of bright light exposure in improving alertness during working time among nurses on the night shift. Griepentrog *et al.*, found that nurses working the night shift may improve their night-time alertness and daytime sleep through exposure to a bright light environment in their workplace. Griepentrog and colleagues found that exposure to high illuminance lighting relative to standard hospital lighting significantly reduced subjective sleepiness among nurses working in the intensive care unit at the end of the night shift. These improvements may be increased by reducing exposure to morning light on the way home. Huang et al., on the other hand, conducted their study in a hospital; nurses in the treatment group were exposed to artificial bright light ranging from 7,000 to 10,000 lux for ≥30 minutes; evening shift exposure occurred between 19:30 and 20:30, and night shift exposure occurred between 23:00 and midnight. The participants were writing or reading during the exposure. An Apollo briteLITE 6 was used to produce illumination. Just above eye level, a light box was put at a 45-degree angle from the face. At roughly 70 cm between the light box and the nurses, a light intensity of 7,000-10,000 lux could be delivered. A Lutron Electronic

LX-1102 light meter was used to evaluate light intensity. At night, ward illumination was kept to a minimum. In the hospital, ward illumination was kept between 100 and 400 lux at night. The individuals were treated for ≥ 10 days over the course of two weeks, and daytime outdoor sun exposure after work and before bedtime was prevented by wearing dark sunglasses with ultraviolet protection, even on off days. The subjects in the control group were not exposed to artificial bright light, although they did wear sunglasses after work and before bed to avoid outdoor sun exposure. The outcome of the study by Huang and colleagues showed that exposure to bright light of 7,000-10,000 lux for at least 30 minutes at night combined with reduced exposure to light in the morning after the night shift was effective in improving sleep quality and mental health among nurses working the night shift. Furthermore, according to Kakooei et al., Nurses at a university teaching hospital were tested and exposed to bright light at an intensity of 4,500 lux or poor lighting at an intensity of 300 lux during two breaks (21:15–22:00 and 3:15–4:00). The nurses were observed for 24 hours while at work, and their plasma cortisol and melatonin levels were examined at 3-hour intervals, as well as their body temperature. The Karolinska sleepiness scale was used to assess subjective alertness. The amount of melatonin produced at night was significantly reduced after being exposed to bright light. Bright light raised cortisol levels and body temperature, as well as considerably improved alertness, according to a one-way ANOVA test, suggesting that bright light exposure at a modest intensity in a healthcare setting can have a major impact on circadian rhythm adjustment thus improving alertness among nurses.

According to the outcome of the investigation carried out by Kakooei and colleagues' exposure to bright light at an intensity of 4,500 lux twice during the night shift (21:15–22:00 and 3:15–4:00) significantly improved alertness and reduced sleepiness among nurses working the night shift. Moreover, accurately timed exposure to bright light can shift the sleep-wake cycle to earlier or later times to balance the misalignment between the circadian system and the anticipated sleep-wake schedule (Crowley *et al.*, 2003). Bright light therapy significantly improves individual ratings of alertness, as well as objective measures of arousal and performance (Gooley, 2008). Bright light therapy reduces sleepiness, improves reaction time, and may help reduce fatigue and decreases in job performance related to shiftwork (Gooley, 2008; Maruani, & Geoffroy, 2009). The side effects of the most prescribed dose and duration of bright light therapy (10,000 lux for 30 minutes) are eye strain and blurred vision, headaches, irritability, and nausea (Botanov & Ilardi, 2013). No study has reported any severe effects of bright light therapy.

4.4.5 Modafinil and armodafinil's efficacy in the management of excessive sleepiness during working hours in night shift workers with shift work sleep disorder

The United States food and drug administration (FDA) approved modafinil and armodafinil for the treatment of shift work sleep disorder, and they can be taken approximately one hour before the beginning of shift work (Pacheco, 2022). Modafinil increased alertness, vigilance, and executive function during simulated night shifts (Walsh *et al.*, 2004). Caution needs to be taken, however, as prolonged use could lead to physical dependence and tolerance, with

withdrawal symptoms observed on abrupt cessation of modafinil (Food and Drug Administration, 2005; Food and Drug Administration, 2007). Two different double-blind randomized controlled trials were done to study the efficacy of modafinil for the treatment of excessive sleepiness associated with shift work sleep disorder, and both studies showed a significant improvement in the quality of life, wellbeing, and the reduction of excessive sleepiness among patients with shift work sleep disorder (Czeisler *et al.,* 2005; Erman *et al.,* 2007). According to Czeisler *et al.,* 2005, treatment with modafinil resulted in a slight reduction in mean nighttime sleep latency from baseline when compared to placebo, and more patients had improvement in their clinical symptoms. Patients on modafinil showed fewer declines in attention during nocturnal testing of their performance on the Psychomotor Vigilance Test, and correspondingly fewer patients reported having had crashes or near-accidents while driving home (Czeisler *et al.,* 2005). However, residual sleepiness was observed, especially during the last one-third of the night shift work hours, which compelled the decision to develop better interventions (Czeisler *et al.,* 2005). Hence, some studies evaluated the efficacy of armodafinil, which is an R-isomer of modafinil, which led to its approval by the FDA. These randomized control trials showed that armodafinil also significantly improved the wakefulness, attention, long-term memory, and overall performance of people with shift work sleep disorder (Czeisler *et al.,* 2009; Drake *et al.,* 2004). According Czeisler *et al.,* 2009, armodafinil significantly improved mean sleep latency all through normal night shift hours in patients with excessive sleepiness associated

with chronic shift work disorder (≥3 months) of modest or more severity from 2.3 (1.6) minutes at baseline to 5.3 (5.0) minutes at final visit, compared with a change from 2.4 (1.6) minutes to 2.8 (2.9) minutes in the control group. When compared to the control, more patients taking armodafinil (79%) improved their clinical status (59%). Armodafinil significantly reduced sleepiness throughout the night shifts, and the trip home, according to patient health records. When compared to placebo, armodafinil increased performance on conventional memory and attention tests. As measured by polysomnography, armodafinil was well tolerated and had no effect on daytime sleep (Czeisler *et al.*, 2009). Remarkably, several nurses who are experiencing excessive sleepiness during the night shift request prescriptions for armodafinil to improve vigilance (O'Malley *et al.*, 2009). Further studies showed that Armodafinil 150 mg administered at the onset of a night shift increased alertness and cognitive performance in shift workers with shift work sleep disorders, implying that armodafinil can bring nocturnal alertness levels to normal daytime levels in most night shift workers with excessive sleepiness (Howard *et al.*, 2014). On the other hand, a study which compared the effectiveness of armodafinil with modafinil in the treatment of excessive sleepiness in patients with shift work sleep disorder demonstrated that the efficacy, safety, and incidence of adverse effects of both medications were comparable (Tembe *et al.*, 2011). The common side effects related to armodafinil and modafinil are dizziness, headaches, nausea, and insomnia. However, armodafinil was shown to have higher plasma concentrations later in the day than modafinil, explaining the reason why armodafinil is

generally preferred for the reduction of excessive sleepiness in patients with shift work disorder compared to modafinil (Darwish *et al.*, 2012; Darwish *et al.*, 2009).

5. DISCUSSIONS

Two of the most considerable factors in the long-term effects of night shift work on nurses' mental health have been identified as disrupted circadian rhythm and inadequate sleep quality and quantity, particularly in the era of COVID-19 epidemic (Salehinejad *et al.,* 2022). Moreover, according to a recent study by Wu *et al.,* 2022, workplace stress may have a direct impact on shift nurses' ability to sleep as well as a secondary impact on the amplitude and stability of their circadian rhythm. Nurses working the night shift mostly treat excessive sleepiness, which is a diagnostic criterion for shift work sleep disorder, with a wakefulness-promoting medication based on a physician's prescription, but some nurses become dependent on sleep-promoting medications, which are primarily used to induce sleep (Cousin *et al.,* 2022). Often, people do not realize they have become dependent on sleep-promoting medication until they try to stop taking it (Richter *et al.,* 2021). Nurses may then experience withdrawal symptoms, a sign of both dependence and addiction (Piper, 2015). Substance use disorder or addiction can develop and then manifest in various behaviors, such as when an individual increases their dose without consulting a physician or exhibits consistent cravings and desires to use the drug of choice to mitigate sleepiness during night shift work and improve job performance or to improve sleep quality and duration after completing a night shift (Cousin *et al.,* 2022; Piper, 2015). There was a significant increase in anxiety and depression among nurses in British Columbia, Canada, in the COVID-19 era (Havaei *et al.,* 2021). Comparable results were observed among healthcare workers in Alberta, Canada

(Mrklas *et al.,* 2020). Canadian nurses often encounter heavy workloads, workplace violence, burnout, and mental fatigue (Stelnicki *et al.,* 2020), which may be impacted for nurses working the night shift due to fatigue and sleepiness associated with circadian misalignment and other reasons. The rates and frequencies of alcohol consumption remain unknown among registered nurses in Saskatchewan. Like many other professionals facing problematic substance use, nurses might have multiple reasons for using alcohol. They could be looking for a way to stay alert on an all-day or overnight shift or a way to escape the emotional pain from a day of challenging decision-making and upsetting outcomes (Monroe *et al.,* 2013; Kunyk, 2015) and responsibility.

According to the outcome of the pilot study, there was a strong positive association between sleep disturbance and depression among the nurses. This finding is similar to the work of Dai *et al.,* 2019, which showed significantly higher PSQI and HADS scores among nurses working night shifts, than those working day shifts alone, as well as a positive correlation between PSQI and HADS scores. We found a positive correlation between depression and occupational exhaustion as well as depersonalization. Anxiety was similarly correlated with occupational exhaustion and depersonalization. These results align with the findings of a recent study by Li *et al.,* 2022, which showed that a significant number of shift nurses had depression and anxiety, and these rates were influenced by fatigue during shifts as well as psychological stress, feeling tired after resting and using sleep medication at points before, during, and after night shifts. Consistent with our findings, sleep quality before and after

night shifts was associated with depression and anxiety. This connection is problematic since there is evidence that nurses may have diminished sleep quality as nurses with past and present night shift experience have higher levels of chronic fatigue than nurses with no night work experience (Øyane *et al.,* 2013). Regarding the outcome of the AUDIT-C score, over a third of the nurses working night shifts reported being at an elevated risk (36.4%) of alcohol use disorder, and this is similar to the findings of Pham & Park, 2019, which showed that female night workers had a higher risk of alcohol use disorders. Moreover, the results of a recent study conducted in 39 public hospitals in Paris, showed frequent daily alcohol use among midwives working night shifts during the first wave of the COVID-19 pandemic (Cousin *et al.,* 2022).

According to the outcome of the meta-analysis used to estimate the association between sleep deprivation and depression among nurses working night shifts, Nurses who worked night shifts had a significantly increased risk of developing depression. Shift work increased the total risk of negative mental health outcomes (such as depression and anxiety) by 28% among 28,431 workers, according to a study by Torquati *et al.,* 2019. As mentioned, humans by nature follow a sleep-wake cycle that involves sleeping during the night and waking during the day (Heo *et al.,* 2022), whereby insufficient sleep has been associated with cognitive problems, mood alterations, reduced job performance, reduced motivation, increased safety risks, and physiological changes (Rogers, 2008). Confirming this, it is interesting to see the finding reported in the studies by Thun *et al.,* 2014, and Berthelsen *et al.,* 2015, that nurses

who changed from night work to day work reported a significant decrease in symptoms of anxiety, depression, and other shift work disorders over time compared to day workers. From our review, it also emerges that depression is often accompanied by sleep disorders, particularly insomnia, as found in the studies of Øyane *et al.*,2013 and Khade *et al.,* 2019. This result is partially consistent with that of a previously reported study, which found that healthcare-seeking nurses were at higher risks for some subtypes of insomnia (Tsai *et al.,* 2017). In the study of Bilge *et al.,* 2020 it was pointed out that nurses who worked night shifts had higher rates of depression and higher rates of sexual dysfunction. A study by Huang *et al.,* 2018 found that nurses do not appear to seek medical attention for some types of disorders, particularly anxiety and depression, even though they may be more susceptible to stress-related psychiatric problems. The nurses' personal attitudes toward such disorders may be a contributing factor in the reasons why nurses are reluctant to seek care for psychological or behavioral health problems. The barriers appear to be more explicitly that getting help for mental health concerns can be stigmatizing in terms of what their friends and employers might think of them, which could have negative effects on their career advancement (Cares *et al.,* 2015; Hernandez *et al.,* 2016). Depression and anxiety were discovered in 58.82% and 62.08% of shift nurses, respectively, according to the findings of the study by Li *et al.,* 2021. These rates were influenced by fatigue during shift work, psychological stress before/during/after night shifts, feeling energetic after resting before/after night shifts, using sleep medication before/after night shifts, physical discomfort

during night shifts, being occupied during night shifts, and food intake during shift work. They suggested that minimizing shift nurses' workloads, preventing causes of stress during night shifts, and promoting rest and relaxation could help with depression and anxiety (Li *et al.*, 2022). Nursing managers should increase rest days after night shifts, increase night shift spacing, and decrease overtime in order to lower the prevalence of shift work sleep disorders among nurses (Li *et al.*, 2021). The findings from our study agree with those of previous meta-analyses conducted in different populations. Considering sociodemographic factors, the outcome of subgroup meta-analysis by gender, night shift work duration, type of occupation, and continent carried out by Lee *et al.*, 2017, showed that night shift work was consistently associated with an increased risk of depression. Moreover, a meta-analysis of five studies revealed a 42% increase in the risk of depression among persons working the night shift, as conducted by Angerer *et al.*, 2017, but the researchers believe that this evidence is not strong enough to sustain a general medical recommendation against night shift work for workers with depressive conditions and that it would seem appropriate to address this question on an individual basis, with strong support from physicians and close attention to the negative psychosocial factors associated with night shift work. According to one study in China, night shift work, shift frequency, and sleep disturbances were associated with an increased risk of depression among workers, and the association between night shift work and depression appeared to be partially mediated by sleep disturbances (Zhang *et al.*, 2022). According to the Heinz Nixdorf Recall Study, which investigated various demographic, lifestyle, and

occupational-correlated features to observe the relationship between shift work and depressive symptoms, women who work nights have higher relative risks of developing depressive symptoms, particularly when working night shifts for 20 years or more (Behrens *et al.*, 2021). Working night shifts consistently increased the likelihood of women developing depression symptoms, according to stratified analysis (Behrens *et al.*, 2021).

5.1 Strengths and limitations

Regarding the pilot study conducted in Canada, it is the first study to specifically examine lifestyle, mental health, and occupational factors among Saskatchewan registered nurses working night shifts during the COVID-19 pandemic. It is innovative and offers new insights into the relationship between work-related stress, sleep quality, anxiety, and depression among registered nurses working night shifts in Saskatchewan, Canada, during the COVID-19 era. This pilot study will make it possible to design and execute larger cohort and cross-sectional studies that focus on the health of registered nurses in Saskatchewan and beyond. It will also help with the design of programs for promoting health among nurses working night shifts. The major limitation of this study was the low sample size amid the nursing shortage in the province. Due to the lack of statistical power, certain outcomes may not have seemed significant when they might have been. Many respondents skipped over several survey items. Another limitation was the low number of males in the population. Only one male nurse responded to the survey, making our results not representative for male nurses.

Regarding the systematic review, it is the first review to principally examine the efficacy of bright light exposure and wakefulness-promoting medications for improvements in alertness during the night shift among nurses. We conducted a complete search and provided an international perspective on this crucial subject. The major limitations of this study were the lack of randomized controlled trials on the efficacy of modafinil and armodafinil in the management of excessive sleepiness among nurses on the night shift, and the efficacy of bright light exposure in improving alertness and vigilance among nurses on the night shift.

From the outcome of the systematic review and meta-analysis, circadian rhythm disruption and sleep deprivation should be considered as clinical risk factors for depression in nurses working night shifts. Circadian and sleep disruptions should be among the therapeutic targets in order to prevent and treat depression among nurses working night shifts and in the planning of occupational health interventions for nurses. One of the major limitations of our review was that it included studies that assessed night shift work effects based on working rotating shifts and casual night shifts and, therefore, could not demonstrate a strong reciprocity of associations between working night shifts and depression. Second, all the included studies were either cross-sectional or cohort studies, so the underlying pathophysiological mechanisms were difficult to ascertain. Second, there was a lack of uniform diagnostic criteria and diagnostic tools as the authors used diverse assessment tools

for depression, which might reduce the comparability between studies. Lastly, the pooled effect sizes of the studies selected for the meta-analysis are small.

5.2 Recommendations for nursing management

Nursing administrators are expected to play crucial roles in tackling significant rates of stress, anxiety, and depression among nurses working night shifts by setting workload priorities and implementing wellness programs in the workplace. Nurses can be urged to concentrate on the things they can control and make detailed to-do lists that will prioritize their workload rather than becoming overburdened. When it comes to reducing work-related stress and enhancing physical and mental health, physical activity and a healthy diet are essential. Wellness programs such as yoga and mindfulness classes, as well as psychological interventions, are examples of how nurses can feel more at ease and confident about their health. Enhancing sleep quality and mental wellbeing among night-shift nurses will improve their overall health, work efficiency, and performance. It is critical to develop new ideas to improve sleep patterns and quality among nurses working night shifts in order to persuade aspiring nurses to work night shifts. We classified known interventions into non-pharmacological/behavioral approaches, pharmacological approaches, and occupational/regulatory approaches (see Table 12). Mathematical and machine learning models may be used to design night-shift work timetables using light exposure and sleep-wake data of workers to create personalised shift work schedules to improve circadian alignment, which may in turn increase sleep, alertness, and job performance. Additional cutting-edge studies are required to develop novel strategies

to promote sleep and wakefulness and to retrain the circadian clock to adjust to different work schedules among nurses working night shifts.

Occupational health promotion strategies and policies may reduce the risk of mental health disorders among night-shift nurses, irrespective of whether they are permanent or rotating night-shift workers. Behavioral signs associated with circadian rhythm disruption could be tracked among nurses working night shifts, and real-time data can be assessed using wearable devices or smartphones with sensors and apps. Moreover, regular assessment of mental wellbeing and screening for sleep disorders among night-shift nurses may help identify individuals at elevated risk of unfavourable health and safety concerns at work, and further preventive and treatment strategies may be designed for them. Scheduled breaks for night-shift nurses to take naps during night duty may help reduce mental fatigue. Timed bright light therapy may be used to manage SWSD and related mental health concerns. Bright light therapy can reset the internal clock and gradually shift sleep patterns to normal. Nursing supervisors and hospital administrators should examine their present rotational shift methods and assess the effects on nurses' mental states and quality of life. Similar considerations may apply to other professions working night shifts in the healthcare setting and other sectors.

Table 12. Summary of some studies that investigated the effectiveness of interventions for improving mental wellbeing among night-shift nurses

Study details	Type and objectives of intervention	Methodology	Significance of the outcome measures	Conclusion
Thottakam et *al.,* 2020	**Pharmacological approach:** To determine the effects of melatonin administration on sleep measures and attention/concentration tasks among doctors and nurses working night shifts.	25 male and female participants were randomized to receive either 6 mg of Circadin™ slow-release melatonin or placebo before sleep after each successive nightshift. Actigraphy was used for the assessment of sleep parameters.	Double-digit addition testing, a concentration/attention task, improved with melatonin treatment ($P<0.0001$).	Exogenous melatonin administration was effective in improving vigilance among doctors and nurses working night shifts.
Miyoshi, 2019	**Non-pharmacological approach**: To ascertain whether restorative yoga is an efficient technique for reducing occupational stress among female nurses working night shifts in Japan.	Twenty female nurses who were working the night shift at a university hospital in Japan participated in the randomized crossover trial, which consisted of a 1-hour guided group yoga session followed by 4 weeks of home-based practice and 4 weeks of usual stress relief practices. The level of stress was assessed among the participants using the Brief Job Stress	The mean questionnaire score for psychological and physical stress reactions, was significantly decreased after the group yoga session ($P = 0.000$). The mean score was significantly lower after 4 weeks of home-based practice than before or after group yoga practice ($P = 0.001$).	Restorative yoga may be an effective strategy for reducing occupational stress among female nurses working night shifts.

		Questionnaire before and after performing restorative yoga.		
Chang *et al.,* 2017	**Non-pharmacological approach:** To assess the effect of aromatherapy massage on sleep quality of nurses working monthly rotating night shifts.	53 female nurses on monthly rotating shifts, having a total Pittsburgh Sleep Quality Index (PSQI) ≥ 5, and between the ages of 20 and 50 years were enrolled. The treatment group received aromatherapy massage and the control group rested in the same aromatherapy room after work. All subjects filled the PSQI surveys, and the sleep quality information was collected during massage or resting time and the following night.	The treatment group had a significant decrease in PSQI after aromatherapy when compared to their previous state ($P < 0.001$) signifying an improvement in sleep quality.	Aromatherapy massage could improve sleep quality among nurses working monthly rotating night shifts.
Huang *et al.,* 2013	**Non-pharmacological approach:** To determine whether bright light exposure during the first half of the evening/night shift combined with light attenuation in the morning is effective in improving sleep quality among nurses working rotational shift who suffer from insomnia.	Female hospital nurses on rotational shifts during the evening or night shift with an Insomnia Severity Index (ISI) score > 14 were registered for the study. Subjects in the treatment group (n = 46) were exposed to	After treatment, subjects in the treatment group showed significant improvements in ISI, hospital anxiety depression scale, anxiety and depression subscale scores compared with pre-treatment ($p < 0.001$).	A greater intensity and shorter duration of bright light exposure during the first half of the evening/night shift with a daytime darkness procedure significantly reduced insomnia, anxiety, and depression among female nurses working rotational shifts, and were diagnosed with insomnia.

		bright light at 7,000-10,000 lux for ≥ 30 minutes. Exposure was continued for at least 10 days, and the subjects avoided daytime outdoor sun exposure after work by wearing dark sunglasses. On the other hand, subjects in the control group (n = 46) were not exposed to bright light, but also wore sunglasses after work.		

6. CONCLUSIONS

According to the outcome of the pilot study, most nurses reported using at least one or more of the following substances: sleep-promoting medication, nicotine, alcohol, and cannabis. Moreover, there was a strong positive association among sleep disturbance, anxiety, and depression in a sample of Canadian nurses working night shifts in the province of Saskatchewan in the era of the COVID-19 pandemic. Anxiety, on the other hand, was associated with occupational exhaustion and depersonalization among the nurses. Moreover, according to the outcome of the systematic and meta-analysis study, there is a significant relationship between working night shifts, the disturbance of sleep and circadian rhythm linked to night work, and the risk of depression in nurses. This indicates that nurses who work night shifts are more likely to experience depression. Regarding the systematic review to address workplace vigilance and sleep issues in nurses working the night shift to improve their job performance, productivity, and well-being, exposure to bright light during the night shift may improve alertness by suppressing melatonin secretion and increasing sleep onset latency. Furthermore, wakefulness-promoting medications are used to reduce excessive sleepiness in individuals with shift work sleep disorder and to reduce the symptoms of this disorder. Armodafinil or modafinil taken before the commencement of night shift work is effective in the treatment of excessive sleepiness associated with shift-work sleep disorder. However, armodafinil appears to have longer-lasting effects compared to modafinil.

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APPENDIXES

Appendix A

University of Saskatchewan, Behavioural Research Ethics Board (Beh-REB), Certificate of Approval

UNIVERSITY OF SASKATCHEWAN

Behavioural Research Ethics Board (Beh-REB) 09-May-2022

Certificate of Approval

Application ID: 3279

Principal Investigator: Marcella Ogenchuk Department: College of Nursing

Locations Where Research Activities are Conducted: Saskatchewan, Canada

Student(s): Chidiebere Okechukwu

Funder(s):

Sponsor: University of Saskatchewan

Title: A cross-sectional survey of the prevalence of substance dependence among Canadian nurses working night shifts in COVID-19 era

Approved On: 09-May-2022

Expiry Date: 09-May-2023

Approval Of: Behavioural ethics application
Consent form
Survey and demographic questions Email invitation

Acknowledgment Of: TCPS2 Core Certificate: Chidibere Emmanuel Okechukwu

Review Type: Delegated Review

CERTIFICATION

The University of Saskatchewan Behavioural Research Ethics Board (Beh-REB) is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TPCS 2 2018). The University of Saskatchewan Behavioural Research Ethics Board has reviewed the above-named project. The proposal was found to be acceptable on ethical grounds. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to this project, and for ensuring that the authorized project is carried out according to the conditions outlined in the original protocol submitted for ethics review. This Certificate of Approval is valid for the above time period provided there is no change in experimental protocol or consent process or documents.

Any significant changes to your proposed method, or your consent and recruitment procedures should be reported to the Chair for Research Ethics Board consideration in advance of its implementation.

ONGOING REVIEW REQUIREMENTS

In order to receive annual renewal, a status report must be submitted to the REB Chair for Board consideration within one month prior to the current expiry date each year the project remains open, and upon project completion. Please refer to the following website for further instructions: https://vpresearch.usask.ca/researchers/forms.php.

Digitally Approved by Diane Martz,
Chair Behavioural Research Ethics
Board University of Saskatchewan

Appendix B

Participant Consent Form

You are invited to participate in a research study entitled "**Lifestyle behaviors among Canadian nurses working night shifts in the COVID-19 era: a cross-sectional study**". This online survey should take about 30 to 40 minutes to complete. Participation is voluntary, and responses will be kept confidential to the degree permitted by the technology being used.

You have the option to not respond to any questions that you choose. Participation or nonparticipation will not impact your relationship with the University of Saskatchewan. Submission of the survey will be interpreted as your informed consent to participate and that you affirm that you are at least 25 years of age.

If you have any questions about the research, please contact the Principal Investigator, Dr. Marcella Ogenchuk, or the student researcher, Mr. Chidiebere Emmanuel Okechukwu, via telephone 4035429813.

Student Researcher:

Chidiebere Emmanuel Okechukwu (i) Visiting research student, College of Nursing, University of Saskatchewan, Saskatoon, Canada.

(ii) PhD candidate, Department of Public health and Infectious Diseases, Sapienza University of Rome, Piazzale Aldo Moro 5 – 00185 Rome, Italy.

Researcher:

Prof. Giuseppe La Torre, Department of Public Health and Infectious diseases, Sapienza of Rome, Piazzale Aldo Moro 5- 00185 Rome, Italy.

Principal Investigator/Supervisor:

Dr. Marcella Ogenchuk College of Nursing, University of Saskatchewan.

Purpose and Objective of the Research

Purpose:

The purpose of this study is to determine the prevalence of nicotine, caffeine, cannabis, sleep-promoting medication, and alcohol use in a sample of nurses working night shifts in the province of Saskatchewan, Canada. In addition, the association between sleep quality, anxiety and depression among Canadian nurses working night shifts in the COVID-19 era.

Procedures:

Registered nurses between the ages of 25 to 65 years who have been working permanent or rotating night shifts for the past two years in the province of Saskatchewan, with no history of major psychiatric illness, and neurological disorders will be invited to participate in this

study. This study will start from May 2022 until August 2022. The study will be conducted in Saskatchewan, Canada.

Funding:

Not applicable.

Potential Risks:

The participants' information is of a sensitive nature. However, there is no potential harm associated with participating in this study. Nurses who are struggling with problematic substance use should call the Saskatchewan Health Line at 811 (24-hour service). Nurses who are also battling with any form of addiction or mental health challenge can contact the Community Adult Mental Health and Addiction Services of the Saskatchewan Health Authority for referral to appropriate mental health services through a centralized intake system at 306-655-7777. Hours of operation: 8:00 a.m. to 12:00 p.m., and 12:30 p.m. to 4:30 p.m.

Potential Benefits:

This study will provide information on the possible association between working night shift and substance use among nurses. This study will also determine any possible association between job stress, sleep problem, anxiety, and depression.

Compensation:

Not Applicable.

Confidentiality:

Your records will be kept confidential and will not be released without your consent. If the results of this study are written in a scientific journal or presented at a scientific meeting, your identity will be kept confidential. The result of this study will be included in the student researcher's dissertation. This survey is hosted by Survey Monkey. Your data will be stored in facilities hosted in Canada. Please see the following for more information on the Survey Monkey Privacy Policy, https://www.surveymonkey.com/mp/legal/privacy/.

Storage of Data:

Electronic data will be stored for long-term on the principal investigator's data storage account in a Usask computer. The names and email addresses of participants will be collected, but the data will be de-identified using a participant code, and the master list will be stored separately from the data for a year, after which it will be destroyed. The principal investigator can share the data with the student through their Usask DataStore or OneDrive account, who will be able to access the data remotely without the need to store it on their own computer. The minimum required storage period is five years post-publication after which the data will be destroyed using a means that does not permit its recovery.

Right to Withdraw:

- Participation in this survey is voluntary.
- You can decide not to participate at any time by closing your browser or choose not to answer any questions you do not feel comfortable with.
- Your right to withdraw data from the study will apply until June 30, 2022, after this, it is possible that some form of research dissemination will have already occurred, and it may not be possible to withdraw your data.
- Whether you choose to participate or not will have no effect on your position (e.g., employment, academic status, access to services) or how you will be treated.

Questions or Concerns:

- Contact the researcher(s) using the information at the top of page 1.
- This research project has been approved on ethical grounds by the University of Saskatchewan Behavioral Research Ethics Board and the research ethics committee of the College of Registered Nurses of Saskatchewan. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office: ethics.office@usask.ca; 306-966-2975; out of town participants may call toll free 1-888-966-2975.

By completing and submitting this questionnaire, your free and informed consent is implied and indicates that you understand the above conditions of participation in this study.

Appendix C

Demographic data collection tool

Instruction: Please answer the following questions with a specific answer.

1. What is your age?

a. 25-29

b. 30-34

c. 35-39

d. 40 and above

2. Please specify your ethnicity:

a. Hispanics of any race

b. White

c. Asian

d. Black or African American

e. Indigenous: First Nations, Inuit, or Métis

3. What is your gender?

a. Man

b. Woman

c. Non-binary

d. Gender fluid

e. Two-Spirit

f. Trans man

g. Trans woman

h. Not listed

i. Prefer not to disclose

4. what is your body mass index (kg/m^2)?

a. <18.5

b. 18.5-24.9

c. 25-29.9

d. 30-34.9

e. ≥ 35

5. What is your marital status?

a. Single

b. In a relationship

c. Married

d. Separated

e. Divorced

f. Widowed

6. What region of Canada were you born?

a. The Atlantic Provinces

b. Central Canada

c. The Prairie Provinces

d. The West Coast

e. The Northern Territories

f. Outside Canada

7. You are an employee of:

a. the hospital

b. a nursing agency

c. long term care home

d. Not listed

8. Which type of hospital unit do you currently work on?

a. community nursing

b. ICU/NICU

c. long-term care

d. Other

9. You are currently working as:

a. general nurse

b. nurse practitioner

c. clinical nurse specialist/educator

d. wellness manager

e. public health manager

f. Not listed

10. Work pattern:

a. full time

b. part time

c. casual

11. How many years have you been practicing as a registered nurse in Saskatchewan?

a. < 2 years

b. 2-5 years

c. 6-10 years

d. 10 + years

12. How many years have you been working night shifts as a registered nurse in Saskatchewan?

a. < 2 years

b. 2-5 years

c. 6-10 years

d. 10 + years

13. What pattern of Night shift?

a. Rotating night shift

b. Permanent night shift

14. Level of education:

a. Diploma

b. Bachelor’s degree

c. Master’s degree

d. Doctorate degree

15. Including yourself, how many people currently live in your household?

a. 1

b. 2

c. 3

d. 4

e. More than 4

16. How many hours do you work in the night in a week?

a. 9 or less

b. 10-19

c. 20-29

d. 30-39

e. 40 and above

17. How stressful is night shift work on your physical and mental health?

a. Extremely stressful

b. Moderately stressful

c. Not very stressful

d. Not at all stressful

18. Do you smoke cannabis?

a. Yes

b. No

19. Do you smoke cigarettes?

a. Yes

b. No

20. Do you consume alcohol?

a. Yes

b. No

21. Do you take caffeine before or during the night shift?

a. Yes

b. No

22. Do you take any sleep-promoting medication after the night shift?

a. Yes

b. No

23. How would you rate your overall experience as a night shift nurse in the past 2 years?

a. Excellent

b. Good

c. Average

d. Below Average

e. Poor

Appendix D

The Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. During the past month, what time did you usually go to bed during the day?

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each day?

3. What time have you normally woken up during the day following initiating sleep after working the night shift in the last month?

4. During the past month, how many hours of actual sleep did you get during the day? (This may be different than the number of hours you spent in bed.)

5. During the past month, how often have you had trouble sleeping because you…	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the day or early afternoon				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				
h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe:				
6. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
	No problem at all	Only a very slight problem	Somewhat of a problem	A very big problem
8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?				
	Very good	Fairly good	Fairly bad	Very bad
9. During the past month, how would you rate your sleep quality overall?				

	No bed partner or room mate	Partner/room mate in other room	Partner in same room but not same bed	Partner in same bed
10. Do you have a bed partner or room mate?				
	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
If you have a roommate or bed partner, ask him/her how often in the past month you have had:				
a. Loud snoring				
b. Long pauses between breaths while asleep				
c. Legs twitching or jerking while you sleep				
d. Episodes of disorientation or confusion during sleep				
e. Other restlessness while you sleep, please describe:				

Scoring the PSQI

The order of the PSQI items has been modified from the original order in order to fit the first 9 items (which are the only items that contribute to the total score) on a single page. Item 10, which is the second page of the scale, does not contribute to the PSQI score.

In scoring the PSQI, seven component scores are derived, each scored 0 (no difficulty) to 3 (severe difficulty). The component scores are summed to produce a global score (range 0 to 21). Higher scores indicate worse sleep quality.

Component 1: Subjective sleep quality—question 9 Response to Q9

Component 1 score

Very good	0
Fairly good	1
Fairly bad	2
Very bad	3

Component 1 score =

Component 2: Sleep latency—questions 2 and 5a

Response to Q2	Component 2/Q2 sub score
< 15 minutes	0
16-30 minutes	1
31-60 minutes	2
> 60 minutes	3

Response to Q5a	Component 2/Q5a sub score
Not during past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

Sum of Q2 and Q5a **sub scores**	**Component 2 score**
0	0
1-2	1
3-4	2
5-6	3

Component 2 score =

Component 3: Sleep duration—question 4

Response to Q4	**Component 3 score**
> 7 hours	0
6-7 hours	1
5-6 hours	2

< 5 hours 3

Component 3 =

Component 4: Sleep efficiency—questions 1, 3, and 4

Sleep efficiency (# hours slept/# hours in bed) X 100%

hours slept — question 4

hours in bed —calculated from responses to questions 1 and 3 Sleep efficiency

Component 4 score

> 85% 0

75-84% 1

65-74% 2

< 65% 3

Component 4 score =

Component 5: Sleep disturbance—questions 5b-5j Questions 5b to 5j should be scored as follows:

Not during past month 0

Less than once a week 1

Once or twice a week 2

Three or more times a week 3

Sum of 5b to 5j scores

Component 5 score

0 0

1-9 1

10-18 2

19-27 3

Component 5 score =

Component 6: Use of sleep medication—question 6

Response to Q6

Component 6 score

Not during past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

Component 6 score =

Component 7: Daytime dysfunction—questions 7 and 8 Response to Q7

Component 7/Q7 sub score

Not during past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

Response to Q8

Component 7/Q8 subs score

No problem at all	0
Only a very slight problem	1
Somewhat of a problem	2
A very big problem	3

Sum of Q7 and Q8

sub scores

Component 7 score

0	0
1-2	1
3-4	2
5-6	3

Component 7 score=

Global PSQI Score: Sum of seven component scores =

Appendix E

Hospital Anxiety and Depression Scale (HADS)

Tick the box beside the reply that is closest to how you have been feeling in the past week.

D	A		D	A	
		I feel tense or 'wound up':			**I feel as if I am slowed down:**
	3	Most of the time	3		Nearly all the time
	2	A lot of the time	2		Very often
	1	From time to time, occasionally	1		Sometimes
	0	Not at all	0		Not at all
		I still enjoy the things I used to enjoy:			**I get a sort of frightened feeling like 'butterflies' in the stomach:**
0		Definitely as much		0	Not at all
1		Not quite so much		1	Occasionally
2		Only a little		2	Quite Often
3		Hardly at all		3	Very Often
		I get a sort of frightened feeling as if something awful is about to happen:			**I have lost interest in my appearance:**
	3	Very definitely and quite badly	3		Definitely
	2	Yes, but not too badly	2		I don't take as much care as I should
	1	A little, but it doesn't worry me	1		I may not take quite as much care
	0	Not at all	0		I take just as much care as ever
		I can laugh and see the funny side of things:			**I feel restless as I have to be on the move:**
0		As much as I always could		3	Very much indeed
1		Not quite so much now		2	Quite a lot
2		Definitely not so much now		1	Not very much
3		Not at all		0	Not at all
		Worrying thoughts go through my mind:			**I look forward with enjoyment to things:**
	3	A great deal of the time	0		As much as I ever did
	2	A lot of the time	1		Rather less than I used to
	1	From time to time, but not too often	2		Definitely less than I used to
	0	Only occasionally	3		Hardly at all
		I feel cheerful:			**I get sudden feelings of panic:**
3		Not at all		3	Very often indeed
2		Not often		2	Quite often
1		Sometimes		1	Not very often
0		Most of the time		0	Not at all
		I can sit at ease and feel relaxed:			**I can enjoy a good book or radio or TV program:**
	0	Definitely	0		Often
	1	Usually	1		Sometimes
	2	Not Often	2		Not often
	3	Not at all	3		Very seldom

Appendix F

Fagerstrom Test for Nicotine Dependence

PLEASE TICK (□) ONE BOX FOR EACH QUESTION		
How soon after waking do you smoke your first cigarette?	**Within 5 minutes** **5−30 minutes** **31−60 minutes**	□ **3** □ **2** □ **1**
Do you find it difficult to refrain from smoking in places where it is forbidden? e.g. Church, Library, etc.	**Yes** **No**	□ **1** □ **0**
Which cigarette would you hate to give up?	**The first in the morning** **Any other**	□ **1** □ **0**
How many cigarettes a day do you smoke?	**10 or less** **11 − 20** **21 − 30** **31 or more**	□ **0** □ **1** □ **2** □ **3**
Do you smoke more frequently in the morning?	**Yes** **No**	□ **1** □ **0**
Do you smoke even if you are sick in bed most of the day?	**Yes** **No**	□ **1** □ **0**
Total Score		
SCORE	**1− 2 = low dependence** **3−4 = low to mod dependence**	**5 − 7= moderate dependence** **8 + = high dependence**

Appendix G

Caffeine Expectancy Questionnaire (CaffEQ)

We are interested your beliefs about the effects that caffeine has on you. Below is a list of possible effects of caffeine. Using the scale below as a guide, please rate each statement in terms of how LIKELY or UNLIKELY you believe each consequence is for you when you use caffeine.

Base your responses on your caffeinated product of choice. If you use many types of caffeinated products, choose just one to base your responses on, or you may choose to base your responses on "caffeine in general". (You can change your choice after responding to the questions)

Even if you very rarely consume caffeine, please rate how you would expect caffeine to affect you, if you consumed it.

My responses below are based on: (please check one) Coffee

Soft Drinks Tea

Caffeine containing medications (E.g., Excedrin, No-Doz) Caffeine in general

Other (please specify):

		Very Unlikely	Unlikely	A little Unlikely	A little Likely	Likely	Very Likely
1	**Caffeine picks me up when I am feeling tired**	□	□	□	□	□	□
2	**Conversations are better when using caffeine**	□	□	□	□	□	□
3	**Caffeine helps me avoid eating more than I should**	□	□	□	□	□	□
4	**I am easily stressed after having caffeine**	□	□	□	□	□	□
5	**Caffeine improves my athletic performance**	□	□	□	□	□	□
6	**I feel less sleepy after having caffeine**	□	□	□	□	□	□
7	**Caffeine suppresses feelings of hunger**	□	□	□	□	□	□
8	**I feel miserable when I do not have my usual caffeine**	□	□	□	□	□	□
9	**Caffeine improves my mood**	□	□	□	□	□	□
10	**I would get anxious if I abstained from caffeine**	□	□	□	□	□	□

Caffeine containing medications (E.g., Excedrin, No-Doz) Caffeine in general

Other (please specify):

		Very Unlikely	Unlikely	A little Unlikely	A little Likely	Likely
11	**Caffeine makes me jittery**	□	□	□	□	□
12	**Workouts are better after having caffeine**	□	□	□	□	□
13	**I would experience caffeine withdrawal**	□	□	□	□	□
	if I went without caffeine	□	□	□	□	□
14	**I don't like the way caffeine makes me feel**	□	□	□	□	□
15	**I would feel sick if I went without caffeine**	□	□	□	□	□
16	**Caffeine increases my motivation to work**	□	□	□	□	□
17	**I feel more confident after having caffeine**	□	□	□	□	□
18	**Caffeine at any time of day throws off my sleep**	□	□	□	□	□
19	**Caffeine makes me feel nervous**	□	□	□	□	□
20	**Caffeine makes me feel more alert**	□	□	□	□	□
21	**Even a small amount of caffeine makes me anxious**	□	□	□	□	□
22	**Caffeine improves my concentration**	□	□	□	□	□
23	**Caffeine makes me friendlier**	□	□	□	□	□
24	**I need to have caffeine every day**	□	□	□	□	□
25	**Caffeine makes me sweat**	□	□	□	□	□
26	**Caffeine allows me to skip meals**	□	□	□	□	□
27	**I have a strong desire for caffeine if I do not have my usual amount**	□	□	□	□	□
28	**I have difficulty sleeping after having caffeine**	□	□	□	□	□
29	**Caffeine makes me irritable**	□	□	□	□	□

30	**I often crave caffeine**	□	□	□	□	□
31	**Caffeine helps me work over long periods of time**	□	□	□	□	□
32	**Caffeine makes me feel happy**	□	□	□	□	□
33	**I would be unable to function without caffeine**	□	□	□	□	□
34	**Caffeine makes my heart beat irregularly**	□	□	□	□	□
35	**I would have difficulty starting my day without caffeine**	□	□	□	□	□
36	**Caffeine upsets my stomach**	□	□	□	□	□
37	**I would have trouble giving up caffeine**	□	□	□	□	□
38	**Using caffeine late in the day disrupts my sleep**	□	□	□	□	□
39	**Caffeine helps me to control my weight**	□	□	□	□	□
40	**I would get a headache if I went without caffeine**	□	□	□	□	□
41	**Caffeine improves my attention**	□	□	□	□	□
42	**I feel more sociable after having caffeine**	□	□	□	□	□
43	**I can exercise longer if I have caffeine**	□	□	□	□	□
44	**Caffeine helps get me through the day**	□	□	□	□	□
45	**Caffeine makes me feel more energetic**	□	□	□	□	□
46	**Caffeine decreases my appetite**	□	□	□	□	□
47	**Caffeine late in the day gives me insomnia**	□	□	□	□	□

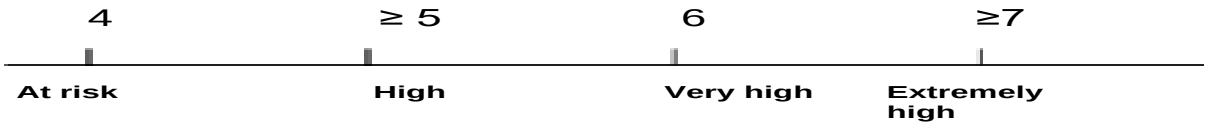
Appendix H

The severity of dependence scale (SDS)

Circle the answer that best applies to how you have felt about your use of over the last twelve months.

	Never/ Almost Never	Sometimes	Often	Always/ Nearly Always
Do you think your use of (substance) was out of control?	0	1	2	3
Did the prospect of missing a fix, shot or dose make you feel anxious or worried?	0	1	2	3
Did you worry about your use of (substance)?	0	1	2	3
Did you wish you could stop?	0	1	2	3

	Not Difficult	Quite Difficult	Very Difficult	Impossible
How difficult did you find it to stop or go without (substance)?	0	1	2	3



SDS TOTAL =

Appendix I

The Alcohol Use Disorder Identification Test-Concise (AUDIT-C)

General Instructions

The Alcohol Use Disorders Identification Test-Concise (AUDIT-C) is a brief alcohol screening instrument. Please give a response for each question.

1. **How often do you have a drink containing alcohol?**

☐ Never
☐ Monthly or less
☐ 2-4 times a month
☐ 2-3 times a week
☐ 4 or more times a week

2. **How many standard drinks containing alcohol do you have on a typical day?**

☐ 1 or 2
☐ 3 to 4
☐ 5 to 6
☐ 7 to 9
☐ 10 or more

3. **How often do you have six or more drinks on one occasion?**

☐
☐

Appendix J

The Maslach Burnout Inventory

How do you perceive your work? Are you exhausted? How capable are you of shaping your relationship to others? To what degree are you personally fulfilled?

Indicate how frequently the following statements apply to you and add the points indicated on top of the respective box:

0 = Never

1 = At least a few times a year 2 = At least once a month

3 = Several times a month 4 = Once a week

5 = Several times a week 6 = Every day

	Never ↓					Every day ↓	
01 – I feel emotionally exhausted because of my work	0	1	2	3	4	5	6
02 – I feel worn out at the end of a working day							
03 – I feel tired as soon as I get up in the morning and see a new working day stretched out in front of me							
04 – I can easily understand the actions of my colleagues/supervisors							
05 – I get the feeling that I treat some clients/colleagues impersonally, as if they were objects							
06 – Working with people the whole day is stressful for me							
07 – I deal with other people's problems successfully							
08 – I feel burned out because of my work							
09 – I feel that I influence other people positively through my work							
10 –I have become more callous to people since I have started doing this job							
11 – I'm afraid that my work makes me emotionally harder							
12 – I feel full of energy							
13 – I feel frustrated by my work							
14 – I get the feeling that I work too hard							
15 – I'm not really interested in what is going on with many of my colleagues							
16 – Being in direct contact with people at work is too stressful							
17 – I find it easy to build a relaxed atmosphere in my working environment							
18 – I feel stimulated when I been working closely with my colleagues							
19 – I have achieved many rewarding objectives in my work							
20 – I feel as if I'm at my wits' end							
21 – In my work I am very relaxed when dealing with emotional problems							
22 – I have the feeling that my colleagues blame me for some of their problems							

Overall score for occupational exhaustion (EE)

Add together the answers to questions 01. 02. 03. 06. 08. 13. 14. 16. 20

Occupational exhaustion	EE < 17	EE 18 - 29	EE > 30
	Low degree	Moderate degree	High degree

Overall score for depersonalisation / loss of empathy (DP)

Add together the answers to questions 05. 10. 11. 15. 22

Depersonalisation	DP < 5	DP 6 - 11	DP > 12
	Low degree	Moderate degree	High degree

Overall score personal accomplishment assessment (PA)

Add together the answers to questions 04. 07. 09. 12. 17. 18. 19. 21.

Personal accomplishment assessment	PA < 33	PA 34 - 39	PA > 40
	Low degree	Moderate degree	High degree

Degree of burnout

Beware if the totals of your EE and DP answers are both in the red area, and above all if your personal accomplishment assessment is also in the red!!!

EE	Occupational exhaustion (burnout) is typically connected to a relationship with work that is perceived as difficult, tiring, stressful… Maslach sees this as different from depression, as it is likely that the symptoms of burnout would be reduced during holidays.
DP	Depersonalisation or loss of empathy is characterised by a loss of regard for others (clients, colleagues…), and by keeping a greater emotional distance, which is expressed through cynical, derogatory remarks, and even callousness.
PA	The personal accomplishment assessment is a feeling that acts as a "safety valve" and contributes to bringing about a balance if occupational exhaustion and depersonalisation occur. It ensures fulfilment in the workplace and a positive view of professional achievements.