

# Biological and practical considerations regarding circadian rhythm and mental health relationships among nurses working night shifts: a narrative review and recommendations

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**Summary. Background.** Sleep is a vital physiological process regulated by the circadian clock and homeostatic mechanisms. Shift work is necessary to ensure continuity of healthcare provision. Worldwide, nurses work night shifts on a rotational or permanent basis. **Objective.** To analyse the impact of circadian rhythm disruption due to night shift work on the mental wellbeing of nurses. **Methods.** The literature search was conducted using 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. **Results.** 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-text review. Seven papers were included in this review. **Conclusions.** 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. Strategies and policies to promote workplace health may reduce the occurrence of mental health disorders among night-shift nurses, whether the shifts are rotational or permanent. Nursing supervisors and hospital administrators should consider developing new guidelines to minimize the negative impact of night shift rotations on mental health and the quality of life among nurses.

**Key words.** Circadian, mood disorders, nursing staff, occupational health, quality of life, sleep, sleep disorders, shift work schedule. **Parole chiave.** Depressione resistente al trattamento, disturbo depressivo maggiore, esketamina, iPSC, ketamina, NMDA.

*Considerazioni biologiche e pratiche riguardanti il ritmo circadiano e le relazioni con la salute mentale tra gli infermieri che lavorano nei turni notturni: una rassegna narrativa e raccomandazioni.*

**Riassunto. Introduzione.** Il sonno è un processo fisiologico vitale regolato dall'orologio circadiano e dai meccanismi omeostatici. Il lavoro a turni è necessario per garantire la continuità dell'assistenza sanitaria. In tutto il mondo, gli infermieri lavorano su turni notturni a rotazione o tempo indeterminato. **Scopo.** Analizzare l'impatto dell'interruzione del ritmo circadiano dovuto al lavoro notturno sul benessere mentale degli infermieri. **Metodi.** La ricerca bibliografica è stata condotta 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. **Risultati.** Le ricerche hanno generato un totale di 22 record nel database PubMed e 9 record nel database Scopus e un totale di 31 studi. Ventinove documenti sono stati identificati dopo la rimozione dei duplicati. Tuttavia, 29 articoli sono stati selezionati in base alla revisione dei titoli e degli abstract. Diciannove articoli sono stati identificati per la revisione completa del test. 7 articoli sono stati inclusi in questa recensione. **Conclusioni.** Ritmi circadiani alterati e scarsa qualità e quantità del sonno sono stati identificati come due degli elementi più significativi negli effetti a lungo termine del lavoro notturno sulla salute mentale degli infermieri. Strategie e politiche per promuovere la salute sul posto di lavoro possono ridurre l'insorgenza di disturbi di salute mentale tra gli infermieri del turno di notte, indipendentemente dal fatto che i turni siano a rotazione o permanenti. I supervisori infermieri e gli amministratori ospedalieri dovrebbero considerare lo sviluppo di nuove linee guida per ridurre al minimo l'impatto negativo delle rotazioni del turno di notte sulla salute mentale e sulla qualità della vita tra gli infermieri.

**Parole chiave.** Personale infermieristico, salute sul lavoro, circadiano, sonno, disturbi del sonno, disturbi dell'umore, turni di lavoro, qualità della vita.

## Introduction

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 diseases 2019 era, shift patterns should be organized systematically, and workers should be assigned coherently<sup>1</sup>. 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<sup>2</sup>. Night shift intolerance may reflect individual differences in responsiveness to internal desynchronization. Difficulties may manifest in the form of adjustments in sleep-wake cycles, alterations in body temperature, and grip strength of both hands<sup>3</sup>. Many night-shift nurses show signs of sleep-wake dysregulation in sleep alterations, asthenia, use of and dependence on sedating medications, and mood disorders<sup>3</sup>. The internal desynchrony of circadian rhythms in night-shift workers may be driven by light-induced phase shifting of the circadian activity clock<sup>4</sup>.

Shift work sleep disorder (SWSD) is a circadian rhythm sleep disorder characterized by sleeplessness, wakefulness, and/or extreme sleepiness. SWSD causes significant distress among night-shift nurses because their working hours overlap with sleep time, resulting in difficulties initiating sleep and maintaining wakefulness, as well as decreased work efficiency<sup>5,6</sup>. One study found that nurses performing night work had an odds ratio of 1.48 for insomnia and 1.78 for chronic fatigue compared to nurses with no night work experience<sup>7</sup>. SWSD in nurses has been linked to the number of nights on duty, gaps of less than 11 hours between working shifts, minimal flexibility, anxiety, and insomnia<sup>8</sup>. Moreover, shift work is associated with risks of committing errors in the healthcare setting, such as needle-stick injuries, mistakes while attending to patients, reduced harmonization, and inattention during working hours<sup>9</sup>. Drowsy driving is often reported by nurses in the morning after night shifts<sup>10</sup>. Night-shift workers appear at an elevated risk of experiencing sleepiness-related motor vehicle accidents due to cognitive dysfunction related to circadian rhythm disruption<sup>11</sup>. The circadian clock may not synchronize with the immediate environment during circadian misalignment<sup>12</sup>. Circadian clock dysregulation and sleep disturbances are harmful to hippocampus-dependent memory and adversely influence recollection of acquired skills. Circadian disruption and diminished sleep quality both

decrease cognitive functioning and performance among night-shift nurses<sup>13</sup>. The neurobehavioral performance of healthcare workers is usually reduced during night shifts, possibly reflecting sleep loss and circadian misalignment<sup>14,15</sup>. Italian night-shift nurses had poorer psychomotor performance during night duty compared to nurses working day shifts<sup>16</sup>. Adjusting light and dark using dark sunglasses, sleeping in the dark, and exposure to bright light during night-shifts might help in reorganizing the circadian clock to discreetly align with the night work and day-sleep schedule, consequently decreasing circadian misalignment<sup>17</sup>. The combination of periodic bright light exposure and the use of darker sunglasses during and after the night shifts, respectively, may also promote better circadian adaptation<sup>18</sup>. Based on the above-mentioned literature, the objective of this review was to analyse the impact of circadian rhythm disruption due to night shift work on the mental wellbeing of nurses.

## Methods

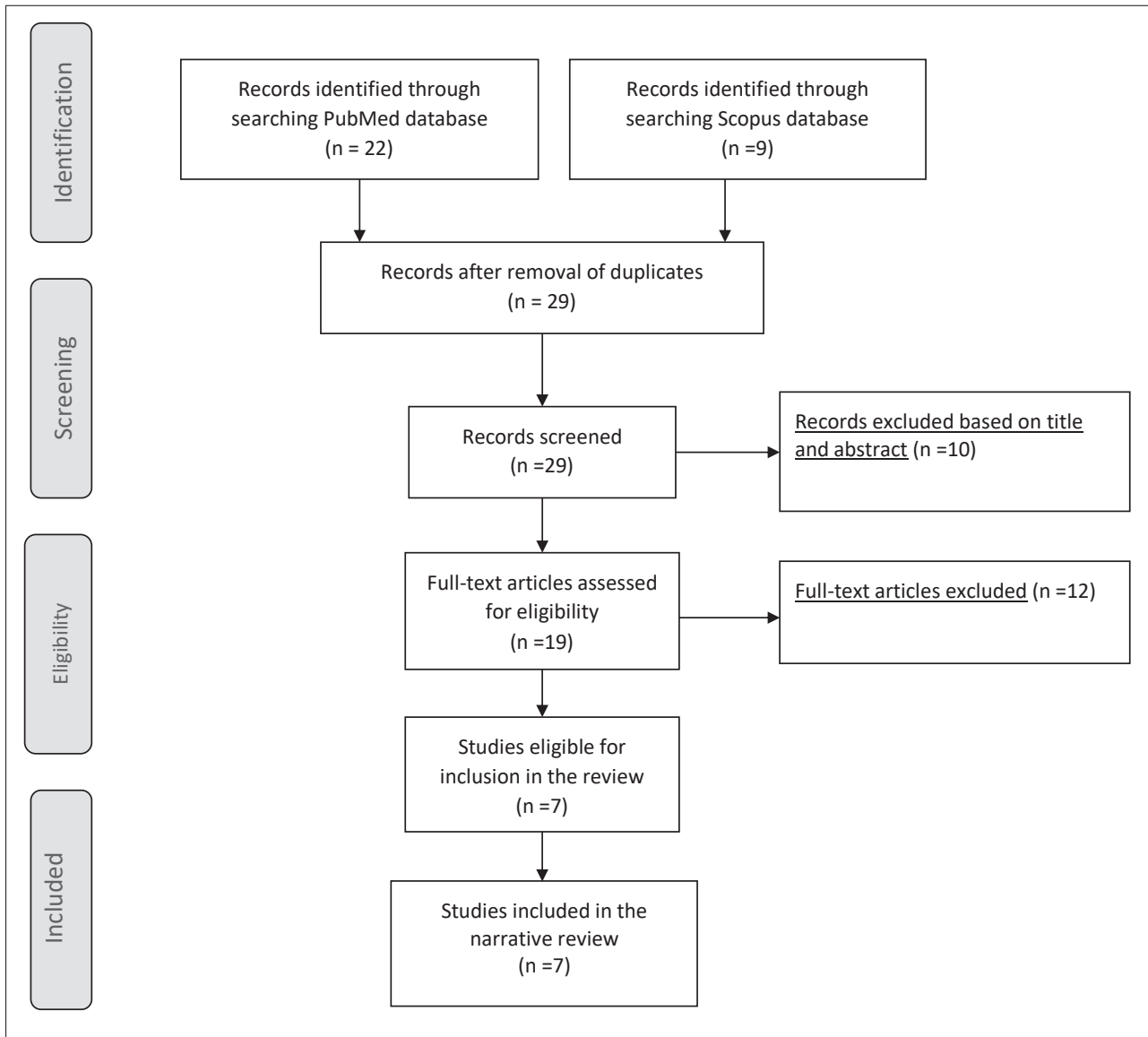
The selection criteria include studies published in English between 1997 and 2021 that examined the impact of night-shift work on the mental health of nurses. Non-English articles were excluded to avoid linguistic bias in translation. The searches were carried out using PubMed and Scopus electronic databases for studies published between 1997 and 2021. The following medical subject headings were used to search for relevant articles on the PubMed database: (((Circadian Rhythm) OR Circadian Disruption) AND Nurses AND Night Shift-work AND Sleep AND Mental Health)). A total of 22 articles were found on PubMed. On the other hand, the following search terms were used to search for relevant studies on the Scopus database: (((Night Shift-work) OR Circadian Disruption) AND Nurses AND Sleep AND Mental Health)). A total of 9 studies were found in Scopus. The search procedures are described in figure 1.

## INCLUSION CRITERIA

This review included randomized controlled trials and intervention studies which conducted primary investigations into nurses working night shifts and were published in English between 1997 and 2021.

## EXCLUSION CRITERIA

Case studies, narrative reviews, systematic reviews, meta-analyses, literature reviews, and opinion articles were not included in the study. Papers that did not examine the impact of night-shift work on nurses' mental health were also excluded.



**Figure 1.** Preferred Reporting Items for Systematic Reviews and Meta Analyses flow diagram.

### SEARCH OUTCOMES

A total of thirty-one papers were found in the two databases (PubMed and Scopus), with two of them being duplicates. Seven papers were chosen for this review after a thorough evaluation of the 29 papers recorded after removal of duplicate publications based on the inclusion and exclusion criteria. Figure 1 shows the PRISMA flowchart for the selection.

### QUALITY APPRAISAL

The quality of the studies was evaluated using the study design-specific tool developed by the National Heart, Lung, and Blood Institute (NHLBI) and Research Triangle Institute International<sup>19</sup>. We gave

point values (e.g., No= 0, Yes= 1, Good= 2, Fair= 1, Poor= 0) to each appraisal of quality and summed them for the final quality score, so that the higher the total score, the better the quality. Three authors reviewed the selected papers independently and unanimously approved the seven papers for the narrative review.

### SYNTHESIS AND EXTRACTION

Six authors extracted data from the studies, which was later reviewed and discussed by all the authors. The data was synthesized via a descriptive approach, which involved a systematic description of a summary of the findings with tabulation of data

(table 1)<sup>20-25</sup>. The purpose of the descriptive synthesis was to categorize the findings and evaluate the effects of night-shift work on the mental health of nurses in various studies. The elements of mental health mostly evaluated in the studies are sleep quality, mood, and cognition.

## Results

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-text 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 1). The selected studies were mostly cross-sectional studies (n=6), and one experimental study involving gene analysis (table 1).

### THE MAIN FINDINGS OF THE SELECTED PAPERS

Clock gene polymorphisms may influence the adverse effects associated with circadian rhythm disruptions caused by working the night shift among nurses. Gamble et al.<sup>20</sup>, 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<sup>20</sup>. 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<sup>20</sup>. Øyane et al.<sup>7</sup> 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<sup>7</sup>. According to Ferri et al.<sup>21</sup> 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<sup>21</sup>. According to Jensen et al.<sup>22</sup>, 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<sup>23</sup> 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.<sup>23</sup> According to the findings of a study by Dai et al.<sup>24</sup>, 353 nurses (40.8%) 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.<sup>24</sup> According to Feng et al.<sup>25</sup>, 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<sup>25</sup>.

## Discussion

Working night shifts is associated with negative mental health consequences, such as depression<sup>24,25</sup>. According to Dai et al.<sup>24</sup>, Chinese nurses

**Table 1.** Summary of the included studies.

Authors	Country	Study design	Year	Sample size	Objectives	Outcomes	Quality assessment Score
Gamble et al	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. <sup>7</sup>	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. <sup>21</sup>	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

(Continued) - Table 1

(Continued) - Table 1

Authors	Country	Study design	Year	Sample size	Objectives	Outcomes	Quality assessment Score
Jensen et al. <sup>22</sup>	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. <sup>23</sup>	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. <sup>24</sup>	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. <sup>25</sup>	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

working night shifts were younger, had a lower job rank and marriage rate, and worked longer hours. Furthermore, marital status was linked to symptoms of depression. Nevertheless, the high points of their studies were that nurses who worked night shifts had more depressive symptoms than those who worked only day shifts; nurses who had poorer sleep quality had more depressive symptoms; and nurses who worked night shifts had poorer sleep quality than those who worked only day shifts<sup>24</sup>. According to Jensen et al., mental symptoms such as headaches and mood swings are common among nurses working the night shift<sup>22</sup>. When compared to day-shift nurses, night-shift nurses had a higher rate of poor sleep quality<sup>25</sup>. Cognitive performance was reduced among night-shift nurses, which was associated with lack of sleep and reduced alertness<sup>23</sup>. Night-shift work may slowly decrease nurses' work performance and potentially increase their risk of medication errors (e.g., via inattention or mathematical errors), particularly towards the end of the shift<sup>21,23</sup>.

It is important to develop and test interventions to target circadian misalignment, excessive sleepiness, and insomnia among night-shift nurses. Attempts to resynchronize circadian rhythms may reduce depression and other issues associated with night-shift work<sup>26</sup>. Behavioral interventions should be developed and implemented to increase awareness of staying healthy while working as a nurse<sup>27</sup>. Yoga may be useful for relieving occupational stress among nurses working the night shift<sup>28</sup>. Night-shift nurses should endeavour to consume food at appropriate times and eat a healthy diet, such as a diet rich in fibre, polyphenols, and unsaturated fatty acids (Mediterranean diet). Adherence to the Mediterranean diet has been associated with better mental health<sup>29</sup>. Exogenous melatonin can be used to advance the sleep-wake rhythm<sup>30,31</sup>. Eszopiclone, zolpidem, and suvorexant may improve short-term sleep outcomes for adults with insomnia, but precautions should be taken when administering them<sup>32</sup>. Agomelatine, which acts by agonizing melatonergic M1/M2 receptors and antagonizing serotonergic 5-HT<sub>2c</sub> receptors, respectively, may be effective as a resynchronizing agent for resetting the central clock and reducing depressive and anxiety symptoms<sup>33</sup>. Adaptation to shift work can be improved using bright light therapy, and phase resetting is achieved because the individual's light exposure patterns have been synchronised with the baseline circadian phase<sup>34</sup>. Ergonomic work schedules should be implemented by employers to preserve and protect the health of their employees and help minimise the psychological stress induced by working night-shifts<sup>35</sup>. Hospital administrators should develop and implement risk-management schemes to mitigate work-related fatigue among

night-shift nurses and to improve patient safety<sup>36</sup>. Nursing supervisors should consider scheduling pauses/naps among night-shift nurses as a preventive strategy to attenuate the adverse effects of night-shift work<sup>37</sup>. D'Ettoire and Pellicani<sup>38</sup> found that a fast-forward alternating ergonomic shift among healthcare workers was useful in preventing misalignment between sleep-wake rhythm and shift work. The approach was associated with reduced risk as assessed by the Rotating Shiftwork Questionnaire and reduced sleepiness as assessed by the Epworth Sleepiness Scale. They evaluated the alternating ergonomic shifts by preparing work schedules in three phases. The day before the night-shift, the nurses must have had unhindered sleep in the morning before the first shift, awoken without an alarm, and supplemented sleep periods by napping during the afternoon<sup>38</sup>. During night shifts, nurses should have kept shift naps to less than 30 minutes to avoid slow wave sleep and tiredness on waking, taken caffeine only once before napping, eaten satisfactorily to stay relaxed during the shift, and endeavoured to avoid caffeine and nicotine for several hours towards the end of the shift. After the night shift, nurses should have napped for 90 to 180 minutes immediately after getting home, gone outside after waking up, and gone to bed early<sup>38</sup>.

Nurse administrators should identify and implement novel approaches to improve mental wellbeing and sleep quality among nurses working night shifts. Enhancing sleep quality and mental wellbeing among night-shift nurses will improve their overall health, work efficiency and performance. Developing new ideas to improve the sleep patterns and quality among nurses working night shifts is vital in order to convince upcoming nurses to work night shifts. We classified known interventions into non-pharmacological/behavioral approaches, pharmacological approaches, and occupational/regulatory approaches (table 2)<sup>39-42</sup>. Moreover, a combination of the afore-mentioned interventions may be more effective in improving sleep quality, vigilance and mental wellbeing among nurses working night shifts.

In humans and animal models, being active during the normal resting phase generates desynchrony in the hypothalamus, disrupting hormonal and neurobehavioral function<sup>43</sup>. Internal desynchrony has been linked to an increased risk of mental disorders among night-shift nurses<sup>44</sup>. Sleep deprivation is linked to poor cognitive performance (inattention and episodic memory)<sup>45</sup>. Circadian misalignment is associated with night-shift work, leading to sleepiness, drowsiness, and fatigue, not only among nurses but among the general healthcare workforce<sup>46</sup>. However, scheduled naps in the hospital setting appear to be an effective strategy to mitigate drowsiness and improve alertness among nurses during night duty<sup>47</sup>.

**Table 2.** 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. <sup>39</sup>	<p><b>Pharmacological approach:</b> To determine the effects of melatonin administration on sleep measures and attention/concentration tasks among doctors and nurses working night shifts.</p>	<p>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.</p>	<p>Double-digit addition testing, a concentration/attention task, improved with melatonin treatment (<math>P &lt; 0.0001</math>).</p>	<p>Exogenous melatonin administration was effective in improving vigilance among doctors and nurses working night shifts.</p>
Miyoshi <sup>28</sup>	<p><b>Non-pharmacological approach:</b> To ascertain whether restorative yoga is an efficient technique for reducing occupational stress among female nurses working night shifts in Japan.</p>	<p>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 Questionnaire before and after performing restorative yoga.</p>	<p>The mean questionnaire score for psychological and physical stress reactions, was significantly decreased after the group yoga session (<math>P = 0.000</math>). The mean score was significantly lower after 4 weeks of home-based practice than before or after group yoga practice (<math>P = 0.001</math>).</p>	<p>Restorative yoga may be an effective strategy for reducing occupational stress among female nurses working night shifts.</p>
Chang et al. <sup>40</sup>	<p><b>Non-pharmacological approach:</b> To assess the effect of aromatherapy massage on sleep quality of nurses working monthly rotating night shifts.</p>	<p>53 female nurses on monthly rotating shifts, having a total Pittsburgh Sleep Quality Index (PSQI) <math>\geq 5</math>, and</p>	<p>The treatment group had a significant decrease in PSQI after aromatherapy when compared to their previous state (<math>P &lt; 0.001</math>) signifying an improvement in sleep quality.</p>	<p>Aromatherapy massage could improve sleep quality among nurses working monthly rotating night shifts.</p>

(Continued) - Table 2



<i>(Continued)</i> - Table 1				
Study details	Type and objectives of intervention	Methodology	Significance of the outcome measures	Conclusion
Huang et al. <sup>41</sup>	<p><b>Non-pharmacological approach:</b> 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.</p>	<p>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 message or resting time and the following night.</p> <p>Female hospital nurses on rotational shifts during the evening or night shift with an Insomnia Severity Index (ISI) score &gt; 14 were registered for the study. Subjects in the treatment group (n= 46) were exposed to 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.</p>	<p>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&lt;0.001).</p>	<p>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.</p>

*(Continued)* - Table 2

(Continued) - Table 1

Study details	Type and objectives of intervention	Methodology	Significance of the outcome measures	Conclusion
Smith-Coggins et al. <sup>42</sup>	<p><b>Occupational/regulatory approach:</b> To determine whether a 40-minute nap break at 3 am can improve cognitive and psychomotor performance among medical doctors and nurses working 12-hour night shifts.</p>	<p>A total number of 49 doctors and nurses working 3 successive night shifts in an emergency unit were randomized to a control group (no-nap condition=NONE) or nap intervention group (40-minute nap break at 3 am=NAP). The major outcome measures were the Psychomotor Vigilance Task, Probe Recall Memory Task, CathSim intravenous insertion virtual reality simulation, and Profile of Mood States, which were administered before (6:30 pm), during (4 am), and after (7:30 am) night shifts. A 40-minute driving simulation was run at 8 am and filmed for behavioral signs of sleepiness and driving accuracy, moreover during the nap period. Furthermore, essential polysomnographic data were recorded.</p>	<p>Polysomnographic data showed that 90% of NAP participants were able to sleep for an average of 24.8 minutes (SD 11.1). At 7:30 am subjects in the NAP category had less performance lapses (NAP 3.13, NONE 4.12; <math>p&lt;0.03</math>; mean difference 0.99; 95% CI: -0.1-2.08), had more vitality (NAP 4.44, NONE 2.39; <math>p&lt;0.03</math>; mean difference 2.05; 95% CI: 0.63-3.47), less fatigue (NAP 7.4, NONE 10.43; <math>p&lt;0.05</math>; mean difference 3.03; 95% CI: 1.11-4.95), and less sleepiness (NAP 5.36, NONE 6.48; <math>p&lt;0.03</math>; mean difference 1.12; 95% CI: 0.41-1.83). The subjects in the NAP group completed intravenous insertion faster (NAP 66.40 sec, NONE 86.48 sec; <math>p=0.10</math>; mean difference 20.08; 95% CI: 4.64-35.52), and demonstrated less drowsy and rough driving, and displayed less behavioral indications of sleepiness during the driving simulation.</p>	<p>A nap at 3 am increased performance and reduced sleepiness and fatigue among physicians and nurses at 7:30 am compared to a no-nap group.</p>

Two to 3 hours of napping during the night shift increases the likelihood of recovery after work<sup>48</sup>.

Salivary cortisol levels have been found to be higher for night-shift nurses compared with day-shift neonatal intensive care unit nurses, suggesting that night-shift work is associated with higher levels of physiological stress<sup>49</sup>. The degree of fatigue is usually aggravated among nurses after night shifts<sup>50</sup>. Circadian disruption has been linked to the development of mood disorders<sup>51</sup>. Sleep disturbances and diurnal mood swings are common in depressed patients<sup>52</sup>. In one study, being at elevated risk of experiencing SWSD was the most significant statistical predictor of depression<sup>53</sup>. The pathophysiological mechanism underlying the link between circadian disruption and depression remains unknown<sup>54</sup>. Clock genes are thought to play a role in mood regulation<sup>55</sup>. Circadian genes such as *CLOCK*, *ARNTL1*, *NPAS2*, *PER3* and *NR1D1* have been linked to bipolar and depressive disorders<sup>56</sup>, implying that genetic, and environmental factors associated with internal desynchronization may be involved in the pathophysiology of mood disorders<sup>57</sup>. Behavioural sleep approaches are associated with nurses' adaptation to a typical night-shift schedule<sup>58</sup>. Nurses are essential for the safety and well-being of patients. Therefore, the implementation of new sleep promotion strategies may reduce sleep/wake dysregulation among nurses and improve their overall wellbeing and job performance<sup>59</sup>.

#### FUTURE PERSPECTIVES

Night-shift work has adverse health consequences for nurses worldwide, and it can affect their job performance and compromise patient safety. Therefore, there is a need to design effective measures to mitigate the adverse health correlates of night-shift work on the wellbeing of nurses. 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<sup>60</sup>. 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.

#### RECOMMENDATIONS FOR NURSING MANAGEMENT

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.

#### STRENGTHS AND LIMITATIONS

The strengths of this review were that it addressed the potential association between circadian disruption, poor sleep quality and the mental health of nurses, and mechanistic insight that may help in the design of new workplace sleep promotion interventions for nurses. The limitations of this review were that most included studies were cross-sectional, and some publications analysed mostly self-reported data.

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#### Conclusions

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. Night-shift work is associated with psychological distress and impaired concentration among nurses and may contribute to the development of depressive and anxiety disorders. Night-shift work may also contribute to errors and poor performance in the workplace. Interventions to mitigate the potential adverse impact of night-shift work on mental wellbeing should aim to restore disrupted circadian rhythms or prevent further disruption of the physiologic clock by identifying and improving physical, psychosocial, behavioral, biological, and environmental factors contributing to performance among nurses during the night shift in every work setting.

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#### References

1. Gao X, Jiang L, Hu Y, Li L, Hou L. Nurses' experiences regarding shift patterns in isolation wards during the

- COVID-19 pandemic in China: a qualitative study. *J Clin Nurs* 2020; 29: 4270-80.
2. Marquie JC, Tucker P, Folkard S, Gentil C, Ansiau D. Chronic effects of shift work on cognition: findings from the VISAT longitudinal study. *Occup Environ Med* 2015; 72: 258-64.
  3. Reinberg A, Ashkenazi I. Internal desynchronization of circadian rhythms and tolerance to shift work. *Chronobiol Int* 2008; 25: 625-43.
  4. Nicholls SK, Casiraghi LP, Wang W, Weber ET, Harrington ME. Evidence for Internal Desynchrony Caused by Circadian Clock Resetting. *Yale J Biol Med* 2019; 92: 259-70.
  5. D'Ettoire G, Pellicani V, Caroli A, Greco M. Shift work sleep disorder and job stress in shift nurses: implications for preventive interventions. *Med Lav* 2020; 111: 195-202.
  6. Thorpy M. Understanding and diagnosing shift work disorder. *Postgrad Med* 2011; 123: 96-105.
  7. Øyane NM, Pallesen S, Moen BE, Akerstedt T, Bjorvatn B. Associations between night work and anxiety, depression, insomnia, sleepiness and fatigue in a sample of Norwegian nurses. *PLoS One* 2013; 8: e70228.
  8. Flo E, Pallesen S, Magerøy N, et al. Shift work disorder in nurses: assessment, prevalence and related health problems. *PLoS One* 2012; 7: e33981.
  9. Olds DM, Clarke SP. The effect of work hours on adverse events and errors in health care. *J Safety Res* 2010; 41: 153-62.
  10. Scott LD, Hwang WT, Rogers AE, Nysse T, Dean GE, Dinges DF. The relationship between nurse work schedules, sleep duration, and drowsy driving. *Sleep* 2007; 30: 1801-7.
  11. Lee ML, Howard ME, Horrey WJ, et al. High risk of near-crash driving events following night-shift work. *Proc Natl Acad Sci U S A* 2016; 113: 176-81.
  12. Molzof HE, Prapanjaroensin A, Patel VH, et al. Misaligned core body temperature rhythms impact cognitive performance of hospital shift work nurses. *Neurobiol Learn Mem* 2019; 160: 151-9.
  13. Di Muzio M, Diella G, Di Simone E, et al. Nurses and night shifts: poor sleep quality exacerbates psychomotor performance. *Front Neurosci* 2020; 14: 579938.
  14. Ganesan S, Magee M, Stone JE, et al. The Impact of shift work on sleep, alertness and performance in healthcare workers. *Sci Rep* 2019; 9: 4635.
  15. Barger LK, Lockley SW, Rajaratnam SM, Landrigan CP. Neurobehavioral, health, and safety consequences associated with shift work in safety-sensitive professions. *Curr Neurol Neurosci Rep* 2009; 9: 155-64.
  16. Di Muzio M, Reda F, Diella G, et al. Not only a problem of fatigue and sleepiness: Changes in psychomotor performance in Italian nurses across 8-h rapidly rotating shifts. *J Clin Med* 2019; 8: 47.
  17. Smith MR, Eastman CI. Shift work: health, performance and safety problems, traditional countermeasures, and innovative management strategies to reduce circadian misalignment. *Nat Sci Sleep* 2012; 4: 111-32.
  18. Crowley SJ, Lee C, Tseng CY, Fogg LF, Eastman CI. Combinations of bright light, scheduled dark, sunglasses, and melatonin to facilitate circadian entrainment to night shift work. *J Biol Rhythms* 2003; 18: 513-23.
  19. NIH National Heart, Lung and Blood Institute. Study quality assessment tools. Retrieved from: <https://bit.ly/3Me72gT> [last accessed July 1, 2021].
  20. Gamble KL, Motsinger-Reif AA, Hida A, et al. Shift work in nurses: contribution of phenotypes and genotypes to adaptation. *PLoS One* 2011; 6: e18395.
  21. Ferri P, Guadi M, Marcheselli L, et al. The impact of shift work on the psychological and physical health of nurses in a general hospital: a comparison between rotating night shifts and day shifts. *Risk Manag Healthc Policy* 2016; 9: 203-11.
  22. Jensen HI, Larsen JW, Thomsen TD. The impact of shift work on intensive care nurses' lives outside work: a cross-sectional study. *J Clin Nurs* 2018; 27: e703-e709.
  23. Zion N, Shochat T. Cognitive functioning of female nurses during the night shift: the impact of age, clock time, time awake and subjective sleepiness. *Chronobiol Int* 2018; 35: 1595-607.
  24. Dai C, Qiu H, Huang Q, et al. The effect of night shift on sleep quality and depressive symptoms among Chinese nurses. *Neuropsychiatr Dis Treat* 2019; 15: 435-40.
  25. Feng HL, Qi XX, Xia CL, Xiao SQ, Fan L. Association between night shift and sleep quality and health among Chinese nurses: a cross-sectional study. *J Nurs Manag* 2021; 29: 2123-31.
  26. Jakovljević M. Agomelatine as chronopsychopharmaceuticals restoring circadian rhythms and enhancing resilience to stress: a wishful thinking or an innovative strategy for superior management of depression? *Psychiatr Danub* 2011; 23: 2-9.
  27. Beebe D, Chang JJ, Kress K, Mattfeldt-Beman M. Diet quality and sleep quality among day and night shift nurses. *J Nurs Manag* 2017; 25: 549-57.
  28. Miyoshi Y. Restorative yoga for occupational stress among Japanese female nurses working night shift: randomized crossover trial. *J Occup Health* 2019; 61: 508-16.
  29. Muñoz MA, Fito M, Marrugat J, et al. Adherence to the Mediterranean diet is associated with better mental and physical health. *Br J Nutr* 2009; 101: 1821-7.
  30. van Geijlswijk IM, Korzilius HP, Smits MG. The use of exogenous melatonin in delayed sleep phase disorder: a meta-analysis. *Sleep* 2010; 33: 1605-14.
  31. Dahlitz M, Alvarez B, Vignau J, et al. Delayed sleep phase syndrome response to melatonin. *Lancet* 1991; 337: 1121-4.
  32. Wilt TJ, MacDonald R, Brasure M, et al. Pharmacologic treatment of insomnia disorder: an evidence report for a Clinical Practice Guideline by the American College of Physicians. *Ann Intern Med* 2016; 165: 103-12.
  33. Kasper S, Hajak G, Wulff K, et al. Efficacy of the novel antidepressant agomelatine on the circadian rest-activity cycle and depressive and anxiety symptoms in patients with major depressive disorder: a randomized, double-blind comparison with sertraline. *J Clin Psychiatry* 2010; 71: 109-20.
  34. Stone JE, Sletten TL, Magee M, et al. Temporal dynamics of circadian phase shifting response to consecutive night shifts in healthcare workers: role of light-dark exposure. *J Physiol* 2018; 596: 2381-95.
  35. Järvelin-Pasanen S, Ropponen A, Tarvainen M, et al. Effects of implementing an ergonomic work schedule on heart rate variability in shift-working nurses. *J Occup Health* 2013; 55: 225-33.
  36. Querstret D, O'Brien K, Skene DJ, Maben J. Improving fatigue risk management in healthcare: a systematic scoping review of sleep-related/fatigue-management interventions for nurses and midwives. *Int J Nurs Stud* 2020; 106: 103513.
  37. Zion N, Shochat T. Let them sleep: the effects of a scheduled nap during the night shift on sleepiness and cognition in hospital nurses. *J Adv Nurs* 2019; 75: 2603-15.
  38. D'Ettoire G, Pellicani V. Preventing shift work disorder in shift health-care workers. *Safety Health Work* 2020; 11: 244-7.
  39. Thottakam BMVJ, Webster NR, Allen L, et al. Melatonin is a feasible, safe, and acceptable intervention in doctors and nurses working nightshifts: The MIDNIGHT Trial. *Front Psychiatry* 2020; 11: 872.
  40. Chang YY, Lin CL, Chang LY. The effects of aromatherapy massage on sleep quality of nurses on monthly rotating night shifts. *Evid Based Complement Alternat Med* 2017; 2017: 3861273.

41. Huang LB, Tsai MC, Chen CY, Hsu SC. The effectiveness of light/dark exposure to treat insomnia in female nurses undertaking shift work during the evening/night shift. *J Clin Sleep Med* 2013; 9: 641-6.
42. Smith-Coggins R, Howard SK, Mac DT, et al. Improving alertness and performance in emergency department physicians and nurses: the use of planned naps. *Ann Emerg Med* 2006; 48: 596-604.e6043.
43. Oriyama S, Miyakoshi Y, Rahman MM. The effects of a 120-minute nap on sleepiness, fatigue, and performance during 16-hour night shifts: a pilot study. *J Occup Health* 2019; 61: 368-77.
44. Salgado-Delgado R, Nadia S, Angeles-Castellanos M, Buijs RM, Escobar C. In a rat model of night work, activity during the normal resting phase produces desynchrony in the hypothalamus. *J Biol Rhythms* 2010; 25: 421-31.
45. Brown JP, Martin D, Nagaria Z, et al. Mental health consequences of shift work: an updated review. *Curr Psychiatry Rep* 2020; 22: 7.
46. Fortier-Brochu E, Morin CM. Cognitive impairment in individuals with insomnia: clinical significance and correlates. *Sleep* 2014; 37: 1787-98.
47. Khan WAA, Jackson ML, Kennedy GA, Conduit R. A field investigation of the relationship between rotating shifts, sleep, mental health and physical activity of Australian paramedics. *Sci Rep* 2021; 11: 866.
48. Han K, Hwang H, Lim E, et al. Scheduled naps improve drowsiness and quality of nursing care among 12-hour shift nurses. *Int J Environ Res Public Health* 2021; 18: E891.
49. Palermo TA, Rotenberg L, Zeitoune RC, et al. Napping during the night shift and recovery after work among hospital nurses. *Rev Lat Am Enfermagem* 2015; 23: 114-21.
50. Brand MC, Shippey H, Hagan J, et al. Comparison of psychological and physiological stress in NICU Nurses: effects of unit design and shift. *Adv Neonatal Care* 2021; 21: E93-E100.
51. Anvekar AP, Nathan EA, Doherty DA, Patole SK. Effect of shift work on fatigue and sleep in neonatal registrars. *PLoS One* 2021; 16: e0245428.
52. Germain A, Kupfer DJ. Circadian rhythm disturbances in depression. *Hum Psychopharmacol* 2008; 23: 571-85.
53. Booker LA, Sletten TL, Alvaro PK, et al. Exploring the associations between shift work disorder, depression, anxiety and sick leave taken amongst nurses. *J Sleep Res* 2020; 29: e12872.
54. Zaki NFW, Spence DW, BaHammam AS, et al. Chronobiological theories of mood disorder. *Eur Arch Psychiatry Clin Neurosci* 2018; 268: 107-18.
55. McClung CA. Circadian genes, rhythms and the biology of mood disorders. *Pharmacol Ther* 2007; 114: 222-32.
56. Etain B, Milhiet V, Bellivier F, Leboyer M. Genetics of circadian rhythms and mood spectrum disorders. *Eur Neuropsychopharmacol* 2011; 21 (Suppl 4): S676-S682.
57. Lanfumey L, Mongeau R, Hamon M. Biological rhythms and melatonin in mood disorders and their treatments. *Pharmacol Ther* 2013; 138: 176-84.
58. Petrov ME, Clark CB, Molzof HE, et al. Sleep strategies of night-shift nurses on days off: which ones are most adaptive? *Front Neurol* 2014; 5: 277.
59. Alsharari AF, Abuadas FH, Hakami MN, Darraj AA, Hakami MW. Impact of night shift rotations on nursing performance and patient safety: a cross-sectional study. *Nurs Open* 2021; 8: 1479-88.
60. St Hilaire MA, Lammers-van der Holst HM, Chinoy ED, Isherwood CM, Duffy JF. Prediction of individual differences in circadian adaptation to night work among older adults: application of a mathematical model using individual sleep-wake and light exposure data. *Chronobiol Int* 2020; 37: 1273-82.

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