



Therapeutic interventions for controlling sleep disorder: An overview

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Abstract

Sleep disorders are among the most common health problems worldwide and significantly affect physical, psychological, and social well-being. Disturbed sleep contributes to impaired cognitive function, metabolic dysfunction, cardiovascular diseases, obesity, diabetes, depression, and reduced quality of life. Various therapeutic interventions have been developed to manage sleep disorders, including pharmacological treatments, behavioural therapies, lifestyle modifications, nutritional interventions, and emerging technological approaches. This review provides a comprehensive overview of different therapeutic strategies used in controlling sleep disorders, emphasizing their mechanisms, effectiveness, advantages, and limitations. The article also highlights recent advances in integrative and personalized therapies for improving sleep quality and overall health outcomes.

Keywords: Sleep disorder, insomnia, cognitive behavioural therapy, pharmacological therapy, melatonin, nutrition, lifestyle modification, sleep hygiene

Introduction

Sleep is a vital biological process essential for maintaining physiological homeostasis, cognitive performance, immune function, hormonal regulation, and emotional stability (Irwin, 2015) [8]. Adequate sleep is necessary for tissue repair, memory consolidation, metabolic balance, and overall health maintenance (Walker, 2017) [17]. Sleep disorders are conditions that disturb normal sleep patterns, affecting sleep quality, timing, and duration (Sateia, 2014) [14]. Common sleep disorders include insomnia, sleep apnea, restless leg syndrome, narcolepsy, circadian rhythm disorders, and parasomnias (American Academy of Sleep Medicine, 2021) [2].

Modern lifestyle changes, increased stress, excessive screen exposure, poor dietary habits, shift work, and reduced

physical activity have contributed to the increasing prevalence of sleep disorders globally (Grandner, 2017) [6]. Chronic sleep disturbances are associated with hypertension, cardiovascular disease, obesity, diabetes mellitus, anxiety, depression, and neurodegenerative diseases (Cappuccio *et al.*, 2010 [4]; Fernández-Mendoza & Vgontzas, 2013) [5]. Therefore, effective therapeutic interventions are essential for improving sleep health and preventing long-term complications. This review discusses major therapeutic interventions used for controlling sleep disorders, including pharmacological and non-pharmacological approaches, nutritional therapies, behavioural interventions, and emerging innovative treatments.

Classification of Sleep Disorders

Table 1: Sleep disorders and several major groups

Type of Sleep Disorder	Description
Insomnia	Difficulty initiating or maintaining sleep
Sleep Apnea	Repeated interruption of breathing during sleep
Narcolepsy	Excessive daytime sleepiness with sudden sleep attacks
Restless Leg Syndrome	Uncomfortable leg sensations causing urge to move
Circadian Rhythm Disorders	Disruption of biological sleep-wake cycle
Parasomnias	Abnormal behaviours during sleep such as sleepwalking

Pharmacological Interventions

Sleep is a vital biological process essential for maintaining physiological homeostasis, cognitive performance, immune function, hormonal regulation, and emotional stability (Irwin, 2015) [8]. Adequate sleep plays a critical role in tissue repair, memory consolidation, metabolic balance, and overall health maintenance (Walker, 2017) [17]. Sleep disorders are conditions that disrupt normal sleep patterns, affecting sleep quality, duration, and timing, and include insomnia, sleep apnea, restless leg syndrome, narcolepsy, circadian rhythm disorders, and parasomnias (Sateia, 2014) [14]. In recent decades, modern lifestyle factors such as

increased psychological stress, excessive screen exposure, poor dietary habits, sedentary behaviour, and shift work have significantly contributed to the rising prevalence of sleep disorders worldwide (Grandner, 2017) [6]. Chronic sleep disturbances are strongly associated with several adverse health outcomes, including hypertension, cardiovascular diseases, obesity, diabetes mellitus, anxiety, depression, and neurodegenerative disorders (Cappuccio *et al.*, 2010 [4]; Fernández-Mendoza & Vgontzas, 2013) [5]. Therefore, effective therapeutic interventions are necessary to improve sleep quality, restore normal sleep patterns, and reduce long-term health complications. This review

highlights various therapeutic strategies for controlling sleep disorders, including pharmacological treatments, behavioural and cognitive therapies, nutritional interventions, lifestyle modifications, and emerging innovative approaches.

1. Benzodiazepines

Benzodiazepines are among the most commonly prescribed pharmacological agents for the treatment of insomnia and anxiety-related sleep disturbances. Drugs such as diazepam, lorazepam, and temazepam act by enhancing the activity of gamma-aminobutyric acid (GABA), the primary inhibitory neurotransmitter in the central nervous system, thereby producing sedative, hypnotic, muscle relaxant, and anxiolytic effects (Roehrs & Roth, 2018) ^[13]. These medications are effective in reducing sleep latency, increasing total sleep duration, and improving sleep continuity, particularly in patients suffering from acute insomnia and stress-related sleep disorders (Morin & Benca, 2012) ^[10]. Benzodiazepines are known for their rapid onset of action and effectiveness in relieving anxiety-associated sleep problems. However, prolonged use may lead to tolerance, dependence, cognitive impairment, daytime drowsiness, memory disturbances, and withdrawal symptoms upon discontinuation (Krystal, 2009) ^[9]. Due to these potential adverse effects, benzodiazepines are generally recommended for short-term use under medical supervision.

Advantages

- Rapid onset of action
- Effective for acute insomnia
- Reduces anxiety-related sleep disturbances

Limitations

- Risk of dependence and tolerance
- Daytime drowsiness
- Cognitive impairment
- Withdrawal symptoms

2. Non-Benzodiazepine Hypnotics

Non-benzodiazepine hypnotics, commonly referred to as “Z-drugs,” include zolpidem, zaleplon, and eszopiclone, which are widely prescribed for the management of insomnia due to their improved safety profile and lower risk of adverse effects compared to traditional benzodiazepines (Roehrs & Roth, 2018) ^[13]. These medications selectively bind to GABA-A receptor subtypes in the brain, producing sedative effects that help initiate and maintain sleep while causing minimal disruption to normal sleep architecture (Krystal, 2009) ^[9]. Non-benzodiazepine hypnotics are particularly effective in reducing sleep latency, improving sleep duration, and enhancing sleep quality in individuals with short-term insomnia (Morin & Benca, 2012) ^[10]. Additionally, these drugs generally produce less daytime sedation, reduced cognitive impairment, and lower risk of dependence when used appropriately. However, prolonged or inappropriate use may still lead to side effects such as dizziness, headache, memory disturbances, complex sleep-related behaviours, and rebound insomnia after discontinuation (Sateia, 2014) ^[14]. Therefore, careful monitoring and short-term therapeutic use are recommended for optimal clinical outcomes.

Benefits

- Improved sleep initiation
- Lower risk of dependence
- Reduced next-day sedation

Limitations

- Possible memory disturbances
- Sleepwalking behaviours
- Limited long-term effectiveness

3. Melatonin and Melatonin Receptor Agonists

Melatonin is a naturally occurring hormone synthesized by the pineal gland that plays a crucial role in regulating the circadian rhythm and maintaining the normal sleep–wake cycle (Hardeland *et al.*, 2012) ^[7]. Melatonin secretion is influenced by light exposure, with higher production occurring during darkness to promote sleep initiation. Melatonin supplements and melatonin receptor agonists are widely used in the management of sleep disorders such as insomnia, jet lag, circadian rhythm sleep disorders, and shift-work sleep disturbances (Zisapel, 2018) ^[21]. These agents improve sleep onset, enhance sleep quality, and help synchronize disrupted biological rhythms, particularly in elderly individuals who often experience reduced endogenous melatonin production (Wade *et al.*, 2011) ^[16]. Ramelteon, a selective melatonin receptor agonist, acts on MT1 and MT2 receptors in the suprachiasmatic nucleus to promote sleep initiation without causing significant dependence or withdrawal symptoms commonly associated with sedative hypnotics (Pandi-Perumal *et al.*, 2009) ^[11]. Due to their favourable safety profile and minimal cognitive side effects, melatonin-based therapies are increasingly recommended as safer alternatives for long-term sleep management.

Therapeutic Effects

- Regulates sleep–wake cycle
- Improves sleep onset
- Useful in elderly populations

Examples

- Melatonin supplements
- Ramelteon

4. Antidepressants and Antipsychotics

Certain antidepressants and antipsychotic medications are commonly prescribed for the treatment of insomnia associated with psychiatric conditions such as depression, anxiety, and mood disorders (Krystal, 2009) ^[9]. Antidepressants including trazodone and mirtazapine possess sedative properties that help improve sleep onset, increase sleep duration, and reduce nighttime awakenings in patients experiencing comorbid insomnia and depressive symptoms (Wichniak *et al.*, 2017) ^[19]. These medications act by modulating neurotransmitters such as serotonin, norepinephrine, and histamine, thereby promoting relaxation and improving sleep quality. Similarly, some atypical antipsychotics, including quetiapine and olanzapine, are occasionally used off-label for severe insomnia due to their sedative effects (Riemann *et al.*, 2017) ^[12]. Although these drugs can be effective in improving both mood and sleep disturbances, their long-term use may be associated with adverse effects such as daytime sedation, weight gain, metabolic dysfunction, cardiovascular complications, and cognitive impairment (Morin & Benca, 2012) ^[10]. Therefore, antidepressants and antipsychotics should be prescribed carefully, particularly in vulnerable populations, and preferably as part of a comprehensive treatment plan that includes behavioural and psychological interventions.

Benefits

- Improve mood and sleep quality
- Helpful in psychiatric sleep disorders

Limitations

- Weight gain
- Sedation
- Cardiovascular side effects

5. Cognitive Behavioural Therapy for Insomnia (CBT-I)

Cognitive Behavioural Therapy for Insomnia is considered the first-line non-pharmacological treatment for chronic insomnia. CBT-I focuses on modifying negative thoughts and behaviours that interfere with sleep.

Table 2: Components of CBT-I

Component	Function
Sleep Hygiene Education	Promotes healthy sleep habits
Stimulus Control	Associates bed with sleep only
Sleep Restriction	Limits time in bed to improve sleep efficiency
Relaxation Therapy	Reduces stress and anxiety
Cognitive Therapy	Changes dysfunctional beliefs about sleep

Benefits of CBT-I

- Long-term effectiveness
- No medication dependence
- Improves sleep quality naturally
- Reduces relapse rates

Numerous studies have demonstrated that CBT-I is highly effective in improving sleep latency, sleep efficiency, and daytime functioning.

Lifestyle and Behavioural Interventions

Lifestyle and behavioural interventions play a critical role in the prevention and management of sleep disorders by improving sleep quality, regulating circadian rhythm, and reducing factors that negatively affect sleep health (Grandner, 2017) ^[6]. Unhealthy lifestyle practices such as irregular sleep schedules, excessive caffeine intake, poor dietary habits, lack of physical activity, increased screen exposure, and chronic stress are major contributors to insomnia and other sleep-related disorders (Watson *et al.*, 2015) ^[18]. Behavioural approaches including sleep hygiene education, stress management, relaxation techniques, regular physical exercise, and mindfulness-based therapies have shown significant effectiveness in improving sleep onset, sleep duration, and overall sleep efficiency (Trauer *et al.*, 2015) ^[18]. Maintaining a consistent sleep-wake routine, limiting electronic device use before bedtime, creating a comfortable sleep environment, and avoiding stimulants during evening hours are commonly recommended strategies for promoting healthy sleep patterns. Additionally, regular exercise and meditation help reduce anxiety, enhance mood, and improve physiological relaxation, thereby supporting better sleep quality (Irwin, 2015) ^[18]. These non-pharmacological interventions are considered safe, cost-effective, and sustainable approaches for long-term sleep disorder management.

1. Sleep Hygiene Practices

Sleep hygiene refers to habits and environmental factors that promote healthy sleep.

Recommended Practices

- Maintaining regular sleep schedules
- Avoiding caffeine before bedtime
- Limiting alcohol and nicotine intake
- Reducing screen exposure at night
- Creating a dark and quiet sleep environment

2. Physical Activity

Regular exercise improves sleep quality by reducing stress, anxiety, and metabolic dysfunction.

Benefits

- Increased sleep duration
- Reduced sleep onset latency
- Enhanced slow-wave sleep

Moderate aerobic exercise and yoga are particularly beneficial for individuals with insomnia.

3. Stress Management

Stress is a major contributor to sleep disturbances.

Techniques

- Meditation
- Deep breathing exercises
- Progressive muscle relaxation
- Mindfulness therapy

These techniques reduce sympathetic nervous system activity and promote relaxation.

Nutritional Interventions

Nutrition significantly influences sleep regulation through neurotransmitter synthesis, hormonal balance, and circadian rhythm modulation.

1. Tryptophan-Rich Foods

Tryptophan is a precursor of serotonin and melatonin.

Sources

- Milk
- Bananas
- Nuts
- Turkey
- Eggs

Consumption of tryptophan-rich foods may improve sleep onset and sleep quality.

2. Magnesium Supplementation

Magnesium is an essential mineral involved in numerous physiological functions, including nerve conduction, muscle relaxation, neurotransmitter regulation, and maintenance of normal sleep patterns (Abbasi *et al.*, 2012) ^[1]. It plays a significant role in the regulation of gamma-aminobutyric acid (GABA), an inhibitory neurotransmitter that promotes relaxation and reduces neuronal excitability, thereby facilitating sleep initiation and maintenance (Wienecke *et al.*, 2016) ^[20]. Magnesium supplementation has been shown to improve sleep quality, reduce insomnia symptoms, enhance sleep efficiency, and decrease nighttime awakenings, particularly among elderly individuals and people with magnesium deficiency (Abbasi *et al.*, 2012) ^[1]. Additionally, magnesium may help reduce stress, anxiety, and muscle tension, which are common contributing factors to sleep disturbances (Boyle *et al.*, 2017) ^[6]. Due to its calming effects on the nervous system and favourable safety profile, magnesium supplementation is increasingly

considered a beneficial nutritional intervention for the management of sleep disorders and overall sleep health.

Benefits

- Reduces insomnia symptoms
- Improves sleep efficiency
- Enhances muscle relaxation

Conclusion

Sleep disorders represent a major public health concern affecting millions of individuals worldwide. Effective management requires a multidimensional therapeutic approach involving pharmacological treatments, cognitive behavioural therapy, lifestyle modifications, nutritional interventions, and emerging digital technologies. Among available treatments, CBT-I and lifestyle modifications are considered highly effective and sustainable long-term strategies. Nutritional and integrative approaches also show promising outcomes in improving sleep quality and reducing associated complications. Future developments in personalized medicine and innovative technologies may revolutionize sleep disorder management and improve patient outcomes.

References

1. Abbasi B, Kimiagar M, Sadeghniiat K, Shirazi MM, Hedayati M, Rashidkhani B. The effect of magnesium supplementation on primary insomnia in elderly: A double-blind placebo-controlled clinical trial. *Journal of Research in Medical Sciences*,2012;17(12):1161–1169.
2. American Academy of Sleep Medicine. International classification of sleep disorders (3rd ed.). Darien, IL: American Academy of Sleep Medicine, 2021.
3. Boyle NB, Lawton C, Dye L. The effects of magnesium supplementation on subjective anxiety and stress—A systematic review. *Nutrients*,2017;9(5):429.
4. Cappuccio FP, D’Elia L, Strazzullo P, Miller MA. Sleep duration and all-cause mortality: A systematic review and meta-analysis of prospective studies. *Sleep*,2010;33(5):585–592.
5. Fernández-Mendoza J, Vgontzas AN. Insomnia and its impact on physical and mental health. *Current Psychiatry Reports*,2013;15(12):418.
6. Grandner MA. Sleep, health, and society. *Sleep Medicine Clinics*,2017;12(1):1–22.
7. Hardeland R, Cardinali DP, Srinivasan V, Spence DW, Brown GM, Pandi-Perumal SR. Melatonin—A pleiotropic, orchestrating regulator molecule. *Progress in Neurobiology*,2012;93(3):350–384.
8. Irwin MR. Why sleep is important for health: A psychoneuroimmunology perspective. *Annual Review of Psychology*,2015;66:143–172.
9. Krystal AD. Psychiatric disorders and sleep. *Neurologic Clinics*,2009;27(4):885–895.
10. Morin CM, Benca R. Chronic insomnia. *Lancet*,2012;379(9821):1129–1141.
11. Pandi-Perumal SR, Srinivasan V, Spence DW, Cardinali DP, Brown GM, Hardeland R. Ramelteon: A review of its therapeutic potential in sleep disorders. *Advances in Therapy*,2009;26(6):613–626.
12. Riemann D, Baglioni C, Bassetti C, *et al.* European guideline for the diagnosis and treatment of insomnia. *Journal of Sleep Research*,2017;26(6):675–700.
13. Roehrs T, Roth T. Drug-related sleep disorders. *Neurologic Clinics*,2018;30(4):1285–1298.
14. Sateia MJ. International classification of sleep disorders-third edition: Highlights and modifications. *Chest*,2014;146(5):1387–1394.
15. Trauer JM, Qian MY, Doyle JS, Rajaratnam SM, Cunnington D. Cognitive behavioral therapy for chronic insomnia: A systematic review and meta-analysis. *Annals of Internal Medicine*,2015;163(3):191–204.
16. Wade AG, Ford I, Crawford G, McConnachie A, Nir T, Laudon M, *et al.* Nightly treatment of primary insomnia with prolonged release melatonin for six months. *Current Medical Research and Opinion*,2011;27(1):87–98.
17. Walker M. *Why we sleep: Unlocking the power of sleep and dreams*. New York: Scribner, 2017.
18. Watson NF, Badr MS, Belenky G, *et al.* Recommended amount of sleep for a healthy adult: A joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society. *Sleep*,2015;38(6):843–844.
19. Wichniak A, Wierzbicka A, Jernajczyk W, Skalski M. Effects of antidepressants on sleep. *Current Psychiatry Reports*,2017;19(9):63.
20. Wienecke T, Olesen J, Ashina M. Role of magnesium in the pathogenesis and treatment of insomnia and neurological disorders. *Clinical Neuropharmacology*,2016;39(6):345–351.
21. Zisapel N. New perspectives on the role of melatonin in human sleep, circadian rhythms and their regulation. *British Journal of Pharmacology*,2018;175(16):3190–3199.