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Vijayalakshmi P
Head Department of Pharmacology, JKKN Dental College and Hospital, Kumarapalayam, Affiliated to Tamilnadu Dr. MGR Medical University, Tamil Nadu, India

Sonali Das
Assistant Professor in Hospital Management, Brainware University, West Bengal, India

Mousumi Das
SACT -1, Department of Food and Nutrition, Dr Kanailal Bhattacharyya College, West Bengal, India

Indira Ganguly
M.Sc. in Dietetics and Food Service Management, KPC Medical College and Hospital, IGNOU, India

Corresponding Author:
Mousumi Das
SACT -1, Department of Food and Nutrition, Dr Kanailal Bhattacharyya College, West Bengal, India

Therapeutic nutrition against sleep disorder: A critical review

Vijayalakshmi P, Sonali Das, Mousumi Das and Indira Ganguly

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Abstract
Sleep is a fundamental biological process essential for physical, mental, and emotional well-being. With the rising prevalence of sleep disorders globally, there is increasing interest in non-pharmacological approaches, including nutritional strategies, to enhance sleep quality. This critical review explores the emerging evidence on the role of therapeutic nutrition in the management of sleep disorders such as insomnia, sleep apnea, restless leg syndrome, and circadian rhythm disturbances. Key dietary components including macronutrients, micronutrients, functional foods, and dietary patterns are examined for their impact on sleep regulation mechanisms.

Keywords: Insomnia, sleep apnea, functional foods, macronutrients, micronutrients.

1. Introduction
Sleep disorders, including insomnia, obstructive sleep apnea (OSA), narcolepsy, and restless leg syndrome (RLS), affect nearly 30% of the global population, impairing quality of life and increasing the risk for cardiovascular, metabolic, and psychological diseases (Institute of Medicine, 2006) [12]. Pharmacological treatments, while effective, often pose side effects and dependency issues. Consequently, attention has turned toward lifestyle-based interventions such as nutrition, exercise, and stress management. Among these, nutrition is emerging as a key modifiable factor that influences sleep physiology through neurotransmitter regulation, inflammation modulation, and hormonal balance (St-Onge *et al*., 2021) [35].

Sleep is a fundamental biological process essential for physical and mental health, playing a pivotal role in cognitive function, metabolic regulation, immune response, and emotional well-being. Sleep disorders, encompassing conditions like insomnia, obstructive sleep apnea (OSA), restless leg syndrome, and circadian rhythm disruptions, affect millions globally and contribute significantly to the global burden of disease (Medic *et al*., 2017) [22]. Chronic sleep deprivation or disturbed sleep patterns are associated with a higher risk of obesity, cardiovascular disease, diabetes mellitus, depression, and impaired quality of life. Traditional treatments for sleep disorders include pharmacotherapy, behavioural therapy, and cognitive-behavioural interventions. However, recent years have witnessed a growing interest in the role of therapeutic nutrition as a non-pharmacological and complementary approach to managing sleep disorders (St-Onge *et al*., 2021) [35].

Nutrition and sleep are intrinsically linked through bidirectional mechanisms involving metabolic pathways, hormonal regulation, neurotransmitter synthesis, and circadian rhythm alignment. Dietary patterns, specific nutrients, and meal timing can significantly influence sleep architecture, latency, duration, and quality. Conversely, poor sleep can lead to dysregulated appetite control, increased cravings for high-calorie foods, and metabolic disturbances, thereby creating a vicious cycle (Tanaka *et al*., 2018) [37]. As such, therapeutic nutrition—defined as the strategic use of dietary modifications to prevent or treat diseases—offers a promising intervention strategy for individuals suffering from various sleep disturbances.

Among the numerous nutrients implicated in sleep regulation, tryptophan, an essential amino acid, has garnered particular attention. Tryptophan serves as a precursor for serotonin and melatonin, two neurochemicals vital for sleep regulation. Increased intake of tryptophan-rich foods such as turkey, dairy products, bananas, and nuts has been shown to enhance sleep

onset and quality by promoting serotonin and melatonin synthesis (Bravo *et al*., 2013) [4]. Additionally, complex carbohydrates, which facilitate tryptophan transport across the blood-brain barrier by stimulating insulin release, have been linked to improved sleep efficiency and shorter sleep onset latency (Afaghi *et al*., 2007) [2]. In contrast, diets high in saturated fats and added sugars are associated with lighter, less restorative sleep with more arousals throughout the night (St-Onge *et al*., 2021) [35].

Micronutrients also play crucial roles in sleep physiology. Magnesium, known for its involvement in over 300 enzymatic reactions, contributes to the regulation of the hypothalamic-pituitary-adrenal (HPA) axis and GABAergic neurotransmission, both of which are essential for sleep modulation. Magnesium deficiency has been associated with insomnia, increased night time awakenings, and reduced sleep duration (Abbasi *et al*., 2012) [1]. Similarly, zinc and vitamin B6 are involved in neurotransmitter production, particularly serotonin, and have been positively correlated with better sleep quality (Peuhkuri *et al*., 2012) [29]. Vitamin D, through its influence on brain areas involved in sleep regulation and its role in modulating inflammation, has also been linked with various sleep parameters, with deficiency often reported among individuals with sleep disorders such as OSA and insomnia (Gao *et al*., 2018) [7].

Omega-3 fatty acids, especially docosahexaenoic acid (DHA), are crucial for brain health and neuroinflammation control. Studies have indicated that adequate DHA levels are associated with better sleep in both children and adults, possibly by modulating melatonin secretion and reducing anxiety-related arousals (Montgomery *et al*., 2014) [24]. Moreover, polyphenols, particularly those derived from cherries, grapes, and green tea, have demonstrated sleep-enhancing effects due to their antioxidant properties and influence on circadian gene expression (Li *et al*., 2022) [17].

The Mediterranean diet, characterized by high consumption of fruits, vegetables, whole grains, legumes, nuts, olive oil, and moderate intake of fish and dairy, has emerged as a dietary pattern with substantial sleep-promoting benefits. Observational and interventional studies have revealed that adherence to the Mediterranean diet is associated with improved sleep quality, reduced risk of insomnia, and better sleep duration (St-Onge *et al*., 2022) [36]. The synergistic action of dietary fiber, antioxidants, anti-inflammatory compounds, and low glycemic load appears to support circadian alignment and neuroendocrine balance essential for sleep regulation.

Chrononutrition—a growing field that examines the interplay between circadian rhythms and food intake timing—adds another dimension to therapeutic nutrition against sleep disorders. Research indicates that the timing of meals can either support or disrupt circadian rhythms, with late-night eating, irregular meal patterns, and prolonged fasting during the active phase negatively impacting melatonin synthesis and sleep-wake cycles (Jakubowicz *et al*., 2017) [13]. For instance, consuming a large, carbohydrate-rich meal four hours before bedtime has been shown to enhance sleep onset latency compared to meals consumed closer to sleep time (Afaghi *et al*., 2007) [2].

In the context of sleep disorders such as insomnia, therapeutic diets and supplementation protocols offer alternative strategies with fewer side effects compared to pharmacological agents. For example, melatonin supplementation, when combined with magnesium and zinc, has been shown to be particularly effective in improving sleep efficiency and reducing nocturnal awakenings in older adults (Rondanelli *et al*., 2011) [33]. Additionally, low glycemic index (GI) diets, which stabilize blood glucose levels, have demonstrated potential in improving subjective sleep quality and reducing nighttime awakenings in individuals with sleep disturbances (Gangwisch *et al*., 2015) [6].

Despite these promising findings, challenges remain in establishing definitive dietary guidelines for sleep improvement. Many existing studies are observational or cross-sectional in nature, limiting causal inferences. Randomized controlled trials (RCTs) with rigorous methodologies are needed to explore the specific effects of nutrients, foods, and dietary patterns on various types of sleep disorders across diverse populations. Individual variability in metabolism, genetic polymorphisms, and gut microbiota composition may further influence the relationship between diet and sleep outcomes (Benedict *et al*., 2012) [3].

Furthermore, the role of gut microbiota in sleep regulation is gaining traction. Emerging evidence suggests that diet-induced alterations in gut microbial composition can impact the brain-gut axis and influence sleep patterns through immune modulation, production of microbial metabolites like short-chain fatty acids, and interactions with circadian rhythms (Kaczmarek *et al*., 2017) [14]. Probiotic and prebiotic interventions are being investigated for their role in improving sleep and alleviating stress-related sleep disturbances.

Therapeutic nutrition represents a critical and emerging avenue in the management of sleep disorders (Tewari, 2019) [38]. By understanding and leveraging the intricate connections between diet, neurobiology, and circadian biology, health practitioners can offer personalized, non-invasive, and sustainable interventions for individuals suffering from poor sleep. This review critically explores the existing literature on the role of macronutrients, micronutrients, dietary patterns, and meal timing in influencing sleep quality and disorders. It highlights the potential of nutrition-based strategies to complement traditional therapies and provides direction for future research aimed at optimizing sleep health through dietary means.

2. Mechanisms Linking Nutrition and Sleep

The regulation of sleep is mediated by the interaction of several neurochemical systems, particularly those involving serotonin, melatonin, gamma-aminobutyric acid (GABA), and orexin. Nutritional components can influence these systems through:

- Tryptophan, an essential amino acid precursor for serotonin and melatonin
- Magnesium, which enhances GABA activity
- Omega-3 fatty acids, which support neural plasticity and anti-inflammatory actions (Peuhkuri *et al*., 2012) [30]

3. Macronutrients and Sleep

3.1 Carbohydrates

High-glycemic-index (GI) carbohydrates consumed 4 hours before bedtime have been associated with shorter sleep onset latency (Afaghi *et al*., 2007) [2]. Carbohydrates facilitate tryptophan entry into the brain, boosting serotonin

production.

Carbohydrates play a critical role in modulating sleep through their influence on neurotransmitter synthesis and hormonal regulation. High-glycemic index (GI) carbohydrates, when consumed four to five hours before bedtime, have been found to shorten sleep onset latency by promoting the availability of tryptophan in the brain—a precursor to serotonin and melatonin, two key regulators of the sleep-wake cycle (Afaghi, O'Connor, & Chow, 2007) [2]. The insulin response triggered by carbohydrate intake reduces the levels of competing amino acids, facilitating the transport of tryptophan across the blood-brain barrier and enhancing melatonin production (Bravo *et al*., 2013) [4]. Moreover, complex carbohydrates found in whole grains, fruits, and vegetables are associated with improved sleep duration and quality, likely due to their slow-digesting nature and ability to stabilize blood glucose levels overnight (St-Onge *et al*., 2021) [35]. In contrast, diets high in refined sugars and low in fiber are linked to lighter, less restorative sleep and increased arousals (St-Onge *et al*., 2021) [35]. Therefore, both the quantity and quality of carbohydrate intake significantly influence sleep patterns, making them an important macronutrient in therapeutic nutritional strategies for sleep disorders.

3.2 Protein

Protein-rich diets, especially those high in tryptophan-containing foods such as turkey, milk, and seeds, are linked to improved sleep quality. However, excessive protein intake late at night may delay sleep onset (Godos *et al*., 2020) [9]. Protein, as a vital macronutrient, plays a significant role in sleep regulation through its influence on neurotransmitter synthesis and hormonal balance. Dietary protein provides essential amino acids, particularly tryptophan, which is a precursor for serotonin and melatonin—two neurochemicals crucial for initiating and maintaining sleep. Consuming moderate to high-protein meals, especially those rich in tryptophan, such as dairy, turkey, soy, and nuts, can enhance sleep quality by promoting melatonin production and reducing sleep latency. Furthermore, protein intake helps stabilize blood glucose levels overnight, preventing hypoglycemia-induced sleep disruptions. Some studies also suggest that diets with balanced protein-to-carbohydrate ratios may reduce nighttime awakenings and improve overall sleep efficiency (St-Onge *et al*., 2021) [35]. However, excessive protein consumption close to bedtime may cause gastrointestinal discomfort or increased alertness, emphasizing the need for personalized dietary timing and composition to optimize sleep outcomes.

3.3 Fats

Saturated fat intake is associated with lighter, less restorative sleep, while diets rich in unsaturated fats, particularly omega-3 fatty acids, are positively associated with improved sleep efficiency (St-Onge *et al*., 2021) [35]. Fats, as essential macronutrients, play a significant role in modulating sleep patterns through their influence on hormonal regulation, neurochemical balance, and inflammatory responses. Diets rich in healthy fats—particularly polyunsaturated fatty acids (PUFAs) such as omega-3 fatty acids—have been associated with improved sleep quality and duration, potentially due to their role in enhancing melatonin synthesis and reducing neuroinflammation (Montgomery *et al*., 2014) [25]. Omega-3s, especially docosahexaenoic acid (DHA), are critical for maintaining brain function and regulating neurotransmitters involved in sleep, such as serotonin. Conversely, excessive intake of saturated fats and trans fats is linked to lighter sleep, more nighttime arousals, and reduced sleep efficiency, possibly due to their contribution to systemic inflammation and disrupted metabolic homeostasis (St-Onge *et al*., 2021) [35]. Therefore, the type and quality of fat consumed in the diet can profoundly influence sleep architecture, underscoring the importance of incorporating healthy fat sources—like fatty fish, nuts, seeds, and olive oil—into dietary strategies aimed at improving sleep.

4. Micronutrients and Sleep

4.1 Magnesium

Magnesium supports GABA receptor function, which calms the nervous system. Magnesium deficiency has been linked to insomnia and nocturnal awakenings (Abbasi *et al*., 2012) [1]. Magnesium is a vital micronutrient that plays a crucial role in regulating sleep by supporting neurotransmitter function and maintaining circadian rhythm stability. It acts as a natural relaxant by modulating the activity of gamma-aminobutyric acid (GABA), a key inhibitory neurotransmitter that promotes calmness and sleep initiation. Magnesium also helps regulate melatonin secretion and reduces the levels of the stress hormone cortisol, both of which are essential for restful sleep. Studies have shown that magnesium deficiency is associated with insomnia, increased nighttime awakenings, and shorter sleep duration, particularly in older adults (Abbasi *et al*., 2012) [1]. Supplementation with magnesium has been found to improve sleep quality, efficiency, and latency in individuals suffering from primary insomnia and other sleep disturbances. Furthermore, magnesium's anti-inflammatory and muscle-relaxing properties may contribute to reduced restlessness and improved overall sleep architecture (Peuhkuri *et al*., 2012) [29]. Thus, maintaining adequate magnesium intake through diet or supplementation may serve as a simple yet effective strategy for enhancing sleep quality and combating sleep disorders.

4.2 Zinc

Zinc contributes to neurotransmitter function and plays a role in melatonin synthesis. Studies have shown that zinc supplementation improves sleep duration and quality in both adults and children (Gao *et al*., 2013) [8]. Zinc, an essential trace mineral, plays a vital role in numerous physiological processes, including immune function, enzyme activity, and neurotransmitter regulation, all of which are intricately linked to sleep quality. Emerging research suggests that zinc may contribute to the modulation of sleep through its influence on the central nervous system, particularly in promoting the function of gamma-aminobutyric acid (GABA), a neurotransmitter that facilitates sleep onset and maintenance. Zinc is also involved in the synthesis and regulation of melatonin, the hormone responsible for regulating circadian rhythms. Clinical and observational studies have reported that adequate zinc levels are associated with improved sleep duration and quality, while deficiency may result in difficulties falling and staying asleep (Peuhkuri, Sihvola, & Korpela, 2012) [30]. Furthermore, zinc supplementation, often in combination with magnesium and melatonin, has shown beneficial

effects in managing insomnia and enhancing sleep efficiency, especially among older adults (Rondanelli *et al*., 2011) [33]. Therefore, maintaining sufficient zinc intake through dietary sources such as meat, seafood, nuts, and legumes may serve as a therapeutic nutritional strategy for improving sleep health.

4.3 Vitamin D

Low vitamin D levels are associated with short sleep duration and poor sleep quality, potentially due to its role in melatonin synthesis and immune function (Gao *et al*., 2018) [7]. Vitamin D, a fat-soluble micronutrient primarily synthesized in the skin upon exposure to sunlight, plays a critical role in regulating sleep through its involvement in brain function and circadian rhythm modulation. Emerging evidence suggests that vitamin D receptors and the enzyme responsible for its activation are present in areas of the brain that control sleep, such as the hypothalamus, indicating its direct influence on sleep regulation (Gao *et al*., 2018) [7]. Deficiency in vitamin D has been linked to a higher prevalence of sleep disorders, including insomnia, poor sleep quality, and shorter sleep duration. It is hypothesized that vitamin D may affect sleep by modulating the production of melatonin, the hormone responsible for sleep-wake cycles, and by exerting anti-inflammatory effects that mitigate sleep disturbances caused by chronic inflammation (Musiek & Holtzman, 2016) [26]. Supplementation studies have shown mixed results, but some indicate that correcting vitamin D deficiency can lead to improvements in sleep latency and efficiency, particularly in populations with low baseline levels (Majid *et al*., 2018) [19]. Thus, maintaining adequate vitamin D status through sunlight exposure, dietary intake (e.g., fatty fish, fortified foods), or supplementation may contribute positively to sleep health.

4.4 B Vitamins

Vitamin B6 is critical for serotonin production, while B12 helps regulate melatonin. A deficiency in these vitamins may lead to circadian rhythm disturbances (Kennedy, 2016) [15]. B vitamins play a crucial role in sleep regulation through their involvement in energy metabolism, neurotransmitter synthesis, and maintenance of healthy neurological function. Specifically, vitamin B6 (pyridoxine) contributes to the production of serotonin and melatonin—neurotransmitters that help regulate mood and the sleep-wake cycle (Peuhkuri *et al*., 2012) [29]. Vitamin B12 (cobalamin) supports the functioning of the circadian rhythm by influencing melatonin secretion and modulating light sensitivity in the brain, which is vital for sleep timing (Gominak & Stumpf, 2012) [10]. Folate (vitamin B9) is also associated with sleep health, as deficiencies can lead to insomnia, restlessness, and fatigue. Inadequate levels of B vitamins, especially in the elderly and individuals with restrictive diets, have been linked to sleep disturbances, poor sleep quality, and increased risk of depression, which further exacerbates sleep issues. Thus, ensuring sufficient intake of B vitamins through diet or supplementation may serve as an effective therapeutic strategy for managing sleep disorders and enhancing overall sleep quality.

Table: 1: Therapeutic Nutrition Interventions for Sleep Disorders

Nutrient / Food Component	Mechanism of Action	Therapeutic Benefit in Sleep Disorders	Text Citation
Tryptophan-rich Foods	Precursor to serotonin → converted to melatonin (sleep hormone).	Improves sleep onset latency and quality of sleep.	Peuhkuri *et al*., 2012 [30]; Bravo *et al*., 2013 [4]
Melatonin-rich Foods	Regulates circadian rhythm; promotes faster sleep onset.	Reduces sleep latency and increases total sleep duration.	Pandi-Perumal *et al*., 2007 [28]
Magnesium	Acts as a GABA agonist; calms the nervous system.	Enhances sleep quality, particularly in older adults with insomnia.	Abbasi *et al*., 2012 [1]
Vitamin B6	Cofactor in tryptophan to serotonin conversion.	Supports melatonin production and REM sleep regulation.	Kennedy *et al*., 2010 [16]
Omega-3 Fatty Acids	Reduces inflammation; supports brain function and serotonin metabolism.	Improves sleep continuity and reduces night-time awakenings.	Montgomery *et al*., 2014 [24]
Vitamin D	Modulates circadian rhythm through influence on sleep-regulating brain centers.	Low levels associated with poor sleep efficiency and shorter duration.	Massa *et al*., 2015 [21]
Probiotics (Gut-Brain Axis)	Influence serotonin production and reduce systemic inflammation.	Alleviate anxiety, depression, and improve overall sleep quality.	Nishida *et al*., 2019 [27]; Liu *et al*., 2019 [18]
Low-Glycemic Index Carbohydrates	Facilitate tryptophan transport across the blood-brain barrier by insulin-mediated amino acid regulation.	Improves sleep onset by enhancing serotonin and melatonin synthesis.	Afaghi *et al*., 2007 [2]
Herbal Teas (Chamomile, Valerian root)	Contain apigenin and valerenic acid; act on GABA receptors.	Reduce anxiety and promote calmness leading to better sleep.	Zick *et al*., 2011 [41]; Fernández-San-Martín *et al*., 2010 [5]
Avoidance of Caffeine and Alcohol	Caffeine blocks adenosine receptors; alcohol disrupts REM cycles.	Prevents sleep fragmentation and insomnia.	Roehrs & Roth, 2008 [32]

5. Functional Foods and Bioactive Compounds

5.1 Tryptophan-Rich Foods

Dairy, eggs, nuts, and seeds are rich in tryptophan and have shown benefits in promoting sleep when consumed in adequate amounts (Silber & Schmitt, 2010) [34].

5.2 Melatonin-Containing Foods

Foods such as tart cherries, grapes, and tomatoes are natural sources of melatonin. Tart cherry juice, in particular, has demonstrated efficacy in improving sleep duration and quality in elderly adults (Pigeon *et al*., 2010) [31].

5.3 Herbal Teas and Adaptogens
Chamomile, valerian root, and ashwagandha have traditionally been used to promote relaxation and sleep. Recent studies support their sedative and anxiolytic effects (Zhao *et al*., 2020) [40].

6. Dietary Patterns and Sleep Health
6.1 Mediterranean Diet
Rich in fruits, vegetables, whole grains, legumes, and healthy fats, the Mediterranean diet is associated with lower insomnia risk and better sleep quality (St-Onge *et al*., 2021) [35].

6.2 Plant-Based Diets
Plant-based diets are linked to higher intake of magnesium, antioxidants, and fiber, which can support sleep regulation by reducing inflammation and oxidative stress (Grandner *et al*., 2013) [11].

6.3 Time-Restricted Eating
Intermittent fasting and time-restricted eating can regulate circadian rhythm and improve sleep by aligning food intake with the body's internal clock (Manoogian *et al*., 2020) [20].

7. Special Populations
7.1 Elderly
Older adults are particularly susceptible to micronutrient deficiencies and circadian disruptions. Nutritional interventions with melatonin-rich foods and vitamin D may help manage age-related sleep decline (Wurtman *et al*., 1999) [39].

7.2 Pregnant Women
Sleep disturbances during pregnancy can be alleviated by focusing on iron, magnesium, and omega-3 intake, which support neurotransmitter synthesis and reduce muscle cramps and anxiety (Mindell *et al*., 2015) [23].

8. Limitations and Future Directions
Although numerous observational and interventional studies suggest promising roles for nutrition in sleep modulation, heterogeneity in study design, small sample sizes, and lack of standardized outcomes limit definitive conclusions. Future research should prioritize randomized controlled trials and mechanistic studies to establish causality and inform clinical guidelines.

9. Conclusion
Therapeutic nutrition presents a promising, low-risk adjunctive strategy for managing sleep disorders. Targeted intake of specific macronutrients, micronutrients, and functional foods can enhance sleep quality through their effects on neurotransmitter production, circadian regulation, and inflammation modulation. A personalized nutritional approach, considering individual needs and comorbidities, may serve as an effective non-pharmacological therapy for sleep-related problems.

10. 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. J Res Med Sci. 2012;17(12):1161-9.
2. Afaghi A, O'Connor H, Chow CM. High-glycemic-index carbohydrate meals shorten sleep onset. Am J Clin Nutr. 2007;85(2):426-30.
3. Benedict C, Vogel H, Jonas W, Woting A, Blaut M, Schürmann A, *et al*. Gut microbiota and sleep-wake regulation. Curr Opin Clin Nutr Metab Care. 2012;15(6):571-7.
4. Bravo R, Matito S, Cubero J, Paredes SD, Franco L, Rodríguez AB. Tryptophan and sleep: Advances from animal studies. Curr Neuropharmacol. 2013;11(6):680-90.
5. Fernández-San-Martín MI, Masa-Font R, Palacios-Soler L, Sancho-Gómez P, Calbó-Caldentey C, Flores-Mateo G. Effectiveness of Valerian on insomnia: A meta-analysis of randomized placebo-controlled trials. Sleep Med. 2010;11(6):505-11. https://doi.org/10.1016/j.sleep.2009.12.009
6. Gangwisch JE, Hale L, Garcia L, Malaspina D, Opler MGA, Rundle AG. High glycemic index diet as a risk factor for depression: Analyses from the Women's Health Initiative. Am J Clin Nutr. 2015;102(2):454-63.
7. Gao Q, Kou T, Zhuang B, Ren Y, Dong X. The association between vitamin D deficiency and sleep disorders: A meta-analysis. Nutr Neurosci. 2018;21(12):379-88.
8. Gao T, Wang Z, Dong Y, Yu X. Zinc supplementation improves sleep quality in school-aged children: A randomized controlled trial. Biol Trace Elem Res. 2013;155(1):27-31.
9. Godos J, Ferri R, Caraci F, Cosentino FI, Castellano S, Galvano F, *et al*. Specific dietary (poly)phenols are associated with sleep quality in a cohort of Italian adults. Nutrients. 2020;12(5):1226.
10. Gominak SC, Stumpf WE. The world epidemic of sleep disorders is linked to vitamin D deficiency. Med Hypotheses. 2012;79(2):132-5.
11. Grandner MA, Jackson N, Gerstner JR, Knutson KL. Dietary nutrients associated with short and long sleep duration. Appetite. 2013;64:71-80.
12. Institute of Medicine. Sleep disorders and sleep deprivation: An unmet public health problem. Washington (DC): The National Academies Press; 2006.
13. Jakubowicz D, Barnea M, Wainstein J, Froy O. High caloric intake at breakfast vs. dinner differentially influences weight loss of overweight and obese women. Obesity. 2017;21(12):2504-11.
14. Kaczmarek JL, Musaad SMA, Holscher HD. Time of day and eating behaviors are associated with the composition and function of the human gastrointestinal microbiota. Am J Clin Nutr. 2017;106(5):1220-31.
15. Kennedy DO. B Vitamins and the brain: Mechanisms, dose and efficacy—A review. Nutrients. 2016;8(2):68.
16. Kennedy DO, Veasey R, Watson AW, Dodd FL, Jones E, Maggini S, *et al*. Effects of high-dose B vitamin complex with vitamin C and minerals on subjective mood and performance in healthy males. Psychopharmacology. 2010;211(1):55-68. https://doi.org/10.1007/s00213-010-1870-3
17. Li Y, Li M, Zhou J, Zhang Y, Li Y. Nutritional modulation of circadian rhythms and its impact on health. Nutrients. 2022;14(1):150.
18. Liu RT, Walsh RFL, Sheehan AE. The microbiome in anxiety and depression. Curr Opin Psychiatry.

2019;32(1):7-13. https://doi.org/10.1097/YCO.0000000000000457
19. Majid MS, Ahmad HS, Bizhan H, Mohammad A. The effect of vitamin D supplement on the score and quality of sleep in 20-50-year-old people with sleep disorders compared with control group. Nutr Neurosci. 2018;21(7):511-9.
20. Manoogian ENC, Chow LS, Taub PR, Laferrère B, Panda S, Varady KA. Time-restricted eating for the prevention and management of metabolic diseases. Endocr Rev. 2020;43(4):405-36.
21. Massa J, Stone KL, Wei EK, Harrison SL, Barrett-Connor E, Lane NE, *et al*. Vitamin D and actigraphic sleep outcomes in older community-dwelling men: The MrOS Sleep Study. Sleep. 2015;38(2):251-7. https://doi.org/10.5665/sleep.4390
22. Medic G, Wille M, Hemels MEH. Short- and long-term health consequences of sleep disruption. Nat Sci Sleep. 2017;9:151-61.
23. Mindell JA, Cook RA, Nikolovski J. Sleep patterns and sleep disturbances across pregnancy. Sleep Med. 2015;16(4):483-8.
24. Montgomery P, Burton JR. Omega-3 fatty acids for major depressive disorder: A randomized double-blind placebo-controlled trial. J Clin Psychiatry. 2014;75(5):e414-20.
25. Montgomery P, Burton JR, Sewell RP, Spreckelsen TF, Richardson AJ. Fatty acids and sleep in UK children: Randomized controlled trial of treatment with the omega-3 fatty acid DHA. J Sleep Res. 2014;23(4):364-88.
26. Musiek ES, Holtzman DM. Mechanisms linking circadian clocks, sleep, and neurodegeneration. Science. 2016;354(6315):1004-8.
27. Nishida K, Sawada D, Kawai T, Kuwano Y, Fujiwara S, Rokutan K. Effects of *Lactobacillus gasseri* CP2305 on stress-related symptoms and sleep quality. Benef Microbes. 2019;10(3):297-309. https://doi.org/10.3920/BM2018.0134
28. Pandi-Perumal SR, Trakht I, Srinivasan V, Spence DW, Maestroni GJM, Zisapel N, *et al*. Melatonin: Nature's most versatile biological signal? FEBS J. 2007;273(13):2813-38. https://doi.org/10.1111/j.1742-4658.2006.05322.x
29. Peuhkuri K, Sihvola N, Korpela R. Diet promotes sleep duration and quality. Nutr Res. 2012;32(5):309-19.
30. Peuhkuri K, Sihvola N, Korpela R. Dietary factors and fluctuating levels of melatonin. Food Nutr Res. 2012;56(1):17252. https://doi.org/10.3402/fnr.v56i0.17252
31. Pigeon WR, Carr M, Gorman C, Perlis ML. Effects of a tart cherry juice beverage on the sleep of older adults with insomnia: A pilot study. J Med Food. 2010;13(3):579-83.
32. Roehrs T, Roth T. Caffeine: Sleep and daytime sleepiness. Sleep Med Rev. 2008;12(2):153-62. https://doi.org/10.1016/j.smrv.2007.07.004
33. Rondanelli M, Opizzi A, Monteferrario F, Antoniello N, Manni R, Klersy C. The effect of melatonin, magnesium, and zinc on primary insomnia in long-term care facility residents in Italy: A double-blind, placebo-controlled clinical trial. J Am Geriatr Soc. 2011;59(1):82-90.
34. Silber BY, Schmitt JAJ. Effects of tryptophan loading on human cognition, mood, and sleep. Neurosci Biobehav Rev. 2010;34(3):387-407.
35. St-Onge MP, Mikic A, Pietrolungo CE. Mediterranean diet and sleep: A systematic review. Curr Nutr Rep. 2021;10:123-35.
36. St-Onge MP, Zuraikat FM, Jean-Louis G, Khalsa DS. Sleep and diet: Mounting evidence of a cyclical relationship. Annu Rev Nutr. 2022;42:177-203.
37. Tanaka E, Yatsuya H, Uemura M, Murata C, Otsuka R, Toyoshima H, *et al*. Sleep duration and the risk of future cardiovascular events in a Japanese population: The Jichi Medical School cohort study. J Epidemiol. 2018;18(4):154-60.
38. Tewari S. Therapeutic diet to control diseases. New Delhi: AkiNik Publications; 2019. p.1-79.
39. Wurtman RJ, Hefti F, Melamed E. Precursor control of neurotransmitter synthesis. Pharmacol Rev. 1999;32(4):315-35.
40. Zhao Y, Wang L, Xue H, Wang H. Efficacy of ashwagandha root extract on sleep: A randomized double-blind placebo-controlled study. Cureus. 2020;12(1):e6823.
41. Zick SM, Wright BD, Sen A, Arnedt JT. Preliminary examination of the efficacy and safety of a standardized chamomile extract for generalized anxiety disorder. BMC Complement Altern Med. 2011;9:2. https://doi.org/10.1186/1472-6882-9-2