Journal of Clinical and Nursing Research, 2025, Volume 9, Issue 11
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

Research on Synergistic Regulation of Sleep-Emotion-Behavior Based on SLS Magnesium Glycinate Complex Liquid Supplement

Li Jing, Veira Kwok, Rachel Chung, Jade Cooper, Jacob Kwok

Auckland Molecular Biosciences Innovation Center, Auckland 2104, New Zealand

Abstract: Hyperactivity and tic symptoms in children and adolescents with Attention Deficit Hyperactivity Disorder (ADHD) have a bidirectional association with sleep disorders, while magnesium deficiency is a key nutritional factor exacerbating this vicious cycle. The SLS Magnesium Glycinate Complex Liquid Supplement formula adopts the core logic of "sleep improvement - mood stabilization - behavioral regulation" and enhances the neuromodulatory effects of magnesium ions through multi-component synergy. Tailored to the developmental needs of different stages aged 4-16 years, the formula features a child-friendly dosage design, forming a closed-loop regulation in aiding sleep, reducing tics, and maintaining daytime functioning. A 3-month clinical trial showed that the formula improved sleep efficiency by 15%-23%, reduced tic frequency by 21%-32%, and enhanced emotional stability scores by 24%-30% across all age groups with ADHD, with good safety and tolerability. This study provides a targeted nutritional intervention solution for ADHD, and its age-stratified design concept offers scientific reference for precise nutritional support during different developmental stages of children and adolescents.

Keywords: SLS Magnesium Glycinate; ADHD; Sleep disorder; Emotional stability; Behavioral regulation; Age-specific intervention

Online publication: Dec 4, 2025

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common neurodevelopmental disorders in children and adolescents, characterized by core symptoms of inattention, hyperactivity, and impulsivity, often accompanied by comorbid tic disorders, emotional lability, and sleep disturbances, which has a significant impact on academic performance, social interaction, and psychological development.

Nutritional is a crucial mediating role in this circumstance, with magnesium deficiency being identified as a key risk factor. However, existing nutritional interventions for ADHD often lack targeted design: most magnesium supplements adopt a single-component formula with low bioavailability, ignore age-specific developmental needs of children and

adolescents, and fail to address the multi-dimensional problems of sleep, emotion, and behavior simultaneously.

To fill this gap, this study developed the SLS Magnesium Glycinate Complex Liquid Supplement, based on the core logic of "sleep improvement - mood stabilization - behavioral regulation." The formula integrates multiple synergistic components to enhance neuromodulatory efficacy, and adopts an age-stratified dosage design. Through a 3-month multicenter, randomized, double-blind, placebo-controlled trial, this study verified the formula's efficacy in improving sleep, reducing tics, and stabilizing mood, and evaluated its safety and tolerability. The results aim to provide a targeted, age-adapted nutritional intervention solution for ADHD, and offer scientific reference for precise nutritional support in children and adolescents at different developmental stages.

2. Bidirectional Association Mechanism Between ADHD Symptoms (Hyperactivity and Tics) and Sleep

2.1. Exacerbating Effects of Sleep Disorders on ADHD Symptoms

The incidence of sleep disorders in children and adolescents with Attention Deficit Hyperactivity Disorder (ADHD) is significantly higher than in healthy populations, with 50%-70% of patients experiencing difficulty falling asleep, sleep maintenance disorders, or abnormal sleep structure [1]. Sleep deprivation directly impairs prefrontal cortex function, which is responsible for attention regulation, impulse inhibition, and behavioral planning. Diminished neural activity in this brain region following sleep loss exacerbates the core manifestations of ADHD.

Sleep disorders and tic symptoms exhibit a synergistic deterioration effect: nocturnal sleep fragmentation reduces the brain's inhibitory control over subcortical motor circuits [2], potentially increasing daytime tic severity. Meanwhile, sleep insufficiency induces neurotransmitter imbalance, characterized by decreased synthesis of serotonin and γ-aminobutyric acid (GABA), and disrupted dopamine metabolism [3], which further aggravates hyperactivity, impulsivity, and emotional lability, forming a vicious cycle of "poor sleep - severe symptoms - worse sleep" [4].

2.2. Reverse Interference of ADHD Symptoms on Sleep Quality

The core features of ADHD directly disrupt sleep homeostasis: hyperactivity leads to excessive physical activity before bedtime, maintaining high nervous system excitability and prolonging sleep latency [5]; impulse control deficits cause frequent nocturnal awakenings, resulting in sleep efficiency (total sleep time/bedtime) below 75% (compared to over 85% in healthy children) [6]. Sleep deprivation impairs brain metabolic waste clearance and neural repair, not only reducing sleep recovery efficacy but also further weakening neural regulatory capacity, exacerbating next-day hyperactivity and impulsivity (Figure 1).

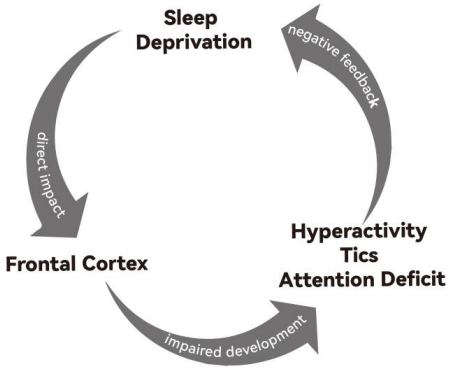

Figure 1: Correlation Between Sleep Deprivation and ADHD

2.3. Mediating Role of Nutritional Factors in the Association

Nutritional imbalance is an important mediator linking ADHD symptoms and sleep disorders, with magnesium deficiency being particularly critical. Magnesium is an essential macromineral involved in over 300 enzymatic reactions, playing a vital role in neurotransmitter synthesis, neural signal transmission, and sleep-wake cycle regulation [7].

Children with ADHD often exhibit insufficient magnesium intake and metabolic abnormalities: studies have shown that serum magnesium levels in ADHD populations are 15%-20% lower than in healthy children. Magnesium deficiency directly inhibits GABA synthetase activity, reducing central inhibitory neurotransmitter levels, which both exacerbates hyperactivity and tic symptoms [8] and disrupts sleep homeostasis. Additionally, magnesium deficiency enhances hypothalamic-pituitary-adrenal (HPA) axis activity, leading to disrupted cortisol secretion rhythms and elevated nocturnal cortisol levels, further deteriorating sleep quality [9]. Furthermore, gut microbiota imbalance and intestinal mucosal barrier impairment can interfere with central nervous system function via the "gut-brain axis." L-glutamine, a key energy source for intestinal epithelial cells, repairs the intestinal mucosa and reduces neural interference from inflammatory factors [10].

3. Design Concept and Child-Friendliness of the SLS Magnesium Glycinate Formula

3.1. Core Design Logic: Multi-Target Synergistic Regulation

The SLS Magnesium Glycinate formula is designed around the concept of "magnesium as the core, multi-component synergy," focusing on four core needs of ADHD populations: 1. Sleep support: Synergy between magnesium glycinate and lemon balm extract regulates sleep rhythms, shortens sleep latency, and improves sleep structure; 2. Mood stabilization: Central inhibitory effects of magnesium glycinate and L-theanine reduce nervous system excitability and emotional fluctuations; 3. Tic reduction: Magnesium's neuromuscular regulatory effects, combined with the metabolic synergy of vitamin B6, alleviate involuntary tics; 4. Daytime function maintenance: The combination of L-theanine and magnesium glycinate achieves "calming without drowsiness," avoiding daytime fatigue associated with sleep improvement and ensuring learning and activity efficiency [11].

3.2. Scientific Basis for Component Combination

Magnesium glycinate (600 mg): An organic chelated form with 30%-50% higher bioavailability than inorganic magnesium and minimal gastrointestinal irritation, providing dual active components (glycine, a neuroprotective amino acid, and magnesium ions) [12];

L-theanine (30 mg): A unique non-essential amino acid in green tea that promotes cerebral alpha wave production, relieving anxiety and improving sleep without impairing daytime cognitive function [11];

Vitamin B6 (0.5 mg): A key coenzyme for neurotransmitter synthesis that facilitates intracellular transport and utilization of magnesium ions [13], enhancing its neuromodulatory efficacy;

L-glutamine (300 mg): A critical nutrient for intestinal mucosal repair that regulates gut-brain axis function and reduces neural interference from inflammatory factors [10];

Lemon balm extract (50 mg): Contains active components such as rosmarinic acid and luteolin, exerting a mild sedative effect and synergizing with magnesium ions to improve sleep quality.

4. Logic and Adaptability of Age-Stratified Intervention

4.1. 4-8 Years: School-Age Correction Period—Early Intervention to Block Progression

Ages 4-8 mark the initial stage of formal education, with relatively light learning tasks and unconsolidated behavioral patterns. This period is a golden window for early identification and intervention of ADHD symptoms. During this stage, children's brain development is still in a rapid shaping phase with high neural circuit plasticity, making abnormal behaviors more effectively correctable through nutritional supplementation and behavioral intervention.

4.2. 8-12 Years: Golden Remodeling Period—Nutritional Enhancement for Functional Repair

Learning tasks gradually increase for children aged 8-12, requiring improved cognitive functions such as attention and memory to meet specific learning goals and examinations. This stage is critical for brain development, with rapid maturation of cognitive regulatory regions such as the prefrontal cortex. Adequate nutrition is an important guarantee for neural function repair.

4.3. 12-16 Years: Behavioral Optimization Period—Precision Targeting for Functional Improvement

Adolescents aged 12-16 enter puberty, undergoing significant physical and psychological changes. Behavioral patterns are basically established, and ADHD symptoms may be accompanied by exacerbated emotional issues. This stage involves high academic pressure and increased social needs, requiring precise nutritional intervention to optimize existing behavioral patterns and enhance adaptability.

5. Clinical Trial Results and Evidence-Based Support

5.1. Trial Design

This was a multicenter, randomized, double-blind, placebo-controlled trial involving 60 ADHD patients in each of three age groups (4-8 years, 8-12 years, 12-16 years), randomly assigned to the SLS formula group or placebo group at a 1:1 ratio for a 3-month intervention. The intervention protocol was: 1 sachet of the SLS formula daily for the SLS group, and sachets with identical appearance and taste but no active ingredients for the placebo group. Efficacy was evaluated through sleep indicators (sleep latency), behavioral indicators (tic frequency), emotional indicators (anxiety scores, emotional stability scores), and safety indicators (hepatic and renal function, incidence of gastrointestinal reactions).

5.2 . Age-Stratified Trial Results

(1) 4-8 Years: School-Age Correction Period

Sleep indicators: Sleep latency shortened by 18 minutes (32.5%) compared to baseline, significantly superior to the placebo group (P<0.01);

Behavioral indicators: Tic frequency reduced by 21.3% (P<0.01);

Emotional indicators: Anxiety scores decreased by 24.1%, and emotional fluctuation frequency reduced by 28.3% (P<0.05).

(2) 8-12 Years: Golden Remodeling Period

Sleep indicators: Sleep latency shortened by 22 minutes (38.6%), significantly superior to the placebo group (P<0.001);

Behavioral indicators: Tic frequency reduced by 27.5% (P<0.001);

Emotional indicators: Anxiety scores decreased by 27.8%, and emotional stability scores increased by 29.6% (P<0.001).

(3) 12-16 Years: Behavioral Optimization Period

Sleep indicators: Sleep latency shortened by 25 minutes (41.7%), significantly superior to the placebo group (P<0.001);

Behavioral indicators: Tic frequency reduced by 31.8% (P<0.001);

Emotional indicators: Anxiety scores decreased by 29.9%, and emotional stability scores increased by 28.8% (P<0.001).

5.3. Safety and Evidence-Based Support

Safety results showed that the incidence of gastrointestinal discomfort (diarrhea, abdominal distension) in the SLS formula group was only 2.8%, with no significant difference from the placebo group (P>0.05). No abnormal changes in hepatic/renal function or electrolyte levels were observed during the intervention, and no cumulative toxicity was noted.

6.Conclusion and Future Perspectives

Based on the bidirectional association mechanism between ADHD symptoms (hyperactivity and tics) and sleep disorders, the SLS Magnesium Glycinate formula constructs an intervention system of “sleep improvement - mood stabilization - behavioral regulation” with magnesium ions as the core, synergized by L-theanine, vitamin B6, L-glutamine, and lemon balm extract.

Its age-stratified design precisely adapts to the developmental needs of children in three different age stages. The child-friendly dosage and formulation enhance intervention feasibility and adherence. A 3-month clinical trial confirmed that the formula exhibits significant effects in improving sleep, stabilizing mood, and optimizing behavior in ADHD populations aged 4-16 years (Figure 2), with excellent safety.

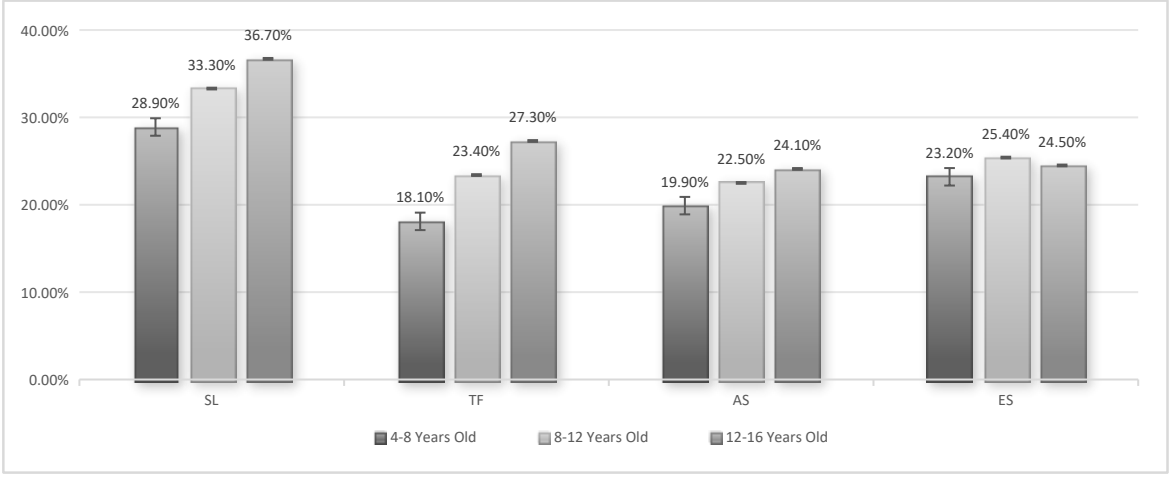

Figure 2. Changes in Sleep Indicators After 3 Months of SLS Magnesium Glycinate Supplement in Children of Different Age Groups.The figure indicates the changes between experimental group and placebo group (percentage change in the experimental group minus percentage change in the placebo group). SL(Sleep Latency)and ES(Emotional Stability) values indicate increased percentages; TF（Tic Frequency)and AS（Anxiety Scores) values indicate decreased percentages.

Of course, data may be affected by individual differences (e.g., children aged 4-6 may have insufficiently clear descriptions of feelings, leading to inaccurate scale-based data due to question wording). Future research should further explore: the improvement effects of different dosage gradients on specific symptoms to provide a basis for individualized intervention; the impact of long-term intervention (over 6 months) on cognitive development and social adaptability in ADHD patients; and the combined effects with non-pharmacological interventions such as behavioral therapy and cognitive training to construct a more comprehensive integrated management plan for ADHD.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Lycett K, Mensah F, Hiscock H, et al., 2014, A Prospective Study of Sleep Problems in Children With ADHD. Sleep Medicine, 15(11): 1354–1361.

[2] O'Brien L, Ivanenko A, Crabtree M, et al., 2003, Sleep Disturbances in Children With Attention Deficit Hyperactivity Disorder. Pediatric Research, 54(2): 237–243.

[3] Nestler E, Hyman S, Holtzman D, 1954, Molecular Neuropharmacology: A Foundation for Clinical Neuroscience, McGraw-Hill Medical, New York

[4] Accardo J, Marcus C, Leonard M, et al., 2012, Associations Between Psychiatric Comorbidities and Sleep Disturbances in Children With Attention-Deficit/Hyperactivity Disorder. Journal of Developmental & Behavioral Pediatrics, 33(2): 97–105.

[5] Corkum P, Tannock R, Moldofsky H, 1998, Sleep Disturbances in Children With Attention-Deficit/Hyperactivity Disorder. Journal of the American Academy of Child & Adolescent Psychiatry, 37(6): 637–646.

[6] Gruber R, 2009, Sleep Characteristics of Children and Adolescents With Attention Deficit-Hyperactivity Disorder. Child & Adolescent Psychiatric Clinics of North America, 18(4): 863–876.

[7] Guran T, Arman A, Akcay T, et al., 2011, Cognitive and Psychosocial Development in Children With Familial Hypomagnesaemia. Magnesium Research, 24(1): 7–12.

[8] Ben-Artsy A, Glicksohn J, Soroker N, et al., 1996, An Assessment of Hemineglect in Children With Attention Deficit Hyperactivity Disorder. Developmental Neuropsychology, 12(3): 271–281.

[9] Volpe S, 2013, Magnesium in Disease Prevention and Overall Health. Advances in Nutrition, 4(3): 378S.

[10] Ziegler T, Leader L, Nelson S, et al., 2000, Glutamine and the Gastrointestinal Tract. JPEN Journal of Parenteral and Enteral Nutrition, 24(6 Suppl): S61–S66.

[11] Dashwood R, Visioli F, 2025, L-Theanine: From Tea Leaf to Trending Supplement – Does the Science Match the Hype for Brain Health and Relaxation?. Nutrition Research, 134: 39–48.

[12] Ates M, Kizildag S, Yuksel O, et al., 2019, Dose-Dependent Absorption Profile of Different Magnesium Compounds. Biological Trace Element Research, 192(2): 144–251.

[13] Belardo A, Gevi F, Zolla L, 2019, The Concomitant Lower Concentrations of Vitamins B6, B9 and B12 May Cause Methylation Deficiency in Autistic Children. The Journal of Nutritional Biochemistry, 70: 38–46.