

PREVENTION OF AUTONOMIC NERVOUS SYSTEM DYSFUNCTION IN EARLY SCHOOL-AGED CHILDREN

Abduboriy Sattorjonovich Soliyev

Department of Pediatrics for the Faculty of Medicine

Abstract: Autonomic nervous system (ANS) dysfunction in early school-aged children is a growing concern due to its impact on physical and psychological development. This study aims to identify key strategies for preventing ANS dysfunction through physiological and psychological interventions. A mixed-method approach, including literature review and observational analysis, was used. Findings suggest that structured physical activity, stress management, and educational interventions significantly reduce the risk of ANS disorders. This paper presents practical recommendations for parents, educators, and healthcare providers.

Keywords: Autonomic nervous system, children, prevention, stress management, physical activity, psychological intervention

Introduction (Expanded)

The autonomic nervous system (ANS) is a fundamental component of the human body that regulates involuntary physiological functions, including cardiovascular activity, respiration, digestion, and endocrine processes. Proper ANS functioning is essential for maintaining homeostasis and enabling the body to respond effectively to internal and external stressors [1]. In children, especially during early school age (6–10 years), the ANS is in a critical developmental phase, where physiological, cognitive, and emotional systems interact intensively. Any disruption in autonomic regulation during this period can have far-reaching consequences on growth, academic performance, and psychosocial well-being [2].

Recent research has highlighted the increasing prevalence of ANS dysfunction in pediatric populations. Manifestations of dysfunction in early school-aged children often include irregular heart rate, sleep disturbances, digestive irregularities, fatigue, and heightened anxiety [3]. Such dysregulation not only affects immediate health outcomes but may also predispose children to long-term cardiovascular, metabolic, and psychological disorders [4].

Several factors contribute to ANS dysfunction in children. Sedentary lifestyles, unhealthy dietary patterns, excessive screen time, and disrupted sleep schedules can impair the balance between the sympathetic and parasympathetic nervous systems [5]. Concurrently, psychological stressors—such as academic pressure, social challenges, and family-related stress—can exacerbate autonomic imbalance, leading to chronic activation of the stress-response system and dysregulated cortisol secretion [6]. Evidence suggests that prolonged sympathetic overactivation during childhood may alter the development of neural circuits involved in emotion regulation and stress resilience, with implications that extend into adolescence and adulthood [7].

Preventive strategies targeting ANS dysfunction require a multifaceted approach that integrates both physiological and psychological interventions. Structured physical activity has been shown to enhance parasympathetic tone and cardiovascular adaptability, while mindfulness-based practices and cognitive-behavioral techniques promote emotional regulation and stress reduction

[8], [9]. Moreover, parental and educational support play a critical role in establishing routines, encouraging healthy behaviors, and providing a stable psychosocial environment [10].

Despite the growing recognition of ANS dysfunction in children, standardized preventive protocols remain limited. Most existing interventions are either fragmented or focused solely on one domain—physical or psychological—without considering the complex interplay of lifestyle, emotional, and developmental factors. Therefore, there is a pressing need to identify comprehensive, evidence-based strategies that can be implemented in both school and home settings to safeguard autonomic health during early childhood.

This study aims to explore preventive approaches for ANS dysfunction in early school-aged children, emphasizing the integration of physical activity, stress management, and educational interventions. By combining a review of current evidence with observational data, the study seeks to provide practical guidelines for parents, educators, and healthcare professionals to promote autonomic stability and overall well-being in this vulnerable population.

Methods

A comprehensive literature review was conducted using PubMed, Scopus, and Google Scholar databases, focusing on studies published between 2010 and 2025. Keywords included “autonomic nervous system,” “children,” “prevention,” “stress,” “physical activity,” and “psychological intervention.” Studies involving early school-aged children were prioritized.

In addition, an observational study was performed with a cohort of 120 children aged 6–10 years from two primary schools. Physiological measures included heart rate variability (HRV), blood pressure, and resting heart rate, recorded using non-invasive monitors. Psychological assessment utilized the Child Stress Questionnaire (CSQ) and the Pediatric Anxiety Rating Scale (PARS). Interventions included:

Daily structured physical activity (30 minutes per day).

Mindfulness and relaxation sessions twice a week.

Nutritional guidance promoting a balanced diet.

Parent education workshops on stress management.

Data were analyzed using SPSS 27.0. Descriptive statistics, paired t-tests, and correlation analyses were conducted to assess the impact of interventions on ANS function.

Results

Table 1. Effect of Interventions on Autonomic Nervous System Indicators

Parameter	Pre-Intervention	Post-Intervention	p-value
Heart Rate Variability (ms)	35.2 ± 6.1	46.5 ± 7.4	<0.001

Parameter	Pre-Intervention	Post-Intervention	p-value
Resting Heart Rate (bpm)	92.4 ± 8.3	85.7 ± 7.6	<0.01
Systolic Blood Pressure (mmHg)	108.5 ± 9.2	103.3 ± 8.7	<0.05
Diastolic Blood Pressure (mmHg)	68.3 ± 6.5	64.7 ± 5.9	<0.05
CSQ Score	21.4 ± 4.2	15.8 ± 3.7	<0.001
PARS Score	14.8 ± 3.1	10.3 ± 2.6	<0.001

The results indicate significant improvement in both physiological and psychological indicators following the interventions. HRV increased, indicating improved parasympathetic activity, while stress and anxiety scores decreased significantly. Correlation analysis revealed that higher physical activity levels were strongly associated with better HRV ($r = 0.62$, $p < 0.001$), and mindfulness sessions were linked with lower anxiety scores ($r = -0.54$, $p < 0.01$).

Discussion

The findings demonstrate that integrated interventions targeting both physiological and psychological factors are effective in preventing ANS dysfunction in early school-aged children. Structured physical activity enhances cardiovascular autonomic regulation by increasing vagal tone and improving HRV [7]. Regular exercise also promotes better sleep patterns and energy balance, which are critical for maintaining ANS stability [8].

Psychological interventions, particularly mindfulness and relaxation techniques, reduce sympathetic overactivity and improve emotional resilience. Children trained in these practices exhibit lower stress hormone levels, such as cortisol, contributing to improved autonomic balance [9].

Parental involvement is another crucial factor. Educating parents about stress management, balanced nutrition, and structured routines creates a supportive environment that mitigates ANS dysfunction risk [10]. Schools can incorporate these strategies into daily routines, combining physical, cognitive, and emotional development programs.

These results align with previous studies emphasizing a biopsychosocial approach to pediatric ANS health. However, further longitudinal research is necessary to assess the long-term effects of such interventions and to establish standardized preventive guidelines.

Conclusion

Autonomic nervous system dysfunction in early school-aged children can be effectively prevented through a combination of physical, psychological, and educational interventions. Regular exercise, mindfulness practices, and parental education significantly improve physiological markers and reduce stress and anxiety. Implementing these strategies in schools and at home provides a practical framework for maintaining optimal autonomic function in children, potentially reducing the risk of future cardiovascular and psychological disorders.

References:

1. Thayer, J.F., & Lane, R.D. (2009). Claude Bernard and the heart–brain connection: Further elaboration of a model of neurovisceral integration. *Neuroscience & Biobehavioral Reviews*, 33(2), 81–88.
2. McEwen, B.S. (2012). Brain on stress: How the social environment gets under the skin. *Proceedings of the National Academy of Sciences*, 109(Supplement 2), 17180–17185.
3. Porges, S.W. (2011). *The polyvagal theory: Neurophysiological foundations of emotions, attachment, communication, and self-regulation*. Norton Series on Interpersonal Neurobiology.
4. Feldman, R., & Eidelman, A.I. (2007). Biological and environmental initial conditions shape the trajectories of cognitive and emotional development across the first years of life. *Developmental Science*, 10(1), 1–13.
5. Lubans, D.R., et al. (2016). Physical activity for cognitive and mental health in children and adolescents: A systematic review of reviews. *Sports Medicine*, 46(9), 1293–1313.
6. Zenner, C., Herrnleben-Kurz, S., & Walach, H. (2014). Mindfulness-based interventions in schools—a systematic review and meta-analysis. *Frontiers in Psychology*, 5, 603.
7. Carter, J.B., Banister, E.W., & Blaber, A.P. (2003). Effect of endurance exercise on autonomic control of heart rate. *Sports Medicine*, 33(1), 33–46.
8. Tremblay, M.S., et al. (2011). Sedentary behavior research network: Terminology consensus project. *International Journal of Behavioral Nutrition and Physical Activity*, 8, 92.
9. Khoury, B., Lecomte, T., Fortin, G., Masse, M., Therien, P., Bouchard, V., & Hofmann, S.G. (2013). Mindfulness-based therapy: A comprehensive meta-analysis. *Clinical Psychology Review*, 33(6), 763–771.
10. Sanders, M.R., Kirby, J.N., Tellegen, C.L., & Day, J.J. (2014). The Triple P-Positive Parenting Program: A systematic review and meta-analysis of a multi-level system of parenting support. *Clinical Psychology Review*, 34(4), 337–357.