

IMPACT OF NUTRITION ON AUTONOMIC NERVOUS SYSTEM REGULATION IN CHILDREN

Abduboriy Sattorjonovich Soliyev

Abstract

Background: Proper autonomic nervous system (ANS) regulation is essential for maintaining physiological homeostasis and supporting growth and development in children. Nutrition is a modifiable factor that can influence ANS function.

Objective: To evaluate the impact of structured nutritional interventions on autonomic nervous system regulation in children aged 6–12 years.

Methods: One hundred children were randomly assigned to an intervention group (structured nutrition program) or a control group (usual diet). Heart rate variability, resting heart rate, and blood pressure were measured at baseline and after 12 weeks.

Results: The intervention group showed significant improvements in HRV, decreased resting heart rate, and stabilized blood pressure compared to the control group. Parents reported improved digestive comfort and overall well-being.

Conclusion: Structured nutrition positively influences autonomic function in children, supporting cardiovascular, cognitive, and emotional development. Early dietary interventions are effective preventive strategies against autonomic dysfunction.

Keywords

Autonomic nervous system, children, nutrition, heart rate variability, resting heart rate, blood pressure, dietary intervention, pediatric health

Introduction

The autonomic nervous system (ANS) plays a crucial role in regulating involuntary physiological functions, including heart rate, blood pressure, digestion, and respiratory activity [1,2]. Proper autonomic regulation is essential for maintaining homeostasis, supporting growth, and promoting cognitive and emotional development in children. Disruptions in autonomic function during childhood can increase the risk of cardiovascular, metabolic, and neurobehavioral disorders later in life [3].

Nutrition is a major modifiable factor influencing autonomic nervous system regulation. The quality, composition, and timing of dietary intake affect the balance between sympathetic and parasympathetic activity, heart rate variability (HRV), and overall cardiovascular health [4,5]. Diets high in saturated fats, refined sugars, and low in essential nutrients have been associated with impaired autonomic function, including reduced HRV and increased resting heart rate in children [6]. Conversely, diets rich in fruits, vegetables, whole grains, lean proteins, and omega-3 fatty acids support optimal ANS function and cardiovascular regulation [7,8].



Early childhood represents a critical period for establishing healthy eating habits, which can positively influence autonomic balance and reduce the risk of future health complications [9]. Despite growing evidence on the link between nutrition and autonomic function, research specifically addressing pediatric populations remains limited, and standardized dietary interventions targeting autonomic regulation are scarce [10].

The objective of this study is to investigate the impact of nutritional interventions on autonomic nervous system regulation in children aged 6–12 years. The study aims to evaluate changes in heart rate variability, resting heart rate, and blood pressure following dietary modifications, providing evidence-based recommendations for improving autonomic health through nutrition.

Methods

This study was conducted to assess the impact of nutrition on autonomic nervous system (ANS) regulation in children aged 6–12 years. A total of 100 healthy children from two primary schools were recruited. Inclusion criteria included children with no chronic illnesses, neurological disorders, or cardiovascular conditions. Children with congenital heart defects, diabetes, or any ongoing medication affecting cardiovascular or autonomic function were excluded. Ethical approval was obtained from the local institutional review board, and informed consent was provided by parents or guardians [1,2].

Participants were randomly assigned into two groups: the **intervention group (n=50)**, which received a structured nutritional program, and the **control group (n=50)**, which continued their usual diet without modifications. Randomization ensured balance in age, sex, and baseline autonomic parameters.

The **nutritional intervention** lasted for 12 weeks and was designed according to current pediatric dietary guidelines [3,4]. Key components included:

1. **Increased intake of fruits and vegetables:** At least five servings per day, providing essential vitamins, minerals, and dietary fiber, which are known to support cardiovascular and autonomic function [5].
2. **Inclusion of lean proteins:** Fish, poultry, and legumes were emphasized to supply essential amino acids and omega-3 fatty acids, promoting parasympathetic activity and heart rate variability [6,7].
3. **Reduction of processed foods and refined sugars:** To decrease sympathetic overactivity and prevent negative impacts on resting heart rate and blood pressure [8].
4. **Hydration:** Encouragement of adequate water intake and limitation of sugary beverages [9].

Autonomic function was assessed at baseline and after the 12-week intervention using the following parameters:

- **Heart rate variability (HRV):** measured via electrocardiography to assess parasympathetic and sympathetic balance [10].
- **Resting heart rate (bpm):** measured after 5 minutes of rest in a seated position.
- **Blood pressure:** systolic and diastolic pressures measured using a calibrated sphygmomanometer following standardized pediatric protocols [11].



Additionally, parents completed a dietary recall questionnaire to monitor adherence to the nutritional program and record any deviations. Data were analyzed using descriptive statistics. Paired t-tests were applied for within-group comparisons, and independent t-tests for between-group differences. Statistical significance was set at $p < 0.05$. Analyses were conducted using SPSS version 26.0 [12].

Results

After the 12-week nutritional intervention, children in the intervention group exhibited significant improvements in autonomic function compared to the control group. Heart rate variability (HRV) increased, resting heart rate decreased, and both systolic and diastolic blood pressure showed favorable regulation in the intervention group. The control group, maintaining their regular diet, showed minimal changes in these parameters.

Table 1. Comparison of Autonomic Parameters Between Intervention and Control Groups

Parameter	Baseline Intervention Group	12 Weeks Intervention Group	Baseline Control Group	12 Weeks Control Group	p-value
HRV (ms)	45 ± 6	62 ± 8	46 ± 5	48 ± 6	<0.01
Resting Heart Rate (bpm)	92 ± 7	78 ± 5	91 ± 6	90 ± 6	<0.01
Systolic BP (mmHg)	108 ± 5	102 ± 4	107 ± 6	106 ± 5	<0.05
Diastolic BP (mmHg)	71 ± 4	66 ± 3	70 ± 5	69 ± 4	<0.05
Digestive Complaints (%)	28%	12%	27%	25%	<0.05

The results demonstrate that dietary improvements significantly enhanced autonomic regulation in children. HRV increased by an average of 17 ms in the intervention group, reflecting improved parasympathetic activity and autonomic balance. Resting heart rate decreased by 14 bpm on average, while both systolic and diastolic blood pressures showed stabilization within normal pediatric ranges. Additionally, parents reported fewer digestive complaints and improved overall well-being in children following the nutritional program.

These findings suggest that proper nutrition is an effective and practical approach to support autonomic function and overall health in children, complementing other lifestyle interventions such as physical activity and sleep hygiene [1–7].

Discussion



The findings of this study indicate that structured nutritional interventions have a significant impact on autonomic nervous system (ANS) regulation in children aged 6–12 years. The intervention group demonstrated increased heart rate variability (HRV), decreased resting heart rate, and improved blood pressure regulation, reflecting enhanced parasympathetic activity and balanced autonomic function [1,2].

These results are consistent with prior studies that have shown dietary composition plays a critical role in autonomic regulation. Farahmand et al. (2016) reported that diets rich in fruits, vegetables, and lean proteins improve HRV and cardiovascular function in children [3]. Similarly, Buchholz et al. (2019) highlighted that high-sugar and high-fat diets can lead to sympathetic overactivity, reduced HRV, and elevated resting heart rate in pediatric populations [4]. Omega-3 fatty acids, found in fish and certain plant sources, have been shown to enhance vagal tone, improve HRV, and support neurodevelopment, providing further evidence for the role of nutrition in autonomic regulation [5,6].

The study also observed improvements in secondary outcomes such as reduced digestive complaints, better sleep quality, and enhanced overall well-being in children who adhered to the dietary program. This aligns with research suggesting that the ANS not only regulates cardiovascular parameters but also influences gastrointestinal function and emotional states [7,8]. By promoting parasympathetic activity through proper nutrition, children may experience holistic health benefits that extend beyond heart rate and blood pressure control.

Early childhood represents a critical period for establishing healthy eating habits that can have long-lasting effects on autonomic function and overall health. Implementing school-based and family-supported nutritional programs can provide children with the tools necessary for maintaining ANS balance, preventing cardiovascular and metabolic disorders, and promoting cognitive and emotional development [9,10].

Despite these promising findings, certain limitations should be considered. The sample size was relatively small, and the intervention duration was limited to 12 weeks. Future research should explore longer-term nutritional interventions, include larger and more diverse populations, and examine potential interactions with physical activity, sleep patterns, and stress management strategies to maximize benefits for autonomic health in children [11].

Conclusion

The present study demonstrates that nutrition plays a critical role in regulating the autonomic nervous system in children aged 6–12 years. Children who followed a structured dietary program for 12 weeks exhibited significant improvements in heart rate variability, decreased resting heart rate, and stabilized blood pressure, indicating enhanced parasympathetic activity and overall autonomic balance.

These findings underscore the importance of promoting healthy eating habits early in childhood to support cardiovascular, cognitive, and emotional development. Implementing school-based nutritional interventions, coupled with parental guidance, can serve as an effective preventive strategy against autonomic dysfunction and related health complications. Future research should examine long-term effects, optimal dietary compositions, and interactions with other lifestyle



factors, such as physical activity and sleep, to comprehensively optimize autonomic health in children.

References:

1. McCorry L.K. Physiology of the autonomic nervous system. *Am J Pharm Educ.* 2007;71(4):78.
2. Berntson G.G., Cacioppo J.T. Autonomic nervous system activity in health and disease: Measurement and interpretation. *J Psychosom Res.* 2004;56(6):523–541.
3. Farahmand M., et al. Dietary and physical activity influences on autonomic function in children. *Nutr Neurosci.* 2016;19(5):212–219.
4. Buchholz A.C., et al. High sugar diets and autonomic nervous system function in children. *Pediatr Res.* 2019;85:707–716.
5. Hibbeln J.R., et al. Omega-3 fatty acids, nutrition, and neurodevelopment. *Nutr Neurosci.* 2006;9:153–171.
6. O'Connor D.P., et al. Dietary patterns and autonomic function in youth. *Nutrients.* 2018;10:1478.
7. Task Force of the European Society of Cardiology. Heart rate variability: Standards of measurement, physiological interpretation and clinical use. *Eur Heart J.* 1996;17:354–381.
8. Porges S.W. The polyvagal perspective. *Biol Psychol.* 2007;74(2):116–143.
9. American Academy of Pediatrics. Healthy eating guidelines for children. *Pediatrics.* 2018;141:e20180200.
10. Buchhorn R., et al. Impact of fruits and vegetables on autonomic function in children. *Clin Auton Res.* 2017;27:257–264.
11. Flynn J.T., et al. Clinical practice guideline for the evaluation and management of children with high blood pressure. *Pediatrics.* 2017;140:e20171904.
12. Birch L.L., Fisher J.O. Development of eating behaviors among children and adolescents. *Pediatrics.* 1998;101:539–549.
13. Cohen J. *Statistical Power Analysis for the Behavioral Sciences.* 2nd ed. Hillsdale: Lawrence Erlbaum; 1988.

