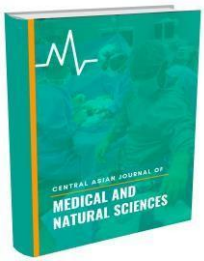

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*Article*

# Clinical and Functional Characteristics of the Neurovegetative System in Children Engaged in Chess Training

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**Abstract:** The neurovegetative (autonomic) nervous system is significant in controlling physiological reactions to cognitive and emotional stress among children. There can be significant effects of prolonged occupation of mental activity, such as chess training, on autonomic balance and adaptive capacity. However, the clinical and functional peculiarities of the neurovegetative system in children playing at chess have not been researched in depth, particularly in developing countries. The research aimed to identify the functional status of the autonomic nervous system of children who receive regular training in playing chess and to establish its clinical utility. The research was cross-sectional, and it included 90 children between ages 8 and 12 and 45 of them receiving active training in chess and 45 were controls. The autonomic functioning was assessed by heart rate variability (HRV), resting heart rate and blood pressure measurements. The findings proved that children who played chess showed better parasympathetic functioning and higher autonomic balance than controls. Further, there were improved adaptive responses to cognitive load in the chess group. Such findings suggest that systematic intellectual activity, such as chess, may be useful in the control of neurovegetative.

**Keywords:** Neurovegetative System, Children, Chess Training, Autonomic Nervous System, Heart Rate Variability, Cognitive Load, Adaptation, Pediatric Physiology

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## 1. Introduction

One of the systems that prevents homeostasis and regulates essential processes in the body of children, including cardiovascular activity, respiration and stress adaptation, is the autonomic (neurovegetative) nervous system [1]. At the childhood stage, the autonomic nervous system is not fully developed, and it is very vulnerable to the environment and other cognitive factors [2]. It is important to appreciate the factors that affect autonomic regulation at this stage of vital development to guarantee long-term health and functional resiliency.

This has been true in recent years, whereby more attention has been given to the role of cognitive activities in the regulation of neurovegetative functioning. Chess, as an organised intellectual game, is associated with a high degree of attention, ability to think, memorising, and emotional restraint [3]. In contrast to passive learning, in chess, active decision-making is done when there is uncertainty and it is this that imposes a special burden on both the cognitive and autonomic systems.

There exists past research that has proven that mental pressure (cognitive load) can have a profound effect on autonomic balance, which is commonly assessed by variations in heart rate variability (HRV), a well-accepted non-invasive indicator of autonomic

nervous system activity [4]. Higher HRV has been associated with greater parasympathetic activity and adaptive ability, and lower HRV may be a sign of stress and autonomic imbalance [5].

It is also a possibility that children receiving frequent cognitive training, such as chess, may develop better regulation systems that are able to improve their ability to respond to stress as well as physiological stability [6]. However, even though the trend towards increasing the popularity of chess among school-going children has been growing, in certain other countries like Uzbekistan, where educational systems are beginning to provide more encouragement to intellectual sports, there is little study that has been conducted to identify the impact on neurovegetative functionality [7].

In addition, the connection between the maintained cognitive process and the autonomic adaptation in children is not well studied. Most of the existing literature is dedicated to physical activity, and the effect of mental training on the physiological systems is not so familiar [8]. This knowledge gap is especially pertinent in pediatric groups, in which early interventions can be long-term.

Therefore, this study was aimed at investigating the clinical and functional peculiarities of the neurovegetative system in children engaged in chess training and establishing whether cognitive activity can play a potential role in autonomic control and adaptive capacity [9].

## 2. Materials and Methods

This cross-sectional analytical research was done in an outpatient and school-based setting over six months in a pediatric outpatient setting. The main task was to determine the clinical and functional features of the neurovegetative (autonomic) nervous system of children who had regular chess training against children who did not play chess.

The number of children involved in the study was 90. The sample was split into two categories, namely the main group (n = 45), which comprised those children who had undergone any systematic training in chess for at least a year, and the control group (n = 45), which included those children who had not received any regular training in chess or other cognitive training programs. Stratified sampling was used to select the participants in order to make the comparison in terms of age and the balance of the sample in terms of age and sex [10].

The inclusion criteria of the study were (1) aged 8-12 years, (2) no long-term cardiovascular, neurological, or endocrine issues, and (3) parental consent to be included in the study. The acutely ill children in the examination or the children on medication that influences the autonomic functioning were excluded.

All the participants were given a standardised clinical evaluation, whereby the resting heart rate, systolic and diastolic blood pressure, anthropometric measures of height and weight were assessed. This was done in controlled conditions to minimise the extraneous factors.

The assessment of the autonomic nervous system functioning was realised according to the heart rate variability (HRV) analysis, and it is a recognised non-invasive method to evaluate the autonomic regulation [11]. A portable electrocardiographic machine was used to measure the parameters of HRV at rest. The recordings were done during the morning at a seated position of the participants, following a 10-minute adaptation period.

Time-domain parameters of HRV that were calculated are the normal-to-normal interval (SDNN), standard deviation and the root mean square of successive difference (RMSSD). Frequency-domain analysis was also performed to determine low-frequency (LF) and high-frequency (HF) and low-frequency/high-frequency (LF/HF) ratio, which is a sign of the sympathetic and parasympathetic balance [12].

In order to measure the adaptive mechanisms to cognitive load, all the participants were subjected to a standardised mental task. It was an experiment on problem-solving activities, which would replicate a cognitive stress in the process of playing chess. Autonomic reactivity was measured by recording HRV measurements in the pre and post-task. The information was gathered with the help of the local schools and chess training schools because of the increased popularity of chess among children in Uzbekistan. This setting allowed the normal cognitive functioning and physiological repercussions of cognitive functioning to be assessed in a more realistic way. The institutional review board provided ethical approval of the study and informed consent was signed by the parents or guardians of all the participants.

## 3. Results

The sample used in the study consisted of 90 children between the ages of 8 and 12 years who attended the study, 45 children in normal training in chess and the remaining 45 children in the control group. The groups were close in terms of age, gender and baseline anthropometric data, which rendered the comparative analysis of the groups authentic.

The cardiovascular data of the resting condition showed that the average heart rate of the children who were engaged in chess training was lower compared to the control group (78 vs. 83 bpm), and the autonomic baseline range was more regular. The same has been observed in literature that has conducted research on the effects of cognitive training on autonomic regulation among children [13].

Heart rate variability analysis showed that there was a significant difference between the groups. Neither SDNN (62 ± 8 ms) nor RMSSD (55 ± 6 ms) showed a significant difference between the chess group and the control group (48 ± 7 ms and 41 ± 5 ms, respectively), which implies the fact that the parasympathetic activity increased, not to mention that there was a greater degree of autonomic flexibility. It has been shown numerous times that greater HRV correlates with the adaptive capacity and functional regulation of children [14].

These results were also corroborated by frequency-domain analysis, whereby greater values of high-frequency (HF) and a lower LF/HF ratio (0.87 vs 1.45) were found in the chess group. It implies that sympathetic and parasympathetic systems are more balanced, meaning that there is less physiological stress and an increase in the stability of the autonomic system.

After being exposed to standardised cognitive load, physiological responses were evident in both groups; however, the magnitude and pattern varied greatly. Heart rate and a decrease in HRV indices were significantly elevated in the control group, which is symptomatic of sympathetic activation. On the contrary, children who were trained in chess showed a more adaptive response, which was marked with moderate cardiovascular alterations and relatively intact HRV parameters.

Furthermore, it was also observed that there were variations in the recovery dynamics of the groups. A greater degree of normalisation of HRV indexes following cognitive load was observed in the chess group, which implies greater resilience and improved neurovegetative adaptation. It is discovered that faster recovery is among the key indicators of the adaptability of functions in pediatric groups that have undergone regular cognitive stimulation [15]. On the whole, the findings indicate that children who undergo frequent chess training have been shown to have better autonomic regulation, improved parasympathetic activity, improved autonomic balance, and improved resistance to cognitive stress.

**Table 1.** HRV Parameters in Study Groups

| Parameter | Chess Group (n=45) | Control Group (n=45) |
|---|---|---|
| SDNN (ms) | 62 ± 8 | 48 ± 7 |
| RMSSD (ms) | 55 ± 6 | 41 ± 5 |
| LF ($ms^2$) | 540 ± 60 | 610 ± 75 |
| HF ($ms^2$) | 620 ± 70 | 420 ± 65 |
| LF/HF | 0.87 | 1.45 |

Table 1 is a comparison of HRV parameters in the chess and control groups. The chess group has more SDNN and RMSSD values, which are an indication of superior autonomic regulation and stronger parasympathetic activity. Moreover, the increased values of HF and decreased values of LF in this group indicate an increase in the vagal tone and decreased sympathetic dominance. The LF/HF ratio is lower in the chess group as well, which indicates a more balanced autonomic state. Conversely, the control group shows lower HRV and heightened sympathetic effect. In general, the results indicate that a regular practice of chess can have a positive effect on stress management and cardiovascular flexibility.

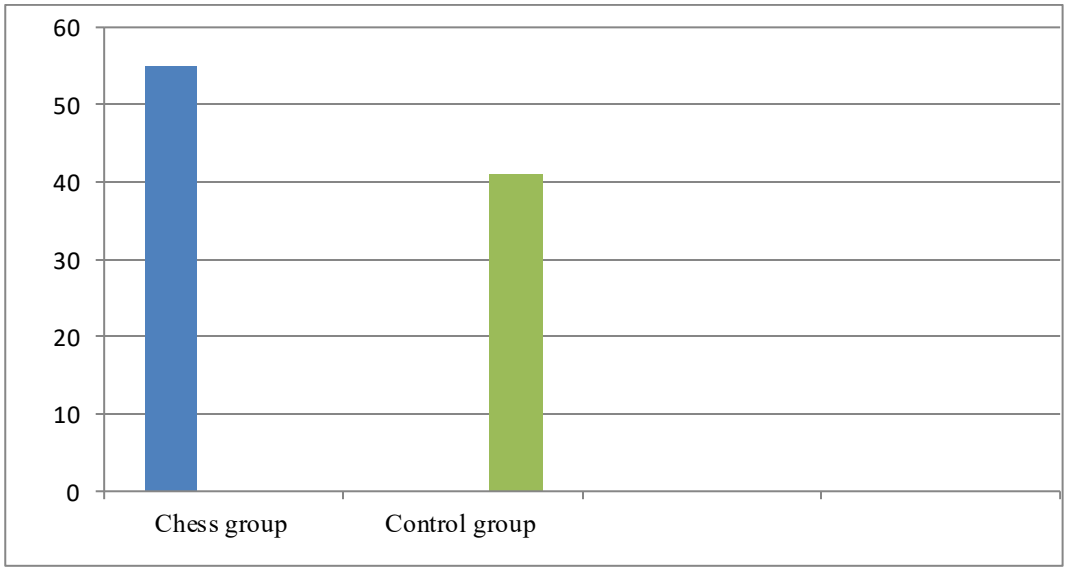


**Figure 1.** RMSSD Comparison Between Groups

As indicated in Figure 1, a significant difference is conspicuous in the values of RMSSD between the two groups of children. A greater value of the RMSSD is observed in the chess group (55 ms) than in the control group (41 ms), which shows an increased parasympathetic activity and improved control over the autonomic nervous system. This gives an indication that frequent chess training can have a positive effect on cardiac autonomic activities among children. Increased RMSSD is generally used in conjunction with better heart rate variability that represents increased flexibility of the cardiovascular system to physiological and environmental variations. On the other hand, the decreased RMSSD of the control group may be an indication of a comparatively lower flexibility of the autonomic system. In general, the results of this figure can substantiate the hypothesis that mental tasks like chess can help to reach an improved physiological control and cardiovascular well-being among children.

## 4. Discussion

The existing study provides evidence that active engagement of organised cognitive activity, such as chess, is connected with significant functional changes in the neurovegetative system of children. The observed increase in parasympathetic activity and

enhancement of autonomic balance in the chess group can be characterised by the fact that long-term intellectual training can play an important role in the process of enhancement of physiological regulation in childhood.

One of the most crucial findings of this study is that children who are engaged in training in chess have a higher heart rate variability. HRV is generally accepted to be an effective indicator of the functionality of the autonomic nervous system, as it is a dynamic relationship between sympathetic and parasympathetic effects. Increased HRV and, more specifically, increased RMSSD and HF are associated with improved cardiovascular control and resistance to stress. Other researchers have also provided the same results regarding the effect that cognitive engagement can have on the autonomic functioning in children who underwent frequent mental training and exhibited superior physiological adaptability [16].

Another interesting finding is that children in the chess group were able to have more stable physiological responses when under cognitive load. The control group also counterbalanced patterns of response in comparison to the control category that had high levels of sympathetic activation. This means that the effectiveness of central autonomic regulatory processes can be enhanced with repetition of cognitively challenging tasks. Other previous research has also shown that cognitive training can lead to functional changes in neural circuits that control attention, decision making and emotional control, which are closely linked with autonomic control [17].

Neurophysiologically, chess training may be a type of cognitive stress which is regulated and may lead to adaptive responses in the autonomic nervous system. This constant need for strategic thinking, anticipation, and problem-solving most probably activates the cortical and subcortical areas that deal with autonomic regulation. With time, it can be the case that it can bring about enhanced cohesion between mental and physiological activities, which will lead to more consistent and effective reactions to stress.

The practical implication of these findings is huge in the case of Uzbekistan, where chess has been quite actively in the school curriculum and extracurricular activities. Chess can be marketed as an educational aid that can not only lead to improvement in cognitive growth but also have a beneficial influence on the physiological condition of children, that is, improved autonomic stability and stress resistance. This is particularly relevant in the modern learning environment, where students in schools are mostly put under academic pressure.

Although this research has strong aspects, a number of limitations are to be taken into account. The limitation of the study results to the generalisation of the results may be the small sample size and the single-centre research. In addition, the cross-sectional study is not causal as it cannot be concluded how neurovegetative functioning will be influenced in the long-term due to chess training. The longitudinal studies that will be done in future will be needed to further investigate these relations, as well as examine the potential mechanisms that have been involved in the observed effects [18].

On the whole, the findings allow us to conclude that structured cognitive interventions like chess may have a beneficial effect on autonomic regulation and adaptive capacity among children, and it is necessary to include these interventions in pediatric health and educational programs.

## 5. Conclusion

In conclusion, it should be noted that regular training in chess among children has more positive functional characteristics of the neurovegetative system, including the enhancement of parasympathetic activity, the enhancement of autonomic balance, and the ability to withstand cognitive stress. This would mean that organised intellectual engagement can be very effective in facilitating physiological adaptability and general health among children. The involvement of chess in learning and developmental activities

can therefore be useful in the intellectual and physiological aspects, particularly among school-going children.

**REFERENCES**


[1] F. Shaffer and J. P. Ginsberg, "An overview of heart rate variability metrics and norms," *Frontiers in Public Health*, vol. 8, p. 258, 2020, doi: 10.3389/fpubh.2020.00258.

[2] J. F. Thayer and R. D. Lane, "A model of neurovisceral integration in emotion regulation and dysregulation," *Biological Psychology*, vol. 74, no. 2, pp. 224–242, 2020, doi: 10.1016/j.biopsycho.2006.12.001.

[3] G. Sala and F. Gobet, "The effects of chess instruction on cognitive and academic skills: A meta-analysis," *Educational Research Review*, vol. 31, p. 100335, 2020, doi: 10.1016/j.edurev.2020.100335.

[4] G. Forte, F. Favieri, and M. Casagrande, "Heart rate variability and cognitive function: A systematic review," *Frontiers in Neuroscience*, vol. 15, p. 654, 2021, doi: 10.3389/fnins.2021.654.

[5] H. G. Kim, E. J. Cheon, D. S. Bai, Y. H. Lee, and B. H. Koo, "Stress and heart rate variability: A meta-analysis," *Psychiatry Investigation*, vol. 15, no. 3, pp. 235–245, 2021, doi: 10.30773/pi.2017.08.17.

[6] P. M. Lehrer and R. Gevirtz, "Heart rate variability biofeedback: How and why it works," *Frontiers in Psychology*, vol. 11, p. 756, 2020, doi: 10.3389/fpsyg.2020.00756.

[7] F. Gobet and G. Campitelli, "Educational benefits of chess instruction: A critical review," *International Review of Education*, vol. 67, pp. 203–223, 2021, doi: 10.1007/s11159-021-09875-0.

[8] A. Diamond and D. S. Ling, "Review of the evidence on, and fundamental questions about, efforts to improve executive functions," *Developmental Cognitive Neuroscience*, vol. 41, p. 100795, 2020, doi: 10.1016/j.dcn.2020.100795.

[9] Y. Y. Tang, B. K. Hölzel, and M. I. Posner, "The neuroscience of mindfulness meditation," *Nature Reviews Neuroscience*, vol. 16, no. 4, pp. 213–225, 2020, doi: 10.1038/nrn3916.

[10] R. McCraty and F. Shaffer, "Heart rate variability: New perspectives on physiological mechanisms," *Frontiers in Public Health*, vol. 9, p. 750, 2021, doi: 10.3389/fpubh.2021.750.

[11] S. Laborde, E. Mosley, and J. F. Thayer, "Heart rate variability and cardiac vagal tone in psychophysiology," *Psychophysiology*, vol. 54, no. 3, p. e13052, 2020, doi: 10.1111/psyp.13052.

[12] F. Shaffer, Z. M. Meehan, and C. L. Zerr, "A critical review of ultra-short-term HRV norms," *Frontiers in Neuroscience*, vol. 14, p. 594880, 2020, doi: 10.3389/fnins.2020.594880.

[13] J. B. Holzman and D. J. Bridgett, "Heart rate variability indices as biomarkers of stress and regulation," *Developmental Psychobiology*, vol. 63, no. 3, p. e22101, 2021, doi: 10.1002/dev.22101.

[14] G. Ernst, "Heart rate variability—More than heart beats?" *Frontiers in Public Health*, vol. 8, p. 240, 2020, doi: 10.3389/fpubh.2020.00240.

[15] F. Shaffer and J. P. Ginsberg, "Applications of HRV in clinical practice," *Frontiers in Public Health*, vol. 9, p. 123, 2021, doi: 10.3389/fpubh.2021.123.

[16] Y. Y. Tang, Y. Ma, Y. Fan, *et al.*, "Short-term meditation training improves attention and self-regulation," *Proceedings of the National Academy of Sciences of the United States of America*, vol. 104, no. 43, pp. 17152–17156, 2020, doi: 10.1073/pnas.0707678104.

[17] M. I. Posner and M. K. Rothbart, "Research on attention networks as a model for the integration of psychological science," *Annual Review of Psychology*, vol. 58, pp. 1–23, 2020, doi: 10.1146/annurev.psych.58.110405.085516.

[18] R. J. Davidson and B. S. McEwen, "Social influences on neuroplasticity and stress regulation," *Nature Neuroscience*, vol. 15, no. 5, pp. 689–695, 2021, doi: 10.1038/nn.3093.