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A COMPARATIVE STUDY ON THE MANIFESTATION OF ENDURANCE, BETWEEN URBAN AND RURAL ENVIRONMENTS IN CHILDREN AGED 10-12 YEARS

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Abstract: This study aims to compare aerobic endurance levels in children aged 10–12 years from urban and rural environments, considering the influence of lifestyle and environmental factors on motor performance. The research was conducted on two groups of fifth-grade boys (n = 28), equally divided between a rural school and an urban school. Aerobic capacity was assessed using the Beep Test, with performance indicators including total distance covered, maximal aerobic speed (MAS), heart rate response, and estimated maximal oxygen uptake (VO_2max). The results revealed significantly higher VO_2max values and better heart rate recovery in the rural group compared to the urban group, indicating superior aerobic adaptation. Despite greater access to organized sports facilities in urban areas, children from rural environments demonstrated higher endurance levels, likely due to increased daily physical activity and reduced sedentary behavior. Questionnaire data supported these findings, highlighting a higher prevalence of informal physical activity in rural children and increased screen time among urban participants. The findings suggest that environmental context and lifestyle habits play a crucial role in the development of aerobic endurance during late childhood. These results underline the importance of adapting physical education strategies to students' living environments, emphasizing increased physical activity intensity in urban settings and structured endurance development in rural schools.

Key words: aerobic endurance, VO_2max, Beep Test, urban and rural environment, physical activity, children

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INTRODUCTION

Endurance represents a fundamental motor capacity, defined as the ability of the human body to sustain physical effort for a prolonged period without a significant decrease in efficiency, under conditions of economical physiological functioning and rapid recovery (Demeter, 1981). In childhood, aerobic endurance constitutes a key indicator of cardiovascular health and overall motor development, playing a decisive role in both physical performance and long-term health outcomes (Manno, 1992).

Aerobic endurance develops predominantly through moderate-intensity, medium-duration efforts and reflects the functional capacity of the cardiovascular and respiratory systems (Alexe, 1993). From a physiological perspective, endurance performance is closely linked to maximal oxygen uptake (VO_2max), which expresses the body's ability to transport and utilize oxygen during sustained effort. At the age of 10–12 years, often described as the "golden age of motor skills," children undergo accelerated somatic, functional, and neuromuscular development, making this period particularly favorable for the formation and optimization of basic motor capacities, including endurance (Epuran, 2005). Specialized literature classifies endurance according to effort duration and dominant energy systems. Long-duration endurance relies almost exclusively on aerobic metabolism and supports activities lasting more than eight minutes, while medium-duration endurance involves a mixed aerobic–anaerobic contribution and characterizes efforts between two and six minutes. Short-duration endurance, typical for efforts lasting less than two minutes, is dominated by anaerobic processes (Bompa, 2001). Understanding these distinctions is essential when selecting appropriate assessment tools and training methods for children.

Beyond biological maturation, environmental factors significantly influence the development of aerobic endurance. Several studies have highlighted differences in physical fitness between children from urban and rural environments, emphasizing the role of lifestyle, daily physical activity, and access to movement opportunities (Chillón et al., 2011). Children living in rural areas often engage in higher levels of informal physical activity, such as walking long distances, outdoor play, and household tasks, which contribute to superior aerobic conditioning compared to their urban peers (Sandercock et al., 2010). Although urban environments typically offer greater access to organized sports programs and modern facilities, these advantages may be counterbalanced by increased sedentary behaviors, including prolonged screen time and reduced spontaneous physical activity. Consequently, environmental context appears to shape not only the quantity but also the quality of physical activity performed during childhood, with direct implications for endurance development. In school settings, the Beep Test has proven to be a practical and reliable method for assessing aerobic endurance and estimating VO_2max in children and adolescents. Its progressive nature allows for objective comparison between individuals and groups, facilitating the identification of differences related to physical conditioning and lifestyle factors (Alexe, 1993; Bompa, 2001).

Given these considerations, the present study aims to evaluate and compare aerobic endurance in children aged 10–12 years from urban and rural environments, using the Beep Test as the primary assessment tool. By analyzing VO_2max values, distance covered, and heart rate responses, the study seeks to identify the extent to which living environment and daily activity patterns influence cardiovascular endurance at a critical stage of motor development.

MATERIALS AND METHODS

Subjects

The study was conducted on a sample of 28 fifth-grade students (boys), aged between 11 and 12 years. The participants were divided into two equal groups based on their living

environment: a rural group (n = 14) and an urban group (n = 14). The rural group consisted of students from a school in Bistrița Bârgăului, while the urban group included students from a school in Oradea. All participants were clinically healthy and attended regular physical education classes.

Study Design

A comparative, cross-sectional research design was applied to evaluate differences in aerobic endurance between children from urban and rural environments. Data collection was carried out under similar environmental and organizational conditions for both groups, during scheduled physical education classes.

Assessment of Aerobic Endurance

Aerobic endurance was assessed using the Beep Test (20 m shuttle run test), a standardized and widely used field test for evaluating cardiovascular endurance in children. The test consists of repeated 20-meter shuttle runs performed at progressively increasing speeds, dictated by audio signals. The test was terminated when the participant was unable to maintain the required running pace for two consecutive shuttles.

The following performance indicators were recorded: total distance covered (meters); maximal aerobic speed (MAS/VMA); heart rate measured at 30 seconds and 1 minute post-exercise; estimated maximal oxygen uptake (VO_2max). VO_2max was calculated using the following predictive formula: $VO_2max = 31.025 + (3.238 \times VMA) - (3.248 \times age) + (0.1536 \times age \times VMA)$.

Environmental Characteristics

The urban environment was characterized by greater access to organized sports facilities and structured physical activity programs but also by increased exposure to sedentary behaviors and limited open spaces. In contrast, the rural environment offered fewer formal sports facilities but provided extensive natural spaces conducive to spontaneous and informal physical activity.

Questionnaire on Physical Activity and Lifestyle

To complement the physiological data, a questionnaire was administered to assess participants' physical activity habits and lifestyle characteristics. The questionnaire focused on: participation and engagement during school physical education classes; frequency and type of individual physical activity outside school; daily screen time and use of social media.

The questionnaire data were used to contextualize the endurance test results and to explore potential associations between lifestyle behaviors and aerobic performance.

Data Analysis

Descriptive statistical methods were used to analyze the collected data. Mean values were calculated for VO_2max, total distance covered, and heart rate responses for each group. Comparative analysis between the rural and urban groups was performed to identify differences in aerobic endurance and recovery capacity. The results were interpreted in relation to environmental and lifestyle factors.

RESULTS

Aerobic Endurance Performance (Beep Test)

The results obtained from the Beep Test highlight clear differences in aerobic endurance between the rural and urban groups. Performance was analyzed using total distance covered, maximal oxygen uptake (VO_2max), and heart rate recovery indicators.

VO_2max Comparison Between Groups

The estimated VO_2max values showed higher aerobic capacity in children from the rural environment compared to their urban counterparts. Individual VO_2max values in the rural group ranged from 42.12 to 51.98 $ml \cdot kg^{-1} \cdot min^{-1}$, with most participants classified in the "excellent" or

"superior" categories. In contrast, the urban group recorded lower values, starting from 37.78 $ml \cdot kg^{-1} \cdot min^{-1}$, with several students falling into the "weak" or "very weak" categories.

Table 1. Comparison of Average VO2max between Urban and Rural Environments

Group	Mean VO2max
Rural Environment (Bistrița Bârgăului)	**45.86**
Urban Environment (Oradea)	**41.25**

The mean VO_2max value for the rural group was 45.86 $ml \cdot kg^{-1} \cdot min^{-1}$, while the urban group recorded a mean value of 41.25 $ml \cdot kg^{-1} \cdot min^{-1}$, representing an approximate 11% difference in favor of the rural group.

Distance Covered During the Beep Test

Total distance covered during the Beep Test further reflected the superior aerobic performance of the rural group. Several rural participants exceeded 1000 meters, with maximum distances reaching 1240 meters. In contrast, some urban participants were unable to progress beyond the early stages of the test, recording distances as low as 200 meters.

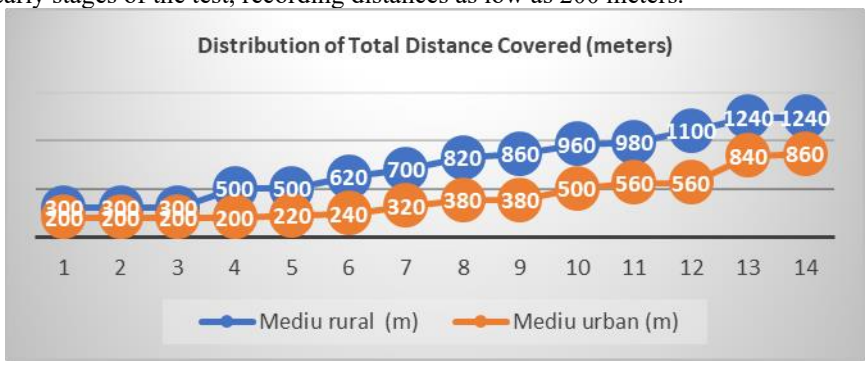

Figure 1. Distribution of Total Distance Covered (meters)

The distribution of distances highlights a greater dispersion and generally lower performance in the urban group, while the rural group demonstrated higher and more homogeneous endurance levels.

Heart Rate Response and Recovery

Heart rate measurements taken at 30 seconds and 1 minute post-exercise revealed more efficient cardiovascular recovery in the rural group. Rural participants showed a consistent and rapid decrease in heart rate following exertion, indicating a higher level of aerobic adaptation.

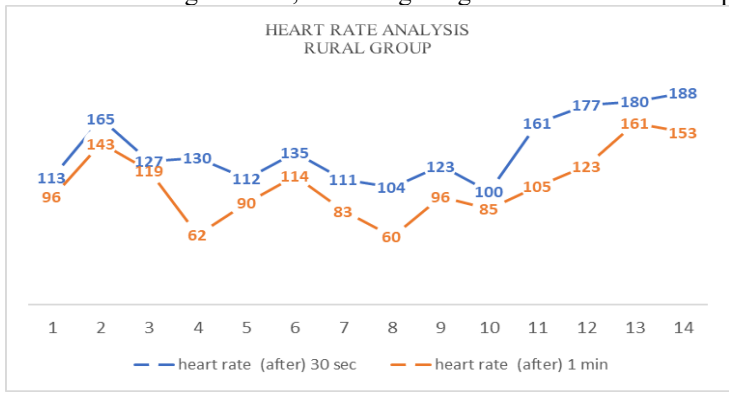

Figure 2. Heart rate analysis rural group

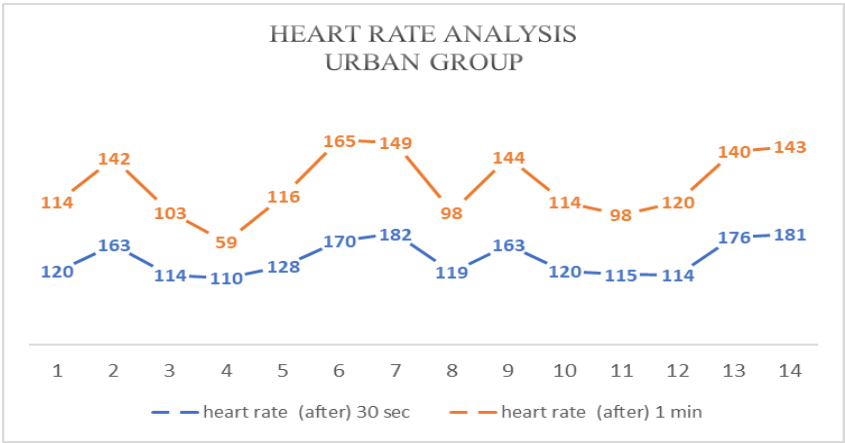

Figure 3. Heart rate analysis urban group

In contrast, the urban group exhibited slower heart rate recovery, suggesting a lower level of cardiovascular conditioning.

Questionnaire Results on Physical Activity and Lifestyle

Analysis of questionnaire data revealed differences in physical activity patterns and lifestyle behaviors between the two groups. Rural students reported higher levels of informal physical activity, including outdoor play and walking, whereas urban students reported greater involvement in organized sports but also higher levels of sedentary behavior outside scheduled activities.

Figure 4. Individual Physical Activity

Screen time analysis showed that students who reported more than 3–4 hours per day spent on social media or electronic devices tended to achieve lower Beep Test levels and reduced VO_2max values. Urban students reported a higher average daily screen time compared to rural students.

Social Media and Screen Time: The survey revealed a direct correlation between high screen time and lower endurance results. Students who spent more than 3-4 hours daily on social media platforms reached lower levels in the Beep Test (Levels 2-4). Urban students recorded a slightly higher average of daily screen time compared to rural students, which may contribute to the differences in cardiovascular resistance (VO2max).

Motivation: The primary motivation for movement in rural areas was "fun and socialization," while urban students were more motivated by "physical appearance and performance."

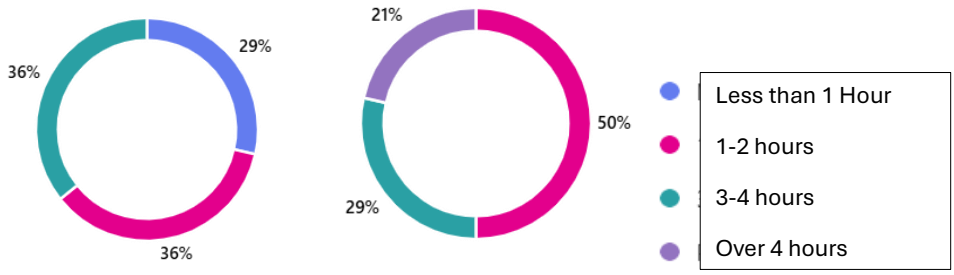

Figure 5. Social media and screen time

DISCUSSIONS

The present study aimed to compare aerobic endurance levels in children aged 10–12 years from urban and rural environments, emphasizing the role of lifestyle and environmental context in cardiovascular development. The findings indicate clear differences in aerobic performance between the two groups, with children from the rural environment demonstrating superior endurance capacity, as reflected by higher VO_2max values, greater distances covered during the Beep Test, and more efficient heart rate recovery.

The higher aerobic capacity observed in the rural group may be attributed to the cumulative effect of daily physical activity inherent to the rural lifestyle. Unlike urban children, who often rely on structured and time-limited sports programs, rural children are more frequently exposed to spontaneous and informal physical activities such as walking long distances, outdoor play, and household tasks. These activities contribute to sustained moderate-intensity effort, which is particularly effective for developing aerobic endurance during late childhood (Alexe, 1993; Epuran, 2005).

The results are consistent with previous research highlighting the influence of living environment on physical fitness in children. Studies conducted by Chillón et al. (2011) reported higher levels of physical fitness among rural children compared to their urban peers, despite reduced access to organized sports infrastructure. Similarly, Sandercock et al. (2010) emphasized the positive relationship between informal physical activity and cardiorespiratory fitness, suggesting that daily movement patterns may outweigh the benefits of structured training alone at this age.

Heart rate recovery analysis further supports the superior cardiovascular adaptation observed in the rural group. Faster post-exercise heart rate reduction is a recognized indicator of efficient autonomic regulation and aerobic conditioning. The slower recovery observed in urban participants may reflect lower habitual physical activity levels and increased exposure to sedentary behaviors, particularly prolonged screen time.

The questionnaire results reinforce this interpretation, revealing a higher prevalence of sedentary habits among urban children, especially extended use of social media and electronic devices. These findings align with current concerns regarding the negative impact of excessive screen time on children's physical fitness and motor development. The inverse relationship observed between daily screen time and endurance performance underscores the importance of limiting sedentary behaviors during a critical stage of growth and development.

Although urban environments generally provide better access to modern sports facilities and organized training, the present findings suggest that these advantages do not necessarily translate into superior aerobic endurance. This may be due to the intermittent nature of organized

sports participation and the lack of consistent daily movement outside scheduled activities. In contrast, the rural environment appears to foster a more active lifestyle overall, which supports the continuous development of aerobic capacity.

From an educational perspective, these results highlight the need for differentiated physical education strategies tailored to students' living environments. In urban schools, physical education programs should place greater emphasis on increasing overall activity volume and intensity to counterbalance sedentary lifestyles. In rural settings, educators may focus on refining motor skills and diversifying physical activities while maintaining the naturally high levels of endurance-related movement.

CONCLUSIONS

The comparative analysis of aerobic endurance in children aged 10–12 years highlights the significant influence of living environment on cardiovascular fitness. The results demonstrate that children from rural environments exhibit higher aerobic capacity, better performance in the Beep Test, and more efficient heart rate recovery compared to their urban peers.

These findings suggest that habitual daily physical activity, characteristic of rural lifestyles, plays a decisive role in the development of endurance during late childhood. Informal and spontaneous movement appears to provide a more consistent stimulus for aerobic adaptation than structured physical activity alone. Conversely, increased sedentary behavior, particularly excessive screen time, negatively affects endurance development in urban children.

The Beep Test proved to be an effective and practical tool for assessing aerobic endurance in school settings, allowing objective differentiation between groups and identification of children with lower cardiovascular fitness levels.

From an educational standpoint, the study emphasizes the need to adapt physical education strategies to the specific environmental context of students. Urban physical education programs should prioritize increasing activity volume and intensity to counteract sedentary behaviors, while rural programs should focus on maintaining endurance levels and expanding motor skill development through diversified activities.

Overall, the results support the importance of integrating environmental and lifestyle considerations into the planning of physical education curricula, with the aim of promoting optimal motor development and long-term health in children.

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