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LETTER TO THE EDITOR

Applications of heart rate variability in pediatric physical training: a complement to the clinical approach

Aplicaciones de la variabilidad de la frecuencia cardíaca en el entrenamiento físico infantil: un complemento al enfoque clínico

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Dear Editor,

We have read with interest the article titled "Heart Rate Variability in Pediatrics: Methodological Aspects and Clinical Applications" published in *Archivos de Cardiología de México*[1]. This study presents a narrative review with the aim of analyzing the essential elements of the measurement, analysis, and application of heart rate variability (HRV) in the pediatric population, with an emphasis on the algorithms and methods most used in the clinical context.

Given the innovative approach of the article, we believe that its principles can also be extended to the field of physical training, specifically in the determination of exercise thresholds. HRV has proven to be a valuable tool as a non-invasive indicator for assessing autonomic nervous system modulation, a key factor in physical exercise adaptation. This approach, by monitoring HRV in its temporal, spectral, and non-linear domains, offers significant advantages, such as its non-invasive nature, its ability to perform continuous measurements, and its sensitivity to detect changes in the autonomic response during progressive exercise. Its practical utility lies in adjusting workloads based on the cardiovagal dynamics proposed by Carrasco-Poyatos et al.[2].

In this context, analyzing HRV metrics related to the aerobic and anaerobic thresholds from the triphasic model of increasing load allows for the identification of key ranges to discern transitions between these two physiological thresholds. During the aerobic threshold, a gradual decrease is observed in temporal metrics such as root mean square of the successive differences (RMSSD) and standard deviation of normal to normal (SDNN), which fall below 30 ms and 50 ms, respectively, indicating parasympathetic activation. In the spectral domain, low frequency (LF) shows a gradual increase while high frequency (HF) decreases, with an LF/HF ratio > 2, reflecting greater sympathetic nervous system involvement in the adaptation process to the effort[3-5]. In the non-linear domain, detrended fluctuation analysis (DFA-α1) decreases to values below 1.0, suggesting a reduction in the coherence and regularity of heart rate oscillations. At the same time, ApEn and SampEn increase above 0.8, indicating greater complexity in HRV, reflecting a transition toward an equilibrium between parasympathetic and sympathetic modulation as exercise intensity continues to increase[6,7].

When the anaerobic threshold is reached, a significant decrease is observed in temporal metrics such as

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RMSSD and SDNN, which fall below 20 ms and 30 ms, respectively, indicating a clear dominance of the sympathetic nervous system. In the spectral domain, LF increases significantly, exceeding 1000 ms², and the LF/HF ratio increases above 4, while HF decreases considerably, reflecting intense sympathetic activation and strong inhibition of vagal modulation[3-5]. In the non-linear domain, DFA-α1 drops below 0.75, indicating greater irregularity and lower coherence in heart rate fluctuations. Both ApEn and SampEn decrease below 0.6, reflecting lower complexity in HRV, marking a transition to a phase of metabolic instability, as described in the triphasic model of increasing intensity[6,7].

In summary, it is observed that at the aerobic threshold (first inflection point), parasympathetic effects predominate, while at the anaerobic threshold (second inflection point), sympathetic activation intensifies, and there is a drop in the complexity of HRV, reflecting the phase of metabolic instability and a higher physiological demand.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical considerations

Protection of humans and animals. The authors declare that no experiments involving humans or animals were conducted for this research.

Confidentiality, informed consent, and ethical approval. This study does not involve personal patient data, medical records, or biological samples, and does not require ethical approval. SAGER guidelines do not apply.

Declaration on the use of artificial intelligence. The authors declare that artificial intelligence was used in the writing of this manuscript, specifically with the use of ChatGPT for grammar correction.

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