Autonomic responses and internal load analysis through acute assessment of heart rate variability after a high-intensity functional training session

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Summary

Backgroud: Heart rate variability (HRV) measurement is an important tool that may help indicate possible physiological changes, and HRV monitorization could be a great strategy for clinical analysis (autonomic control) and performance (internal load).
Objective: The aim of the present study was to evaluate autonomic responses and internal load through HRV during a high-intensity functional training (HIFT) session.
Material and method: Thirty-three individuals (22 men and 11 women) participated in the study (Age: Mean = 34.9 ± 7.2 years; Weight: Mean = 72.3 ± 13.7 kg; Height: Mean = 1.72 ± 0.1 m; BMI: Mean = 24.4 ± 3.0 kg/m^2). All participants engaged in a 60-to-90-minute HIFT session. HRV analysis was performed during the specific warm-up period (targeted warm-up or skill training that followed the general mobility and light cardiovascular warm-up), during exercise (approximately 50 minutes), and in the recovery phase (10 minutes post-training). A Polar H10 heart rate monitor chest strap (Kempele, Finland®) was used to collect HRV and was connected to the Elite HRV mobile application. The data were further transferred to Kubios HRV Standart software, version 3.3.1, in order to process the acquired data.
Results: For isolated analyzes (pre- and post-), differences were found for SDNN (P<0.001), RMSSD (P<0.001) and HF (P=0.041), yet not for LF / HF (P=0.483). In the analysis of HRV kinetics, significant results were found between moments for RR, SDNN, RMSSD, LF and HF (P<0.05). In the analysis of the internal load, the highest level of stress was identified in 40 (P=0.010) and 50 minutes of exercise (P=0.001), as well as in recovery (P<0.001), this assessment being carried out through HRV through the LnRMSSD index. A negative correlation was observed between maximum heart rate (HRmax) and LnRMSSD at 40 (r=-0.51) and 50 minutes of exercise (r=-0.58). In recovery, the correlation was positive, yet insignificant (r=0.032).
Conclusion: The present study observed that HIFT could alter HRV and thus cause changes in autonomic behavior. In addition, this type of modality can offer significant levels of training loads, thus affecting the physiological responses and consequently the individual's functional efficiency.

Key words:
Heart Rate Variability. Autonomic Response. Training Load. High-Intensity Functional Training. CrossFit.

Respuestas autonómicas y análisis de la carga interna mediante la evaluación aguda de la variabilidad de la frecuencia cardíaca tras una sesión de entrenamiento funcional de alta intensidad

Resumen

Introducción: La medición de la variabilidad de la frecuencia cardiaca (HRV) es una herramienta importante que puede ayudar a indicar posibles cambios fisiológicos. La monitorización de la HRV podría ser una gran estrategia para el análisis clínico (control autonómico) y el rendimiento (carga interna).
Objetivo: El objetivo del presente estudio fue evaluar las respuestas autonómicas y la carga interna a través de la VFC durante una sesión de entrenamiento funcional de alta intensidad (HIFT).
Material y método: Treinta y tres individuos (22 hombres y 11 mujeres) participaron en el estudio (Edad: Media = 34,9 ± 7,2 años; Peso: Media = 72,3 ± 13,7 kg; Altura: Media = 1,72 ± 0,1 m; IMC: Media = 24,4 ± 3,0 kg / m^2). Todos los participantes participaron en una sesión HIFT de 60 a 90 minutos. El análisis de la VFC se realizó durante el periodo de calentamiento

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específico (calentamiento dirigido o entrenamiento de habilidades que seguía al calentamiento cardiovascular ligero y de movilidad general), durante el ejercicio (aproximadamente 50 minutos) y en la fase de recuperación (10 minutos después del entrenamiento). Se utilizó una banda de pecho con pulsómetro Polar H10 (Kempele, Finlandia®) para recoger la VFC y se conectó a la aplicación móvil Elite HRV. Los datos se transfirieron posteriormente al software Kubios HRV Standart, versión 3.3.1, para procesar los datos adquiridos.

Resultados: En los análisis aislados (pre y post), se encontraron diferencias para SDNN (p <0,001), RMSSD (p <0,001) y HF (p = 0,041), pero no para LF / HF (p = 0,483). En el análisis de la cinética de la VFC, se encontraron resultados significativos entre momentos para RR, SDNN, RMSSD, LF y HF (p <0,05). En el análisis de la carga interna, el mayor nivel de estrés se identificó en 40 (p = 0,010) y 50 minutos de ejercicio (p = 0,001), así como en la recuperación (p <0,001), realizándose esta valoración mediante la VFC a través del índice LnRMSSD. Se observó una correlación negativa entre la frecuencia cardiaca máxima (FCmáx) y el LnRMSSD a los 40 (r = -0,51) y 50 minutos de ejercicio (r = -0,58). En la recuperación, la correlación fue positiva, aunque insignificante (r = 0,032).

Conclusiones: En el presente estudio se observó que el HIFT podía alterar la VFC y, por tanto, provocar cambios en el comportamiento autonómico. Además, este tipo de modalidad puede ofrecer niveles significativos de cargas de entrenamiento, afectando así a las respuestas fisiológicas y, en consecuencia, a la eficiencia funcional del individuo.

Palabras clave:
Variabilidad de la frecuencia cardíaca. Respuesta autonómica. Carga de entrenamiento. Entrenamiento funcional de alta intensidad. CrossFit.

Introduction

Heart rate variability (HRV) is an important parameter for analyzing autonomic behavior and might be an excellent tool for physiological assessment[1]. As known, HRV is a time (measured in milliseconds) between two adjacent heartbeats (rate a rate — RR)[2]. Higher values determine better cardiac conditions and, consequently, indicate a greater balance of the autonomic nervous system[3]. For this matter, it is possible to have a prognosis of an abnormality related to the cardiovascular system through HRV, as well as for other systems, and also to assess the physiological and functional condition of a certain individual[4].

Traditionally, HRV is widely used to assess autonomic responses (sympathetic and parasympathetic interaction) and thus identify certain unwanted reactions, preserving health and functional integrity[5]. Additionally, HRV can change because of intrinsic reasons such as aging[6] and according to sex characteristics[7,8], as well as extrinsic factors such as supplementation[9] and type of training[10]. However, HRV seems to be an easily accessible tool for clinical assessment[11] and for determining physical condition[12].

In the identification of better autonomic responses, different HRV indices (commonly time and frequency domain) can detect physiological changes that could serve for important adjustments favoring cardiovascular health[4]. On the other hand, HRV could also be useful for analyses of physical performance[13] and, consequently, help control stress and fatigue[14], preventing individuals from getting injured[15] and providing a greater assessment of an individual's adaptation to a given training sequence[16].

In a sports environment, HRV has been used for analyzing not only the autonomic balance (cardiovascular health) but also internal load (performance), providing greater efficiency of an individual, regardless of their level[15]. In terms of internal load assessment, HRV has already been used as an important strategy for the assessment of possible stresses and high levels of fatigue resulting from overtraining[13,14,17]. In order to assess clinical condition and performance, studies have used HRV to identify changes that can generate negative responses in exercisers/athletes of different modalities[18].

One of the modalities that have been gaining popularity is high intensity functional training (HIFT), supported by the well-known CrossFit® brand. Due to the high physiological demand of this activity[19], studies with physiological behavioral analyzes are extremely useful for better understanding of the repercussions caused by the training load in exercisers or athletes. Studies on HRV in HIFT are still scarce[20], therefore, it is extremely viable to further analyze this variable in exercisers or athletes of this modality. In this activity, the control of the training load (mainly internal) is indispensable since it is a type of training with high physiological demand, thus avoiding possible disorders and even the risk of injuries. Therefore, the aim of the present study was to evaluate the autonomic and internal load responses through HRV in a HIFT session.

Material and method

Participants

33 individuals participated in the study (22 men and 11 women) (Table 1), all of them were HIFT exercisers with regular practice of at least 3 months, with training frequency of at least 3 times per week. The exclusion criteria were medication use and / or ergogenic resources that could influence the expected results (i.e., pharmacological drugs for blood pressure control, beta-blockers, drugs related to cardiovascular control, performance enhancers, among others) and presenting musculoskeletal disorders that would compromise the interventions. In

Table 1. Anthropometric characteristics of the participants.

Variables	Participants (n=33) M±SD
Age (years)	34.9 ± 7.2
Weight (kg)	72.3 ± 13.7
Height (m)	1.72 ± 0.1
BMI (kg/m²)	24.4 ± 3.0