Editorial

HRV AS A BIOMARKER FOR TRAINING INDIVIDUALIZATION: SCIENTIFIC EVIDENCE IN CARDIAC REHABILITATION

EL HRV COMO BIOMARCADOR PARA LA INDIVIDUALIZACIÓN DEL ENTRENAMIENTO: EVIDENCIAS CIENTÍFICAS EN REHABILITACIÓN CARDIACA

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What if your heart could tell you how to train each day? Imagine being able to determine each morning whether your body is prepared for high-intensity exercise, in need of a lighter session, or simply requires rest, not based on assumptions or subjective feelings, but on a clear, objective, validated, and personalized physiological marker. That marker exists and is known as heart rate variability (HRV), a metric that holds great promise as a valuable tool in cardiac rehabilitation, cardiovascular health monitoring, and physical training contexts.

Each year, thousands of people in Spain experience myocardial infarctions, develop heart failure or receive a cardiovascular disease diagnosis. While these conditions are partly associated with an ageing population, a significant proportion of the burden can be attributed to modifiable behavioural risk factors, such as an unhealthy diet, a sedentary lifestyle, chronic stress and insufficient sleep. Of particular concern is the growing prevalence of cardiovascular risk factors among younger populations (Andersson & Vasan, 2018).

Physical exercise is one of the most powerful tools for the prevention and treatment of cardiovascular diseases, and has consistently demonstrated its effectiveness among the various interventions that comprise cardiovascular healthcare (Mehra et al., 2020). Current evidence suggests that physical activity should be regarded as a primary therapeutic intervention, rather than merely recommended. This non-pharmacological treatment improves cardiac function, lowers blood pressure, strengthens blood vessels and, perhaps most importantly, restores individuals' autonomy and quality of life (Abdelhalem et al., 2018). In Spain, thousands of individuals experience myocardial infarctions, develop heart failure or receive a cardiovascular disease diagnosis each year. While these conditions are partly associated with population ageing, a substantial proportion of the burden is attributable to modifiable behavioural risk factors, including unhealthy dietary habits, sedentary lifestyles, chronic stress and insufficient sleep. Of particular concern is the growing prevalence of cardiovascular risk factors among younger populations (Andersson & Vasan, 2018).

Traditionally, cardiac rehabilitation programmes have relied on moderate and continuous aerobic training as the primary form of exercise (Price et al., 2016). However, recent research has shown that, when appropriately prescribed, high-intensity interval training (HIIT) may be even more effective in enhancing cardiac function without increasing risk (McGregor et al., 2023). HIIT involves alternating short bursts of vigorous exercise with periods of active or passive recovery. This approach has been shown to improve cardiac efficiency and encourage long-term adherence to physical activity programmes (Ballesta-García et al., 2019; Wewege et al., 2018).

A major limitation of current physical exercise interventions is that they are often applied as a generic, one-size-fits-all prescription. This frequently overlooks how each patient truly feels, how their body responds and where they are in their recovery process. This issue has been highlighted in recent studies, such as McGregor et al. (2023). The reality is that not all hearts respond or recover in the same way. While some individuals demonstrate rapid improvement, others show minimal change. In some cases, excessive exercise stimulus may even lead to adverse outcomes. This interindividual variability means that standardised programmes may be inadequate or even counterproductive, particularly in clinical populations where physical exercise can have negative consequences and multiple health-related factors must be considered. Consequently, recent research has emphasised the importance of individualised interventions.

In this context, for exercise to function as an effective therapeutic intervention, it must be tailored to each patient's individual needs. Just as medication dosages are adjusted based on a patient's characteristics and clinical profile, the 'dose' of physical exercise should also be personalised. But how can exercise be individualised? How can we measure the body's perception of effort or account for internal load? This is where heart rate variability (HRV) comes in, a physiological marker that quantifies the small variations in time between successive heartbeats (Task Force, 1996). HRV has been shown to reliably indicate recovery status due to its close relationship with autonomic nervous system activity (Shaffer et al., 2014) and thus provides valuable insight into the body's readiness to tolerate physical exertion.

Although it may seem counterintuitive, a healthy heart does not beat like a metronome. Instead, its rhythm exhibits continuous, subtle variations. These fluctuations reflect the dynamic balance between the sympathetic and parasympathetic branches of the autonomic nervous system and the heart (Rodas et al., 2008). Until recently, one of the main limitations of HRV monitoring was the need for complex medical equipment. However, advances in validated mobile technologies, such as wearable devices and applications like HRV4Training (Plews et al., 2017), now enable simple, reliable HRV assessment. This paves the way for a paradigm shift in which daily training can be adapted based on each patient's HRV profile.

Although research investigating HRV-guided training in cardiac rehabilitation is limited, it has yielded compelling evidence in favour of individualised exercise prescription. A recent study by López-Osca et al. (2025) identified a characteristic psychophysiological profile in patients who had experienced an acute myocardial infarction. Their findings suggest that almost half of middle-aged individuals with ischaemic heart disease exhibit HRV values below expected levels, which may indicate a reduced ability of the autonomic nervous system to respond to physiological stress. Low HRV has been associated with adverse health outcomes, including increased all-cause mortality (Dekker et al., 1997), cardiovascular disease and stress-related conditions (Orellana-Naranjo, 2018). Furthermore, older patients report a poorer perception of their overall health and present with blood pressure imbalances. In this population, reduced HRV levels have been found to correlate with age, blood pressure, and resting heart rate (López-Osca et al., 2025). These findings highlight the need for more individualised, safer cardiac rehabilitation programmes that are tailored to each patient's physiological profile. Accordingly, baseline HRV, age and blood pressure should be considered when designing training sessions. Additionally, incorporating multidisciplinary interventions, including self-regulation strategies, is emphasised as a means to enhance recovery and improve overall patient well-being.

However, in spite of the limited number of studies on the topic, there is also a notable absence of standardised protocols for implementing HRV-guided training in practice. Addressing this issue, Carrasco-Poyatos et al. (2022) published a training protocol comparing HRV-guided exercise with high-intensity interval training (HIIT). This protocol incorporated the assessment of physiological, psychological and functional variables. They proposed an eight-week intervention comprising three sessions per week. In the experimental group, training intensity was adjusted according to each participant's baseline HRV value. Following the guidelines adapted from Kiviniemi et al. (2007), participants trained at a high intensity when their HRV was within their normal range and at a low intensity when their HRV fell below this threshold (Carrasco-Poyatos et al., 2022). When implemented in cardiac rehabilitation settings, both the HRV-based and traditional HIIT protocols led to similar improvements in VO_2 max and other psychophysiological markers. However, the HRV-guided approach achieved these outcomes with a lower volume of high-intensity training (Carrasco-Poyatos et al., 2024). This suggests that such a protocol can optimise training load, delivering cardiovascular benefits while minimising unnecessary intensity. Furthermore, the intervention resulted in improvements in functional capacity, quality of life and body composition parameters, thus reinforcing its effectiveness in individualising training even in group-based rehabilitation settings (Carrasco-Poyatos et al., 2025).

Therefore, HRV emerges as a valuable indicator of cardiovascular health and autonomic balance. As well as being useful for predicting cardiac risk, HRV has multiple functions: it helps to prevent overtraining, enables exercise intensity to be adjusted according to the patient's actual physiological state, improves adherence and safety, and reflects the effects of stress, ageing, and sleep quality on the body. Furthermore, there is growing evidence to suggest an association between HRV and mental health, cognitive function, and emotional regulation (Castillo-Escamilla et al., 2024).

Current research supports HRV-guided training as a safer, more effective and more individualised alternative to conventional approaches. While further studies are warranted, preliminary findings are promising, showing improved performance with reduced training load and greater safety, as well as genuine adaptation to the patient's needs.

If hearts and their rhythms are not generic, why should training be? Heart rate is not just a number; it is a powerful tool for guiding daily health and well-being.

Conflict of Interest

The authors declare that there is no conflict of interest.

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