

High heart rate peaks from chest-strap recordings in athletes: prevalence, characteristics, and clinical relevance

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Introduction: Chest strap heart rate monitors (HRMs) are commonly used to assess cardiovascular load in endurance athletes. Despite their reliability, transient, abnormally high heart rate (HR) spikes are occasionally observed. Their interpretation as artefacts or arrhythmias remains enigmatic.

Purpose: To systematically evaluate the prevalence, morphology, and clinical relevance of extreme HR recordings in athletes.

Methods: HRM recordings from 251 endurance athletes (167 Pro@Heart cohort; 84 Master@Heart cohort; 57,282 training sessions), were analysed. For each athlete, the individual physiological maximal HR was calculated using the tangent method, identifying the inflection point of the kernel density of all peak HR values as the upper physiological limit (HRmaxTan). Extreme HR events were defined as recordings exceeding this threshold (HRmaxHRM); sessions where HRmaxHRM > HRmaxTan were identified and visually classified based on the HRmaxHRM tracing morphology (Figure 1). A morphology with a paroxysmal spike was considered as potential tachyarrhythmia. The cumulative incidence of the first such event was evaluated using Kaplan–Meier (KM) analysis, and its predictors were assessed with a generalised linear mixed model (GLMM) with participant as a random intercept, and group, sex, age, HRM brand, sport type, eTRIMP, and session duration as fixed effects. Clinical and Holter data were reviewed for documented arrhythmias or ablation.

Results: Extreme HR values occurred in 1.0% of sessions (545/57,282) across 133 athletes (53.0%). A gradual overshoot morphology was the most common HRmaxHRM pattern (49.4%), followed by paroxysmal spikes (28.1%), erratic noise (15.8%), isolated outliers (4.0%), and signal saturation traces (2.8%). Paroxysmal spikes occurred in 0.27% of sessions (153/57,282) and 23.9% of athletes, with a cumulative KM incidence of 33.8% (95% CI 26.1–41.4%) after 291 sessions. In sessions with concurrent power data (n=113), paroxysmal spikes coincided with abrupt workload changes in 26.5%, plausible power variations in 34.5%, and no discernible power change in 26.5%. No predictors reached significance within the GLMM. Paroxysmal spikes were observed in 71.4% (10/14) of athletes with arrhythmia compared to 21.1% (50/237) without (p<0.001). In nearly all cases, HRmaxHRM spikes preceded Holter-based arrhythmia documentation.

Conclusions: Many characteristics point to true arrhythmias as the cause of HRmaxHRM recordings with paroxysmal spike morphology: these are overall rare, do not occur randomly across athletes, and cosegregate with clinically documented arrhythmias. Whether these events in otherwise healthy athletes represent malignant arrhythmias or an extreme expression of an athletic cardiac phenotype remains to be determined and is relevant to the role of HRM as a surveillance tool. HRmaxHRM tracings with spike morphology should not be readily dismissed as artefact, but require work-up to determine their clinical relevance.

Different patterns of peaks in HRmax

