Letter to the Editor

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Sports Heart Rate Monitors as reliable diagnostic tools to detect arrhythmias in athletes – the need for more sophisticated Digital Devices

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Digital devices for training control with HR monitoring, commonly known as Heart Rate Monitors (HRM), are widely used by athletes in many sports, including both amateurs and professionals [1]. They are also increasingly used by people leading healthy lifestyles to monitor their physical activity, as well as by patients who are prescribed specific "doses" of physical activity, i.e., exercise of a certain intensity and duration, as part of their therapeutic regimen [2–5].

For many years we have been studying the usefulness of sports HRMs in the diagnosis of cardiac arrhythmias, mainly in athletes engaging in endurance sports [6–10]. The first article describing their usefulness in diagnosing arrhythmias in athletes was rejected by subsequent journals, on the argument that, as a non-medical device, sports HRMs do not provide reliable data that can serve as a basis for clinical diagnoses (as do medically certified diagnostic devices). This article ultimately found acceptance, unchanged, in the *Scandinavian Journal of Medicine & Science in Sports* and is still widely cited today [11]. Moreover, sports HRMs have since then begun to be increasingly appreciated as devices that help diagnose both brady- and tachyarrhythmias, gaining recognition in subsequent publications [12–14].

Nevertheless, since the beginning of research into the usefulness of HRMs for assessing cardiac arrhythmias, their value has been seen as hampered by an inability to distinguish true brady- and tachyarrhythmias from artifacts [15]. We have developed schemes for dealing with sudden unexpected HRM indications that are suggestive of cardiac arrhythmia [16]. Often, the only feature differentiating arrhythmia from artifacts is clinical data – i.e., symptoms cooccurring with "arrhythmia" indications on an HRM, preventing the athlete from continuing to train or compete. For this reason, top athletes often refuse to use any HR monitoring while competing in events, seeing it as a source of unnecessary distraction, frustration, and anxiety, triggered by sudden indications of HRMs suggesting arrhythmia but not necessarily reflecting the factual condition [17–19]. Sometimes, however, the only device that registers arrhythmia is a sports HRM. This was the case, for instance, for a marathon runner in whom arrhythmia occurred at 30 km of a competition; an inability to induce it in a clinical setting initially led this athlete to be misdiagnosed with Münchausen syndrome [20].

There are countless sports HRMs on the market, based on two different principles: photoplethysmography (PPG) or electrogram (ECG) techniques [16]. Optical HRMs, using PPG, can only monitor HR by registering an arrhythmia as an irregular heart rate, without being able to distinguish its type (e.g. distinguishing atrial fibrillation from numerous supraventricular or ventricular arrhythmias). Electrical HRMs also have the same limitation, as long as they are based on registering the main eclectic field. However, there are more and more sports HRMs on the market that are able to record ECGs – from one lead to all-limb leads [19]. Their disadvantage, however, is either an inability to record ECG continuously (the Apple Watch) or their exclusive availability for clinical trials (QARDIO MD) [19]. However, there are also devices designed for general use by athletes with the possibility of continuous ECG recording (Frontier X2) [16]. The challenge for designers, however, is still the quality of the recording, which deteriorates significantly the more intensively the exercise [20].

Increasing the safety of athletes using sports HRMs through the function of continuous ECG recording, resistance to artifacts, user-friendliness and appropriate design were all named by a recent consensus-building gathering of experts (athletes, doctors and trainers dealing with various sports HRMs on a daily basis) as features for the "optimal" sports HRM for use by athletes, particularly in endurance sports. The full set of consensus statements worked out by this panel has been presented in an article published in *Sports Medicine* [16]. This expert consensus also indicates that athletes, coaches and physicians expect the market for digital devices for training control with HR monitoring to evolve towards further enhancing athlete safety, mainly by continuously recording the ECG curve

and recognizing actual arrhythmia both during training and at rest. Data reliability is of paramount importance here. Otherwise, doctors caring for athletes as well as anyone using sports HRMs will be burdened with having to analyze unreliable data from frustrated users of unreliable sports devices that additionally monitor heart rhythm.

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