



Current definitions of an *athlete* range from loosely defined to overly restrictive, rely on qualitative subjective descriptors, and fail to capture the majority of physically active patients. To improve the understanding between exercise and health metrics a more standardized and granular classification of exercising patients is required. We propose a simplified algorithm to categorize and define exercising patients based on the: (1) *intent of exercise*, (2) *volume of exercise* (hours/week), and (3) *level of competition*. Further classification of physically active patients can be derived based on the *intensity* and *volume* of activity using metabolic equivalent-hours per week. In conclusion, a formal framework to classify athletes and quantify both the volume and intensity of exercise will enable more precise and meaningful associations between exercise and health outcomes.

The word “*athlete*” is derived from the Greek word “*athlos*” which means “achievement” or “contest.”<sup>1</sup> *Athletes* are often viewed as patients with superior physical fitness and psychological attributes that propel them to achieve sporting excellence. The population of patients considered *athletes* is diverse and not so easily defined. Traditional definitions of an *athlete* encompass a wide spectrum of patients, from archers to decathletes, but are imprecise, amorphous, and rely on vague qualitative descriptors.<sup>2,3</sup> These definitions fail to capture the type, duration, and intensity of activity, and neglect the larger population of active patients who engage in regular exercise. The synthesis of a universal, all-encompassing definition of an “*athlete*” is a formidable challenge. Perhaps focus should shift from what characteristics define an *athlete* to more accurately quantifying the physiologic demands placed upon an exercising individual. In order to facilitate standardization and enable more meaningful and precise associations between exercise and health outcomes, a framework for categorizing exercising patients’ is imperative.

## Current Definitions of an Athlete

Several organizations, including the American Heart Association<sup>3</sup> and European Society of Cardiology (ESC),<sup>4,5</sup> offer definitions that emphasize “organized competition” and a “premium on excellence and achievement” as integral components in defining an *athlete*. The American Heart Association defines an athlete as “one who participates in an organized team or individual sport that requires regular competition against others as a central component, places a high premium on excellence and achievement, and requires some form of systematic (and usually intense) training.”<sup>3</sup> Similarly, the ESC defines an athlete as “an individual of young or adult age, either amateur or professional, who is engaged in regular exercise training and participates in official sports competition.”<sup>5</sup> Araújo and Scharhag’s 2016 definition of an *athlete* further restricts the definition of *athletes* to patients who devote the majority of their professional or leisure time to their sport. By inference, this suggests that the majority of *athletes* will obtain their financial income from their sporting career or competitive results.<sup>1</sup> This stipulation may be too restrictive in defining an

*athlete*, and is perhaps best reserved for *elite or professional athletes*.

“*Volume of exercise*” (hours/week) has been introduced as a variable to help define and classify athletes. However, there is marked heterogeneity with respect to the volume of training guiding classification. The *Refined Electrocardiogram Criteria* considers an athlete to be “*elite*” if regularly competing at a regional, national, or international level and exercising for  $\geq 6$  hours/week.<sup>6</sup> Conversely, the *2017 International Recommendations for Electrocardiographic Interpretation in Athletes* state that a minimum of 4 hours/week of intense exercise is associated with the physiological electrical changes observed on an athlete’s *electrocardiogram*.<sup>7</sup> The *2016 ESC European Association for Cardiovascular Prevention and Rehabilitation* definition further subdivides *athletes* into “*elite*,” “*competitive*,” and “*recreational*,” in part based on hours/week of exercise: *elite* and *competitive athletes* both exercise  $>10$  hours/week and participate in sporting competitions, however *elite* athletes are distinguished from *competitive* athletes as placing a higher premium on performance.<sup>4</sup> It is important to note that hours/week of physical activity is an arbitrary measure and is not based upon objective end points such as cardiac remodeling or a demarcation in cardiac risk. Presumably, these definitions have been created to define a population with unique hemodynamic stressors and distinctive physiological adaptations.

*How do “exercisers” differ from “athletes?”*

The *intent* of the physical activity is the primary feature that distinguishes an *exerciser* from an *athlete*. In response to Araújo’s proposed definition of an *athlete*,<sup>1</sup> MacMahon et al emphasized the importance of identifying the goal or motivation of the physical activity being performed as a key criterion for separating *athletes* from *exercisers*.<sup>8</sup> *Exercisers* are patients who participate in physical activity with the motivation to increase fitness, promote health, improve physique, and learn or refine skills.<sup>8</sup> Whereas, *athletes* engage in physical activity with the primary goal of improving performance to bolster athletic excellence and/or achievement. A proportion of athletes and exercisers may both engage in harmful behaviours (i.e., steroids, blood doping, stimulants, overtraining). However, the intent of these behaviours is disparate. Consider the example of an *exerciser* and an *athlete* abusing anabolic steroids: the *intent* of the *exerciser* taking steroids may be to improve

See page 534 for disclosure information.

physique, which differs from an *athlete*, who uses steroids with the *intent* to improve performance to gain a competitive advantage (despite knowingly sacrificing his/her health). The same core variables of “*intent*,” “*volume of exercise*,” and “*level of competition*” should be applied to persons with physical impairments engaging in exercise. For example, a Paralympian trains many hours with the *intent* of bolstering performance to improve the likelihood of success at high-level competitions. Adding to the complexity is the distinction between a *recreational athlete* and an *exerciser*. Historically, the term *recreational athlete* has been used to denote patients participating in sports for pleasure, at a lower level of competition, perhaps without officiating or score keeping. *Recreational athletes* typically do not require systematic training, and there is less focus on the pursuit of excellence and prevailing against others.<sup>4</sup> An industrial or occupational athlete may impose significant physical stressors upon their bodies as a part of their job (i.e., firefighter, ski patrol, military),<sup>9</sup> similar to the traditional “*athlete*,” but the intent of the exercise is similar to an “*exerciser*.”

*An algorithm to classify athletes and exercisers*

The *intent* of the exercise being performed is a key criterion for discerning an *athlete* from an *exerciser*. “*Volume of exercise*” (hours/week) is a quantitative metric that further allows stratification of athletes. Finally, the “*level of competition*” is the last criterion to help subdefine groups of patients who fulfill the criteria of an athlete. *Elite* athletes are defined as patients who exercise >10 hours/week and whose athletic performance has achieved the highest level of competition (i.e., members of a regional or national team, Olympians, professional athletes, and some college athletes).<sup>4</sup> *Competitive* athletes exercise >6 hours/week with an emphasis on improving performance and participating in official competitions (i.e., high school and most college athletes). *Recreational* athletes exercise >4 hours/week for pleasure, fitness, or unregulated competitions (i.e., intramural sports and “pick-up” games). An *exerciser* engages in >2.5 hours/week of physical activity with the primary aim to maintain health and fitness (Table 1). There is inherent physiologic overlap between athletes and exercisers as both may engage in moderate or high intensity exercise. Participating in competitions amends an *exerciser* to an *athlete* as the *intent* of the

exercise being performed changes and there is a call for purposeful training. An *exerciser* may participate in a 10-kilometre race with the purpose of running to raise money for charity; whereas, an *athlete* may run the same race, at the same speed but with the *intent* of competing. The physical stressors may be parallel but the *intent* differs.

*A proposed method to quantify exercising patients*

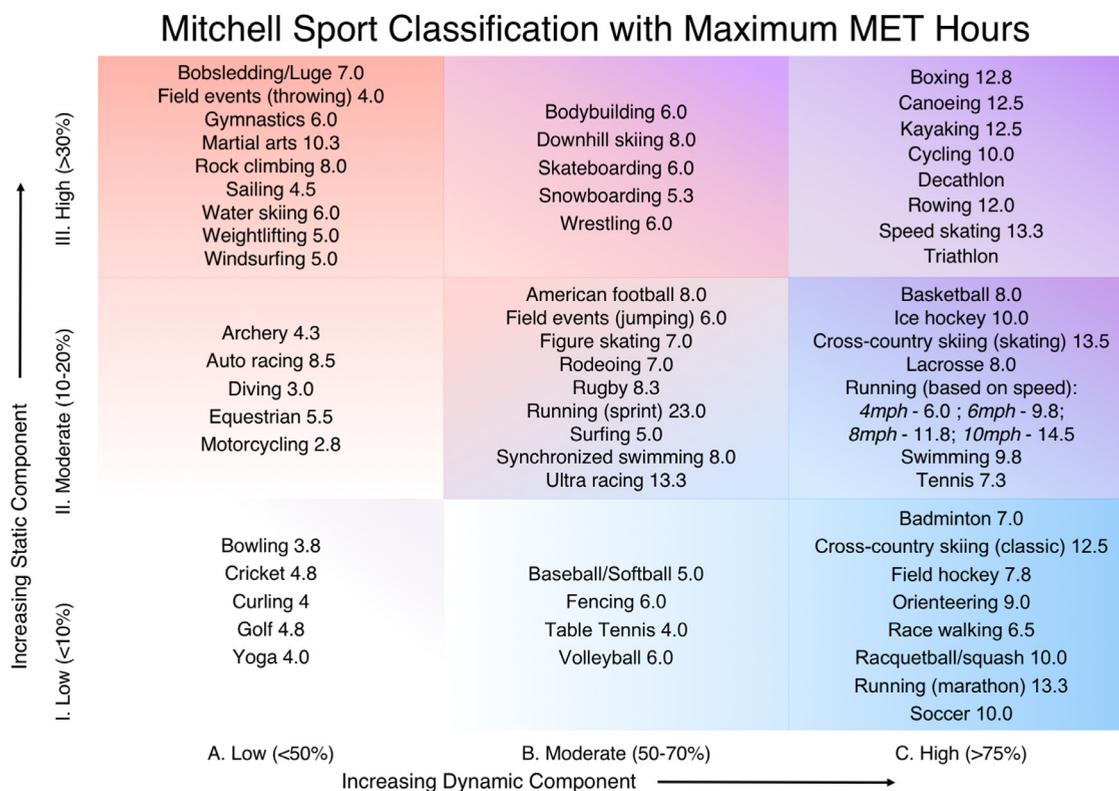
While it is important to have a broad sense of what defines an *athlete*, a more granular schema to quantify the type, intensity, volume, and dose of physical activity is required to further our understanding between exercise and health and disease. The importance of possessing a standardized framework to categorize exercising patients stems from the demonstration that some athletes may be at a higher risk of sudden cardiac death; and the association of excessive endurance exercise with coronary artery calcification, atrial fibrillation, pathological right ventricular remodeling, or myocardial fibrosis.<sup>10,11</sup> Questions regarding the type, intensity, and dose of exercise inevitably arise when attempting to elucidate the optimal dose of exercise for health. Regardless of how an *athlete* is defined, the ability to quantify both *volume* and *intensity* will enable more precise categorization of exercising patients and help shed light on these questions. The 2016 ESC position statement calls for the inclusion of the Mitchell Classification<sup>12</sup> when describing the nature of the sport an *athlete* is performing.<sup>4</sup> The Mitchell Classification of sport is an established method for categorizing sports based on the proportion of static and dynamic demand associated with an activity, which further has been suggested to classify types of sports and expected cardiac remodeling.<sup>13</sup> However, the anticipated degree of cardiac remodeling is most accurately classified by the *intensity* and *amount of training*.<sup>13</sup> The energy cost and intensity of an activity can be represented by multiples of the resting metabolic rate. A metabolic equivalent (MET) is defined as the amount of oxygen consumed while sitting at rest (3.5 ml O<sub>2</sub>/kg/min).<sup>14</sup> Inclusion of METs as a quantitative variable in the description of an exercising individual allows for *intensity* to be ascertained and metabolic equivalent hours (MET-hours) to be calculated. Metabolic equivalents during a specific physical activity can be estimated from the Ainsworth Compendium of Physical Activities,<sup>15</sup> allowing for a quantitative assessment of

Table 1  
Proposed classification of athletes and exercisers

Subcategory	Intent to compete	Volume of exercise (hours/week)*	Level of competition
Elite athlete	+	≥10	Regional or national team, Olympians, professional and some college athletes
Competitive athlete	+	≥6	Official competitions <sup>†</sup> (high school and most college athletes)
Recreational athlete	+	≥4	Registered recreational league, open events
Exerciser	0	≥2.5	Personal fitness
Physical inactive	0	<2.5	Does not meet recommended minimums of low intensity physical activity

\* For volume of exercise/week, only include moderate to vigorous exercise.  
<sup>†</sup> Official sports competitions (local, regional, national, or international) are defined as organized team or individual sports events that place a high premium on athletic excellence and achievement and are organized by a recognized athletic association.<sup>4</sup>

## Step 1. Determine Mitchell Classification\*



## Step 2. Calculate the number of MET-hours/week\*\*

- Multiply the METS for a particular activity times the number of hours that activity is performed to ascertain the total number of MET-hours/week. If multiple activities are performed sum all the MET-hours/week.

## Step 3. Determine the average intensity of activity

- Divide the total number of MET-hours/week by the number of hours of exercise per week to determine the average intensity.  
(Low intensity <3METs; Moderate intensity 3.1-6METs, High intensity >6METs)

Figure 1. Determining Mitchell classification and MET-hours/week.

MET-hours from the 2011 Ainsworth Compendium of Physical Activities<sup>15</sup> added to the Mitchell Classification of Sport.<sup>12</sup>

\*The assigned Mitchell Classification should be based on the primary sport of competition.

\*\*An athlete or exerciser may partake in a wide variety of different forms of activity to train for his/her primary sport. When calculating MET-hours/week the time during physical activity should be counted toward hours of physical activity as opposed to hours spent at training facility. For athletes/exercisers who train in multiple sporting activities the time and corresponding METs be calculated and then summed. For example, an American football player who spends 6 hours/week playing football (8.0 METs), with an additional 4 hours/week weight training (5.0 METs), completes a total of 68 METs-hours/week. Spread over 10 hours they average 6.8METs/hour, constituting "high intensity." The primary sport of competition is football, and thus would be labeled IIB.

intensity (Figure 1). When estimating the energy expenditure (METs) for persons with physical impairments we recommend using the values presented in Supplement Table 1. Combining METs with the duration of activity (in hours) allows for MET-hours to be calculated. Last, ascertaining the number of years of exercise provides an estimation of the lifelong *dose* of exercise. The use of a simplified method to classify athletes, and the incorporation of tangible quantitative descriptors, will provide the standardization required for more precise and meaningful associations between varying levels of exercise and health

outcomes, and facilitate more accurate comparisons between studies.

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The investigators have no conflicts of interest to disclose.

## Supplementary materials

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