How do we define an elite athlete?

Brief review

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Abstract

The purpose of the current work was to explore the use of the term 'elite' in describing participant credentials, by categorising the reporting methods used in literature.

A search of Pubmed with the term 'elite athlete' was conducted and 500 articles were selected, from which those that did not actually claim to involve elite athletes; or were qualitative, review, therapeutic or medical reports were excluded. Articles were reviewed and catalogued for the reporting of; competitive level; sporting activity performed; training volume; training/competitive experience; physiological capability; and sporting performance.

From the 167 remaining journal articles, 37.7% included participants from athletic/linear sports; 29.9% from games; 21.6% from mix sports groups; 5.4% from combat sports; 2.4% from other groups; 1.8% from artistic; and 1.2% from target events.

Of the articles considered, 80.8% reported competitive level of their athletes, (10.2% regional, 49.1% national, 45.5% international and 12.0% Olympic/Paralympic; studies included participants from several categories). Training volume (16.5 ± 6.4 hours/week) was recorded in 31.7% of studies; training/competitive experience (8.7 ± 3.9 years) in 24% of papers; physiological variable in 16.2% and a performance noted in 14.4% of articles. No substantiation or categorisation of elite characteristics were offered by 3.6% of studies.

This sample review highlights the variability in the description and therefore justification of the term 'elite' in categorising participant cohorts. For the benefit of those interested in high performance athletes it is recommended that authors should report all possible categories of elite descriptors; wherever possible or to simply describe their status objectively.

How do we define an elite athlete?

Keywords: Elite athlete, competition level, physiological status

Introduction

The Oxford English dictionary defines 'elite' as "The best or most skilled members of a group". The number of papers identified from an article search with the term 'elite athlete' shows an exponential increase from the mid 1970's to the present day. However, access to high performing athletes remains limited due to time commitments, disturbances in training and potential invasiveness of measurement techniques. It is not clear how authors are defining the eliteness of the participant group. The purpose of the current work was to categorise the reporting methods, of physiology based studies, used in a sample of the current literature to describe participant's credentials.

Methods

A search of pubmed with the term 'elite athlete' was conducted in April 2012. The most recent 500 articles were selected. Studies that were returned in the search but were not found to claim the involvement of elite athletes were excluded from the review. Furthermore, the following types of investigation or report were also excluded; qualitative, review, therapeutic or medical reports. Articles were reviewed and catalogued, firstly to the sporting activity performed (athletic/linear, games, mixed sports groups, combat, artistic, target, other) and then for the way in which participant characteristics are reported; sporting competitive level (regional, national, international, Olympic/Paralympic or World); training volume (time or distance); training/competitive experience (years undertaking training and competition); physiological capability; and a sporting performance standard (e.g. personal or season best). All percentages are expressed relative to the number of selected studies.

Results

From the 167 remaining journal articles, 37.7% included participants from athletic/linear sports; 29.9% from games; 20.4% from mixed sports groups; 5.4% from combat sports; 2.5% from other groups; 1.8% from artistic; and 1.2% from target events. The mean ± sd participant number (*n*) was 122 ± 230.

Of the articles considered 86.2% (144 papers) reported the competitive level of their 'elite' athletes, with 10.2% (17 papers) reporting regional, 49.1% (82 papers) national, 45.5% (76 papers) international and 12.0% (20 papers) Olympic/Paralympic (numerous studies included participants from several categories). Training volume (16.5 ± 6.4 hours/week) was recorded in 31.7% of studies (53 papers). Training/competitive experience was noted in 24% of studies (40 papers), being 8.7 ± 3.9 years. A physiological variable was reported in 16.2% (27 papers) and an actual performance was noted in 14.4% of articles (24 papers). No substantiation or categorisation of any characteristics were offered by 3.6% of studies (6 papers) to justify the elite claim.

Discussion

This sample review highlights the variance in the description, classification and therefore the justification of the term 'elite' in categorising a participant cohort.

Amongst the studies reviewed, there were some characteristics reported that one might naturally expect to typify elite athletes; Mikami et al[1] reports on 139 Olympic athletes;

Aagard et al[2] reports 26 years of training experience; Georgepoulos et al[3] reports 29 hours of training per week; Döring et al[4] reports $\dot{V}O_{2max}$ of 79 $ml \cdot kg \cdot^{-1} min^{-1}$; and Ferri et al[5] reports 1500m run times of 233 s. However, it is not the purpose of this article to comment on whether these are truly elite or to recommend an artificial benchmark above which authors could claim their athletes as elite. Any such suggestion would be counter to the dictionary definition and an imposition of our own biases. With elite being defined as "the best or most skilled members of a group", the majority of authors of the studies surveyed have complied with the definition by stating the "group" with whom their athletes compete. However, authors who claim to include elite athletes appear to use a number of methods of qualifying the elite label. The most common descriptor of elite status was the level of sporting representation, i.e. regional, international etc. The dictionary definition, therefore, would not constrain authors to a certain method or level of categorisation, so that for one reader, 'Olympic/Paralympic finalist', would be a suitable definition, but for another 'best in the regional team', could be chosen. Thus, authors are at liberty to self-define the group, meaning ostensibly that 'elite is in the eye of the beholder'. Whilst the definition is open and inclusive, by inference it would seem unsatisfactory to claim the status of elite without adequate or consistent means of group definition. In the current work six studies did not include any descriptor of elite credentials, other than in the title of the paper [6,7,8,9,10,11]. In contrast, Croft et al[12] and Leicht et al[13], both of the same research group, were the only studies of those considered, to include 5 descriptors of participant eliteness; competitive level; training volume; training/competitive experience; physiological capability; and sporting performance. The latter studies would appear to demonstrate best-practice when authors label athletes as

elite, by providing the reader with an array of evidence to make an informed judgement as to the standing of the athlete group.

The reported cohort size illustrates a notable elite dichotomy, where eliteness implies 'the best', but because they are the best, there can't be many of them. Studies such as that by Sanchis-Gomar et al[14], exploring longevity in Tour de France cyclists amongst 1318 participants and Horn et al[15] investigating immune function in a mixed cohort of 1310 participants, with such large numbers would appear contradictory to the selection of the best. Whereas, Plews et al[16] takes a selective approach with just 2 triathletes, with the statement of physiological status in the form of a $\dot{V}O_{2max}$ of 70 $ml \cdot kg^{-1} \cdot min^{-1}$, presumably offered in support of their eliteness. One might assume that the athletes of the Sanchis-Gomar et al[14] or Horn et al[15] investigations would be of a similar if not superior physiological status to the triathletes used by Plews et al[16], due to their selection and participation in an event requiring very high levels of aerobic power. Hence, participant number alone offers little insight into the elite credentials. Further, Erlacher et al[17] report on 632 elite regional level athletes, which could be argued is contradictory to being 'the best' in two ways; competitive level and cohort number. However, when considering the original definition (best of a group), the aforementioned studies do indeed define their groups and so any misgivings about the eliteness of the group are a product of individual biases or interpretation of the term.

It seems reasonable to take the lead of the Croft et al[12] and Leicht et al[13] studies of how authors could best serve the reader's interpretation of participant credentials with a wide range of participant credentials. Moreover, perhaps the 'elite' label would in fact be better substituted with a simple label of their actual characteristics both in the title, keywords and

throughout the manuscript, such as ‘world finalist’, ‘domestic and international’, ‘highly trained’, ‘highly experience’.

Practical applications

It is recommended that for consistency of interpretation and for the benefit of those interested in high performance athletes, that greater differentiation in cohort classification should be achieved by reporting all of the possible categories of elite descriptors, wherever possible or to simply describe their status objectively.

References

1. Mikami E, Fuku N, Takahashi H, Ohiwa N, Pitsiladis YP, Higuchi M, Kawahara T, Tanaka M. Polymorphisms in the control region of mitochondrial DNA associated with elite Japanese athlete status. *Scand J Med Sci Sports*. 2013;23:593-9
2. Aagaard P, Andersen JL, Bennekou M, Larsson B, Olesen JL, Crameri R, Magnusson SP, Kjaer M. Effects of resistance training on endurance capacity and muscle fiber composition in young top-level cyclists. *Scand J Med Sci Sports*. 2011;21:e298-307.
3. Georgopoulos NA, Rottstein L, Tsekouras A, Theodoropoulou A, Koukkou E, Mylonas P, Polykarpou G, Lampropoulou E, Iconomou G, Leglise M, Vagenakis AG, Markou KB. Abolished circadian rhythm of salivary cortisol in elite artistic gymnasts. *Steroids*. 2011;76:353-7.

4. Döring FE, Onur S, Geisen U, Boulay MR, Pérusse L, Rankinen T, Rauramaa R, Wolfahrt B, Bouchard C. ACTN3 R577X and other polymorphisms are not associated with elite endurance athlete status in the Genathlete study. *J Sports Sci.* 2010;28:1355-9.
5. Ferri A, Adamo S, La Torre A, Marzorati M, Bishop DJ, Miserocchi G. Determinants of performance in 1,500-m runners. *Eur J Appl Physiol.* 2012;112:3033-43.
6. Hansen KT, Cronin JB, Newton MJ. The reliability of linear position transducer, force plate and combined measurement of explosive power-time variables during a loaded jump squat in elite athletes. *Sports Biomech.* 2011;10:46-58.
7. Hunter SK, Stevens AA, Magennis K, Skelton KW, Fauth M. Is there a sex difference in the age of elite marathon runners? *Med Sci Sports Exerc.* 2011;43:656-64.
8. Marin DP, dos Santos Rde C, Bolin AP, Guerra BA, Hatanaka E, Otton R. Cytokines and oxidative stress status following a handball game in elite male players. *Oxid Med Cell Longev.* 2011;2011:804873
9. Terruzzi I, Senesi P, Montesano A, La Torre A, Alberti G, Benedini S, Caumo A, Fermo I, Luzi L.. Genetic polymorphisms of the enzymes involved in DNA methylation and synthesis in elite athletes. *Physiol Genomics.* 2011;24;43:965-73.
10. Vantorre J, Seifert L, Fernandes RJ, Boas JP, Chollet D. Comparison of grab start between elite and trained swimmers. *Int J Sports Med.* 2010;31:887-93.
11. Scharf M, Brem MH, Wilhelm M, Schoepf UJ, Uder M, Lell MM. Atrial and ventricular functional and structural adaptations of the heart in elite triathletes assessed with cardiac MR imaging. *Radiology.* 2010;257:71-9.

12. Croft L, Dybrus S, Lenton J, Goosey-Tolfrey V. A comparison of the physiological demands of wheelchair basketball and wheelchair tennis. *Int J Sports Physiol Perform.* 2010;5:301-15.
13. Leicht CA, Bishop NC, Goosey-Tolfrey VL. Submaximal exercise responses in tetraplegic, paraplegic and non spinal cord injured elite wheelchair athletes. *Scand J Med Sci Sports.* 2012;22:729-36.
14. Sanchis-Gomar F, Olaso-Gonzalez G, Corella D, Gomez-Cabrera MC, Vina J. Increased average longevity among the "Tour de France" cyclists. *Int J Sports Med.* 2011;32:644-7.
15. Horn PL, Pyne DB, Hopkins WG, Barnes CJ. Lower white blood cell counts in elite athletes training for highly aerobic sports. *Eur J Appl Physiol.* 2010;110:925-32.
16. Plews DJ, Laursen PB, Kilding AE, Buchheit M. Heart rate variability in elite triathletes, is variation in variability the key to effective training? A case comparison. *Eur J Appl Physiol.* 2012;112:3729-41.
17. Erlacher D, Ehrlenspiel F, Adegbesan OA, El-Din HG. Sleep habits in German athletes before important competitions or games. *J Sports Sci.* 2011;29:859-66.