# Defining Eminence in Endurance Cycling Sports: A Delphi Study with Some of the World's Most Successful Cyclists, Coaches, and Directors

Jesse Korf[1] and Joseph Baker[2]

[1]School of Kinesiology and Health Science. York University, Canada
[2]Tanenbaum Institute for Science in Sport, Faculty of Kinesiology and Physical Education, University of Toronto, Canada

Correspondence:  Joseph Baker, joseph.baker@utoronto.ca

## Abstract

In order to define criteria for eminence in endurance cycling, a Delphi study with World Championship medal-winning athletes and technical leaders in relevant cycling sports was conducted. The Delphi study involved two independent groups: athletes ($n = 9$) and technical leaders ($n = 13$). Participants in the athlete group had all won at least one World Championship or Olympic medal while the technical leaders have supported a minimum of three such performances. A survey using a balanced Likert-scale design with a randomized question sequence was conducted followed by a round of virtual discussions using an anonymous chatroom and video conference media. Findings from the survey were validated and discussed in the separate groups and consensus was set at 70%. Cross-group outcomes were only shared upon completion of the study. The definition for eminence in endurance cycling sports generated through this study indicated cyclists must win a minimum of three races in an exclusive subset of races containing World Championships, Olympic Games, Monuments, and Grand Tours or World Cup overall classification over the course of their careers to be considered eminent.

## Keywords

talent, eminence, cycling, expertise, coaching

## Introduction

The frontiers of human capability have fascinated scientists for centuries. Studying those who operate at, and indeed advance, the edges of human performance may hold lessons that could benefit athlete development for all ages and stages of competition. For example, studying the journeys that elite athletes take to reach Olympic level performance may inform the development of supportive pathways for others who are training for international competition.

Identifying appropriate groups and/or individuals to study, however, can be a challenge due to a lack of demarcation criteria when it comes to defining elite populations. With a long list of names including "elite," "expert," "skilled," and "Olympic medalist," along with publications listing a broad spectrum of performance as "elite" (e.g., "elite" 9-year-olds, see Goto et al., 2015 for one example), inadequate study designs and imprecise terminology compromise our

understanding of which traits and characteristics have broader benefits, and why (McAuley et al., 2022; Swann et al. 2016). This issue has been highlighted in several recent publications that call for a more robust taxonomy for indexing and categorizing varying levels of performance (Baker et al., 2015; McKay et al., 2022; Swann et al., 2016). More specifically, these studies highlight, among other things, a need for a subdivision within the elite (or expert) category.

Several terms have been used to capture individuals at the highest levels of skill in various domains. In some of the earliest work in this area, Francis Galton used the term "genius" (Galton, 1869), although upon reflection, in the preface to his 1892 edition, he felt "eminence" was more appropriate. In the more than a century since, various terms have been used by researchers in a range of fields to explore the pinnacle of human achievement (e.g., in team sports, Baker et al., 2019; and in the arts and sciences, Murray, 2003; Simonton, 1999, 2014a, 2014b). What is clear, regardless of how top achievers are categorized, is that there is a need to distinguish those who make exceptional contributions to a field from their peers who are elite but not exceptional to the same degree.

Precisely how to characterize eminence has been challenging. Previous work from the arts and sciences by Simonton, for example, has shown a large variability in how eminence was determined, ranging from frequency in important biographical dictionaries (Murray, 2003; Simonton, 1984) and productivity (Simonton, 2002) to awards won (Simonton, 2004) and stability of reputation/value over time (Simonton, 2014a, 2014b). In sport, studies exploring the differences and histories of the most elite athletes (e.g., multi-Olympic medalists, generational superstars, or members of a sport's "hall of fame") juxtaposed with slightly-less-elite populations (i.e., athletes who might have won a single major trophy in their careers, or non-medalists) are rare but important for understanding the factors explaining skill differences (Baker et al., 2015). Furthermore,

the type of general indicators of success considered in other sports (Baker et al., 2015) and domains (e.g., Simonton, 1991) may not be relevant in all areas due to differences in the factors influencing performance across domains of human achievement (e.g., domains underpinned by elements of cognition or intelligence versus physical capacities like endurance or power).

## Eminence in Cycling

The focus of the present investigation is elite cycling. Professional teams in mountain bike and road cycling operate on multi-million-dollar annual budgets (Van et al., 2016). In addition, many nations invest millions of dollars per year with aims of Olympic medal performances in cycling sports (Groot, 2008; Hogan & Norton, 2000; Houlihan & Zheng, 2016). Through their performances, top cyclists (e.g., the most prolific winners in peak international races such as the Olympic Games and World Championships) have a major effect on both society and the cycling industry at large (e.g., through audiences of tens of millions of spectators for some races). In addition, these riders can help drive innovation and marketing of equipment such as bikes and clothing, which eventually trickle down to consumer products. From a scientific perspective, however, we know very little about performers at the highest levels of achievement (i.e., the "eminent," Baker et al., 2019) either in general or in specific sports such as cycling. Furthermore, there have been no retrospective or longitudinal studies on the development of expert or eminent cyclists to date (Baker et al., 2020). This study explores the concept of eminence in cycling disciplines, by exploring how key stakeholders conceptualize and define this term. Defining what eminence in cycling sports looks like is a first step to informing future research examining performance characteristics, team selection, pathways, and other aspects of athlete development.

Importantly, cycling is an umbrella phrase for a number of sports with different characteristics. It includes sports that are measured by time (often described as

Centimeter, Grams, and Seconds [CGS] sports as a class) such as Road cycling, Track Endurance, Track Sprint, Mountain Bike, BMX, Cyclo Cross (cx), and E-racing. These disciplines can be further sub-divided into endurance (e.g., Track Endurance, Road, Mountain Bike, Cyclo Cross) and power sports (e.g., Track Sprint, BMX Race), each with vastly different race characteristics and performance demands. Cycling also includes artistic sports such as BMX Freestyle and game sports such as Cycle Ball.

In endurance cycling, there have been several research investigations of physiological characteristics, including examples of athletes who might be considered eminent (Baker et al., 2019; Craig & Norton, 2001; Gardner et al., 2005; Schumacher et al., 2006; van Erp, 2019). However, there has been little scientific exploration on the development of elite cyclists, with the exception of two studies that looked at the correlations between junior and elite performance (e.g., Henriksen et al., 2013; Mosteart et al., 2021) and a recent publication on relative age effects in road cycling (Mosteart et al., 2021).

Capturing and understanding the nuances between cycling sports, or expert performance of any kind, requires the establishment of domain-specific criteria to clearly determine athlete skill/achievement level. This domain-specificity and demarcation of skill groups holds the promise to increase understanding through more specific inquiries (e.g., clearer designs and methods). To this end, this study attempts to define the upper-most echelon of elite performers in endurance cycling, to establish sport-specific criteria for indexing aptitude, as proposed by Baker and colleagues (2019). This taxonomy could subsequently be used to explore topical issues in talent research in cycling in particular, or as a model for other sport-specific contexts.

## Methods

In order to establish what eminence means in endurance cycling (e.g., what do cyclists have to do to be considered eminent?), a Delphi study with World Championship medal-winning athletes and technical leaders (i.e., coaches, sport directors, and performance directors) in relevant cycling sports was conducted. In general, Delphi studies involve a systematic, qualitative method of forecasting by collecting information and opinions from a group of experts through several rounds of questioning. Despite an increase in popularity, there is considerable variation in the methodology of Delphi studies (Nasa et al., 2021). In the current investigation, we attempted to increase the analytical robustness of the study design in several ways. First, athlete and technical leader groups were interviewed independently from each other to increase the validity of findings (i.e., through convergence) and to reduce or buffer any biases that might exist in either population. Second, both groups helped improve the study design, as issues raised by one group helped tailor questions for the other group. This allowed for similar topics to be discussed independently by both groups and yet ensure that no critical issues were missed. Overall, the goal was to establish reasonably objective demarcation criteria for eminence in cycling that could be used in further quantitative analyses.

### Study Design

The study comprised three phases. Phase one involved participant recruitment. Using the network of contacts from the primary investigator, participants from multiple endurance-based cycling sports were contacted to participate in the study. Out of these participants, two panels were created. To meet the high standard for inclusion in this expert panel, the first group, athletes (A; $n = 9$), had to have obtained a minimum of one Olympic or World Championship medal. Final members of the athlete group were from Canada, the United States, and the Netherlands, representing Road, Track, and Mountain Bike events.

A second group, technical leaders (TL), was included due to unique elements of professional cycling; for instance, Mountain Bike and Road events are structured differently. In addition, many National Sporting Organizations (NSO) have national teams that compete in the Olympics and/or World Championships in

specific cycling sports. Across different environments, coaches, trainers, sport directors, or technical directors have different roles relative to training design, team design, and race deployment, and all would be considered topical experts. Members of the TL group had to have led one or more athletes to a minimum of three Olympic or World Championship medals. Members of this group were from Belgium, The Netherlands, Great Britain, Australia, Switzerland, Canada, Spain, and the United States. The athlete and technical leader groups combined accounted for a total of 148 World Championship and Olympic medals won (see Table 1). All participants provided informed consent to participate in the study. The interview guide, informed consent forms, and overall study design received ethics approval from the authors' institutional ethics review board.

**Table 1.** Demographics of expert panels

|  |  | Olympic & World Championship Medal Totals | Sample Size | Track | Road | Mountain Bike | Cyclo Cross |
|---|---|---|---|---|---|---|---|
| **A** |  | 31 | 9 | 3 | 8 | 1 | 1 |
|  | Male |  | 3 | 1 | 3 | 0 | 0 |
|  | Female |  | 6 | 2 | 5 | 1 | 1 |
| **TL** |  | 117 | 13 | 7 | 13 | 4 | 2 |
|  | Male |  | 12 | 6 | 12 | 4 | 2 |
|  | Female |  | 1 | 1 | 1 | 0 | 0 |
| **Totals** |  |  |  |  |  |  |  |
|  | Sample |  | 22 | 10 | 21 | 5 | 3 |
|  | Medals | 148 |  | 74 | 54 | 4 | 16 |

**Note.** Athletes (A) and Technical Leaders (TL) might be/have been active in multiple cycling sports.

To ensure that questions had relevancy, starting questions were formed through informal conversations with athletes and coaches who had participated in Olympic cycling competitions. As a result, the starting questions were grounded in the experience and expertise of the panels, thus providing a degree of ecological validity to the starting survey.

In the second phase, participants completed the aforementioned survey, which included eight open questions structured to explore the criteria that could indicate whether a cyclist reached "eminent" status. These open questions were subdivided into four questions that considered which races would be relevant to the discussion as well as which results in those races would satisfy the participants' requirements for inclusion (e.g., whether they needed to win the race, finish on the podium, etc.). In addition, participants completed a short survey examining four topics: the importance of career length for determining eminence, the duration of an athlete's career at the peak of competition, the races at which the athlete had achieved success, and the degree to which domain-specific performance was important (e.g., they compared winning exclusively in a single cycling sport such as Road cycling versus winning in multiple cycling sports such as Road cycling *and* Mountain Bike). These topics were identified during preliminary discussions with technical leaders as being relevant to understanding cycling eminence. Participants responded to each item on a Likert-scale (from 1 = strongly disagree to 5 = strongly agree) and question presentation was randomized across both panels, which allowed the researchers to compare findings from both groups to examine initial convergence or divergence between views of independent groups. As a result, this process allowed for items to be removed from subsequent discussion or highlighted in phase three.

Broadly, the goals of the phase two survey were to gain insights in three areas: (1) establishing tiers in race levels; (2) establishing qualifications required to be considered eminent; and (3) gaining early insights into pathways towards eminence. Establishing tiers in competition was important, as there are many races throughout the year, yet not all races are considered of equal prestige. Some riders choose to peak for certain races (i.e., World Championships or the Tour de France) and, as such, pre-select a small subset of races they deem most important.

Establishing the most important races, as reflected by those that the best riders focus on, was considered important to assess which races should be included in the demarcation criteria when investigating eminence. Furthermore, beyond race results, other qualifications might be relevant in determining whether a rider is eminent. Popularity or skill, for example, might be considered by some to be important markers.

Phase three involved discussions with the expert groups to develop a cohesive, comprehensive framework for assessing cycling eminence. Given the limited guidance around Delphi studies, we attempted to increase the analytical robustness of the study design in several ways. First, athlete (Panel A) and technical leader (Panel TL) groups were interviewed independently from each other to increase the validity of findings (i.e., through convergence) and to reduce or buffer any biases that might exist in either population. Second, both groups helped improve the study design, as issues raised by one group helped tailor questions for the other group. This allowed for similar topics to be discussed independently by both groups and yet ensure that no critical issues were missed. Overall, the goal was to establish objective demarcation criteria for eminence in cycling that could be used in further quantitative analyses. The ability to discuss and revisit previous positions was introduced via online methods. Participants were given the option to participate via a virtual, anonymous chatroom (Leapchat.com), or via video conference call (Zoom rooms version 5.0).

The discussion portion of the study involved a prespecified number of rounds ($n = 3$). This design was chosen due to several factors. First, participants came from three different continents making it challenging to meet at the same time. Second, participants were in a pre-Olympic year, posing considerable constraints on their availability. Third, the global COVID pandemic made it impossible to set up group discussion in-person, even if participants were in relative proximity to each other.

A methods journal containing structure, decision rules, and justifications to changes was used during the onset of the study, and notes were kept during the online discussions as well as throughout the data collection stages. Consensus for the survey and the discussion were set *a priori* ($\tilde{x} = 70\%$ agreement on a criterion) as this was considered appropriate given the selected method of two independent groups and the diversity of participants. Furthermore, this is only slightly below the mean consensus used in medical studies using a single group design ($\tilde{x} = 75\%$) (Diamond et al., 2014).

Following the survey round, the following criteria were used to include, discuss, or reject items: Accepted, >70% in both groups; discussed, >70% in only one group; rejected, <70% in both groups. Items from the survey that were over the threshold in both groups (accepted criteria) and under the threshold for both groups (dropped criteria) were presented back to the individual groups for final review. Items with uncertainty were discussed among the panels individually (same group) and cross-group findings were shared after the study was completed.

## Results

The first topic of inquiry for the panelists centered on whether there was a specific subset of races within endurance cycling events that were considered to be of the highest quality. To explore this possibility, panelists discussed elements of race "prestige," depth in the field of competitors, and historical trends regarding

proportion of top athletes who would peak for different events. Interestingly, after discussions with both panels in Round 1, Cyclo Cross was included in the category of events to be considered. Subsequently, there was discussion around which Cyclo Cross races or classifications should be included. Ultimately, based on panel feedback only the Cyclo Cross World Championships was included as the key race for establishing eminence in this sport. For example, A3 noted: "Cyclo Cross should also get consideration. But the world cup system is changing, so many different races and it is not very international. Women maybe more than men. The only race we should consider are the World Championships as I am not sure on how to place the other races." Similarly, A1 stated that "most of the top performing Cyclo Cross riders are top Mountain Bikers or top Roadies that cross over, and it is only a part of their season. They come in with good form in races that matter but are also picking and choosing based on the calendar, so it doesn't interfere with their primary sport. We should only look at events later in the season and perhaps only Worlds as it is the only race where you have everybody participating." For the races and

classifications for Road, Mountain-Bike, and Track (endurance) categories, both panels found consensus on the same subset of races (displayed in Table 2).

After establishing this set of key events, five items were used to help guide the discussion around qualifications to reach eminence (Table 3, next page). First, career length (A=74.2%, TL=76.6%) and winning the World Championships, Tour de France (men)/Giro d'Italia Femminile (Giro Rosa), a monument, or an Olympic medal (A=71.4%, TL=76.6%) were accepted as important considerations for individuals to be qualified as eminent.

Whether or not cyclists can be considered eminent after a relatively short career (A = 77.2%, TL = 58.4%) was brought into the panels for further discussion. The possibility of being considered eminent after a single short period (A = 51.4%, TL = 46.6%), the years ranked in the UCI top 10 (A = 60%, TL = 63.4%) and the opportunity to become eminent without winning any of the agreed upon "premier league" races (A = 48.6%, TL = 46.6%) were "rejected" at this stage, and put forward to the panels for further review.

**Table 2.** "Premier League" races and classifications in cycling

|  | Male | Female |
|---|---|---|
| **Road** | World Championships, Olympic Games, the Monuments (*Milan-San Remo, Paris – Roubaix, Tour of Flanders, Liege - Bastogne – Liege, Giro di Lombardia*), the three Grand Tours (*Giro d'Italia, Tour de France, Vuelta a Espana*) | World Championships, Olympic Games, the Monuments *(varies per year)* and the Giro Rosa |
| **Mountain Bike** | Olympics, World Championships, overall World Cup winner | Olympics, World Championships and the overall World Cup winner |
| **Track** | Olympics, World Championships | Olympics, World Championships |
| **Cyclo Cross** | World Championships | World Championships |

**Table 3.** Items considered by expert panelists for establishing qualifications of eminence

| Item | Athletes | Technical Leaders | Accepted(A)/Rejected (R)/ Discussed (D) |
|---|---|---|---|
| Career length is an important differentiator between non- eminent cyclists and eminent cyclists | 3.71 (74.2%) | 3.83 (76.6%) | A |
| In order to be labelled eminent, one has to have won World Championships, The Tour de France/Giro Rosa, a monument or Olympic Games | 3.57 (71.4%) | 3.83 (76.6%) | A |
| A cyclist can be considered Eminent after a single short and successful period | 2.57 (51.4%) | 2.33 (46.6%) | R |
| The number of years ranked in the top 10 of the UCI ranking is an important differentiator | 3.00 (60%) | 3.17 (63.4%) | R |
| A cyclist might be considered eminent without winning races in the "premier league" events you described | 2.43 (48.6%) | 2.33 (46.6%) | R |
| A cyclist can be considered eminent with a relatively short career | 3.86 (77.2%) | 2.92 (58.4%) | D |

**Note.** Each item was considered relative to a scale from 1 (strongly disagree) to 5 (strongly agree). Percentages refer to the % agreement among the groups that this item should be included as a criterion for eminence.

## Panel Discussions

In the panel discussions, Phase 3 of the Delphi, both groups considered whether a cyclist could be classified as eminent after a relatively short career. Both groups found that while an athlete might show traits of eminence, ultimately one must win multiple premier league events (e.g., World Championships, Olympic Games, or Grand Tours) to be considered eminent. Both groups supported the need for further differentiation between pre-eminent stages and reached consensus on a qualification of "emerging eminence" to reflect cyclists who had won at least one of the listed premier events.

Beyond performance milestones, various developmental traits and circumstances were also discussed. For instance, the panel raised the issue of whether the ability to overcome adversity, or perhaps the need to overcome it, was an important element of eminence, not dissimilar from discussion points noted in the Great British Medalists study (Hardy et al., 2017). Furthermore, the ability to win in multiple cycling sports was also broadly discussed, similar to previous inquiries in ski sports. More specifically, Barth et al (2018) found that serial winners (those who won multiple events in the same disciple) as well as multiple winners (those who won in varying disciplines) were common in the top of the elite categories.

Both points were captured well in one of the arguments in the Technical Leader (TL) group. For example, TL 11 noted:

> One must be able to win multiple top races, over multiple seasons, while demonstrating versatility and composure. Versatility = crossing disciplines or types of races. Composure = ability to handle high pressure, both on and off the bike. Including, when needed, coming back from setbacks. Top races are world championships, monument classics (or like), world cups, Olympics, grand-tours (GC or stages). These are the best races, the most prestigious. In addition, overcoming adversity should be considered. For

example, Vos: winner in Cyclo Cross, Track and Road, now returning to winning ways from a 1-year career set back. Ferrand-Prevot: wins in Cyclo Cross, Road, Mountain Bike. Wiggins: went from Track - to - Road, wins in short 1-day events as well as grand tours. Theo Bos: from Track Sprint to Road and back There are more athlete examples. However, these few all demonstrate multiple wins, versatility, and composure.

Finally, milestones and transitional phases were discussed to gain understanding of the potential pathways to eminence. A7 shared:

> I think there is a ladder of achievement in the sport that is important, like winning at local level, regional level, provincial or state level, national level and then international level. Some skip a level or two, especially if they come from another sport that they have participated in at a high level. I believe that in climbing the ladder to eminence, it is important to have exposure to as many different types of races and disciplines within the sport of cycling as possible. It is also important to aim for success at one level before moving onto the next, as jumping into too high of a level that the athlete is not yet ready for.

Similarly, TL 3 noted three stages athletes move through during their careers that are necessary to achieve the aptitude linked to eminence.

> Much like Maslow's hierarchy of needs, a cyclist and coach duo can evolve in the same way. Initially, riders are purely physiological specimens who need complete structure and guidance. I would call this the "robot stage." They are sponges of information and follow commands almost without question. Then, as they evolve, they develop more knowledge and autonomy and become more independent professionals, which I call the "learning" phase. Finally, as riders evolve further their autonomy allows the coach to play a much smaller role. In essence act as a sounding board and this is

where athletes are the driving force behind the process and peak performance is achieved. I call this the "expert" phase.

TL 6 offered the following commentary around the development of eminent cyclists:

> I think the evolution can be very different between cyclists. Some are so extremely talented that even without significant experience, they can immediately compete at the highest level (Mathieu van der Poel, Remco Evenepoel, Egan Bernal, and Tadej Pogacar as some current examples). However, others need to build up experience before gradually growing to the level of eminence as indicated above. To my experience, it is also very important that general athletic development via different sports, including different disciplines in cycling, should be the primary focus until post-puberty. Great competitors at the age of 12-16 seldom become great adult cyclists, at least on the road. If young riders need a very professional approach and very high volumes of training to be able to win a race, they probably won't make it at a later age. It is crucial to maintain sufficient spare capacity to increase specific cycling training workload as long as possible during athletic development. This is also important to avoid mental fatigue even before "the real game" starts. I have seen too many young cyclists fading out at an early age because of too professional an approach too early on.

While many points were discussed, consensus was reached in both groups, through the discussion on three items, to expand on the key "prestige" or "premier league" races identified in Phase 2. After the survey and discussions phases, the group showed consensus on the following criteria of eminence:

1. Cyclists must have won a minimum of three "premier league" races (as defined in Table 2).
2. This may occur in the same sport or via a combination of cycling sports.

3. Cyclists who have won at least one but fewer than three "premier league" events reflect "emerging eminence."
4. The pace or rate at which one accumulates criteria 1 and 2 is not relevant.

## Discussion

Although the fields of skill acquisition and expertise are increasing at rapid rates, studies of eminence are rare due to challenges around access and sparsity of subjects (although for exceptions see Murray, 2003; Simonton, 1991). Yet, the topic has been part of academic debate since 1869 (i.e., Galton's initial work), and recent discussions highlight the value that rare, small sample sized studies might provide to scientific understanding (Ploutz-Snyder et al., 2014). In sport, some publications have begun exploring eminent groups, such as comparisons between champions and "super champions" (Collins et al., 2016; Collins & Macnamara, 2017; Farrow, 2017) as well as medalists versus non-medalists or multiple medalists in Olympic sports (Güllich, 2017, Hardy et al., 2017). However, contextual differentiators (such as differences between individual sports and team sports, Olympic versus non-Olympic, depth of competition, etc.) and sport-specific taxonomies have been lacking, creating potential risks of over-generalization between the field of expertise as a whole and its relevance for individual sports that have unique cultures, traditions, and development systems.

The objective of this study was to define sport specific criteria for the highest level of achievement in endurance-based cycling sports, allowing for more robust inquiries about eminence in cycling and a potential framework for future inquiries. Panel members in this study highlighted several areas for future exploration such as the value of domain specialization (e.g., focusing on only Road or only Mountain Bike) versus multi-domain engagement (e.g., participating in Road and Mountain Bike) for the development of expertise and eminence in cycling sports, which have implications for programming, training, and athlete pathway designs.

A greater understanding of the costs and benefits of single versus multisport cycling engagement during key phases of development could contribute to selection and elite program design within the professional and Olympic cycling communities. A number of exceptional cyclists have managed to win races at the highest international levels in multiple sports. For example, several athletes have managed to be successful in Track and Road cycling, including Bradley Wiggins, Elia Viviani, Amy Pieters and Chloe Dygert. Similarly, multiple World Champions such as Marianne Vos, Wout van Aert and Mathieu van der Poel have been able to attain success in both Cyclo Cross and Road cycling. On the Track, one of the premier disciplines, the Team Pursuit, often sees medal-contending nations fielding multiple riders who also compete on the Road. Interestingly, the most recent Olympic Games in Tokyo saw Tom Pidcock of the United Kingdom, a top contender in some of the world's major road races and a member of the world's wealthiest road cycling team (Ineos Grenadiers) win the men's Mountain Bike race. This ability to compete in multiple cycling sports appears to be becoming more frequent. While this has not yet been confirmed in cycling, the possibility of crossing over between disciplines in endurance sports has been noted in cross-country skiing (Barth et al., 2018). All this to say, the Delphi approach raised several intriguing areas of future exploration.

## Limitations

While this investigation had notable strengths, there were several limitations to our design. First, although it is possible that in-person conversations may have led to different and/or more fruitful discussions, the relative scarcity of participants at this level of skill, their geographical location around the globe, and limitations due to the SARS-COVID19 pandemic made this impossible for this study. In the current study, these concerns were somewhat mitigated by increasing the flexibility to participants in how they engaged with the discussions, such as offering the choice of either video conference discussions or anonymized chat rooms.

In addition, the number of participants in some areas was very low. For example, the

investigators managed to recruit only a single female Technical Leader, which likely reflects the low number of female technical leaders in the sport and the stringency of the inclusion criteria. Mountain Bike and CycloCross also had a relatively low number of representatives. While this does not necessarily constrain the design nor the value of Delphi-type studies, the possibility exists that this may have skewed potential findings. Further, this study focused only on endurance-based cycling sports, meaning sports such as BMX SX, BMX Freestyle, Track sprint, MTB Downhill, and others were excluded from inquiry. Future work should consider the unique elements of performance defining eminence in these sports. Finally, a more general limitation is the lack of clear guidelines for conducting Delphi studies. The variability in how Delphi methods have been used in various fields has been acknowledged, and some researchers (Nasa et al., 2021) have proposed important criteria for assessing the quality of Delphi approaches. Although the authors were not aware of this work prior to conducting the current study, we were encouraged that many of the steps taken reflected these criteria.

## Conclusions

Using Delphi methods to define definitions of target groups can create a rich discussion and has proven to be effective in setting definitions for eminent populations. While further discussion is needed regarding the creation of a taxonomy with well-defined indicators of categorization at lower levels of skill, both World or Olympic medal-winning athletes and technical leaders agreed that in order to be considered among those at the highest level of achievement, cyclists must win a minimum of three races in an exclusive subset of races containing World Championships (all cycling sports), Olympic Games (Track, Mountain Bike and Road), Monuments (Road), or World Cup overall classification (Mountain Bike) over the course of their careers to be considered eminent. Active cyclists who have won at least one of these events can be considered emerging eminent. These definitions provide a more

defined taxonomy for researchers exploring this topic. The findings of this study might help future researchers considering the various sciences related to cycling sports, such as exercise physiology, psychology, sport management, biomechanics and kinesiology, to better define their sample groups. Conversely, practitioners working with professional or Olympic populations might have a more informed way to qualify research articles in their field when assessing validity of findings for their own groups. This work builds on the call for more detailed taxonomies in sports by Baker et al. (2019) and is the first to provide definitions for eminence in a sport-specific context.

## Authors' Declarations

The authors declare that there are no personal or financial conflicts of interest regarding the research in this article.

The authors declare that the research reported in this article was conducted in accordance with the Ethical Principles of the Journal of Expertise.

The authors declare that they are not able to make their data publicly available but are able to provide it upon request.

## ORCID iD

Joseph Baker
https://orcid.org/0000-0002-5686-1737

## References

Baker, J., Schorer, J., Lemez, S., & Wattie, N. (2019). Understanding high achievement: The case for eminence. *Frontiers in Psychology*, *10*.

Baker, J., Wattie, N., & Schorer, J. (2015). Defining expertise: A taxonomy for researchers in skill acquisition and expertise. In J. Baker and D. Farrow (Eds.), *Routledge handbook of sport expertise* (pp. 145–155). Routledge.

Baker, J., Wilson, S., Johnston, K., Dehghansai, N., Koenigsberg, A., de Vegt, S., & Wattie, N.

(2020). Talent research in sport 1990–2018: A scoping review. *Frontiers in Psychology*, *11*.

Barth, M., Güllich, A., & Emrich, E. (2018). The rich get richer and the poor get poorer: The Matthew mechanism as an approach to explain selection effects and the occurrence of multiple medalists in the "production" of international success in alpine ski racing. *Current Issues in Sport Science (CISS)*, *3*, 008–028.

Collins, D. J., & Macnamara, A. (2017). Making champs and super-champs-current views, contradictions, and future directions. *Frontiers in Psychology*, *8*(MAY), 1–8.

Collins, D.J., MacNamara, Á., & McCarthy, N. (2016). Super champions, champions, and almosts: Important differences and commonalities on the rocky road. *Frontiers in Psychology*, *6*, 2009.

Craig, N. P., & Norton, K. I. (2001). Characteristics of track cycling. *Sports Medicine, 31,* 457–468.

Diamond, I. R., Grant, R. C., Feldman, B. M., Pencharz, P. B., Ling, S. C., Moore, A. M., & Wales, P. W. (2014). Defining consensus: A systematic review recommends methodologic criteria for reporting of Delphi studies. *Journal of Clinical Epidemiology*, *67*(4), 401–409.

Farrow, D. (2017). Super-elite athletes: Some complimentary observations from Australia and some lessons for sports expertise research: Comment on Hardy et al. In *Progress in Brain Research* (1st ed., Vol. 232). Elsevier.

Galton, F. (1869; 1892). *Hereditary genius*. D. Appleton.

Gardner, S. A., Martin, T. D., Barras, M., Jenkins, G. D., & Hahn, G. A. (2005). Power output demands of elite track sprint cycling. *International Journal of Performance Analysis in Sport*, *5*(3), 149–154.

Goto, H., Morris, J.G. & Nevill, M.E. (2015). Match analysis of U9 and U10 English premier league academy soccer players using a global positioning system: Relevance for talent identification and development. *The Journal of Strength & Conditioning Research 29(4),* 954–963.

Groot, L. (2008). The contest for Olympic success as a public good. *The Journal of Income Distribution, 21*(1), 102–117.

Güllich, A. (2017). International medallists' and non-medallists' developmental sport activities–a matched-pairs analysis. *Journal of Sports Sciences*, *35*(23), 2281–2288.

Hardy, L., Barlow, M., Evans, L., Rees, T., Woodman, T., & Warr, C. (2017). Great British medalists: Psychosocial biographies of super-elite and elite athletes from Olympic sports. In *Progress in Brain Research* (1st ed., Vol. 232). Elsevier B.V.

Henriksen, K., & Christensen, M. K. (2013). Athletes' careers in Denmark. In N. B. Stambulova & T. V. Ryba (Eds.), *Athletes' careers across cultures* (pp. 77–89). Routledge/Taylor & Francis Group.

Hogan, K., & Norton, K. (2000). The "price" of Olympic gold. *Journal of Science and Medicine in Sport*, *3*(2), 203–218.

Houlihan, B., & Zheng, J. (2016). The Olympics and elite sport policy: Where will it all end? In F. Hong and L. Zhouxiang (Eds.) *Delivering Olympic and elite sport in a cross cultural context: From Beijing to London* (pp. 1–18). Routledge.

McAuley, A.B.T., Baker, J. & Kelly, A.L. (2022). Defining "elite" status in sport: From chaos to clarity. *German Journal of Exercise and Sport Research, 52*, 193–197.

McKay, A. K., Stellingwerff, T., Smith, E. S., Martin, D. T., Mujika, I., Goosey-Tolfrey, V. L., Sheppard, J. & Burke, L. M. (2022). Defining training and performance caliber: A participant classification framework. *International Journal of Sports Physiology and Performance*, *17,* 317–331.

Mostaert, M., Vansteenkiste,P., Pion., Deconinck,F., & Lenoir, M (2021) The importance of performance in youth competitions as an indicator of future success in cycling, *European Journal of Sport Science, 22,* 481–490.

Murray, C. (2003). *Human accomplishment: The pursuit of excellence in the arts and sciences, 800 B.C. to 1950*. Harper Collins.

Nasa, P., Jain, R., & Juneja, D. (2021). Delphi methodology in healthcare research: How to decide its appropriateness. *World Journal of Methodology*, *11*(4), 116–129.

Ploutz-Snyder, R. J., Fiedler, J., & Feiveson, A. H. (2014). Justifying small-*n* research in scientifically amazing settings: Challenging

the notion that only "big-*n*" studies are worthwhile. In *Journal of Applied Physiology, 116*, 1251–1252.

Schumacher, Y. O., Mroz, R., Mueller, P., Schmid, A., & Ruecker, G. (2006). Success in elite cycling: A prospective and retrospective analysis of race results. *Journal of Sports Sciences*, *24*(11), 1149–1156.

Simonton, D. (1984). Scientific eminence historical and contemporary: A measurement assessment. *Scientometrics*, *6*(3), 169–182.

Simonton, D. K. (1991). Latent-variable models of posthumous reputation: A quest for Galton's *G. Journal of Personality and Social Psychology, 60*(4), 607–619.

Simonton, D. K. (2002). *Great psychologists and their times: Scientific insights into psychology's history*. American Psychological Association.

Simonton, D. K. (2004). Film awards as indicators of cinematic creativity and achievement: A quantitative comparison of the Oscars and six alternatives. *Creativity Research Journal*, *16*(2-3), 163–172.

Simonton, D. K. (Ed.) (2014a). *The Wiley handbook of genius*. John Wiley and Sons.

Simonton, D. K. (2014b). Creative genius in literature, music, and the visual arts. In V. Ginsburgh & D. Throsby (Eds.), *Handbook of the economics of art and culture* (Vol. 2, pp. 15–48). Elsevier.

Swann, C., Moran, A., & Piggott, D. (2015). Defining elite athletes: Issues in the study of expert performance in sport psychology. *Psychology of Sport and Exercise*, *16*, 3–14

Van Erp, T. (2019). Load, intensity and performance in professional road cycling. *PhD Thesis, Vrije Universiteit van Amsterdam*.

Van Reeth, D., & Larson, D. J. (2016). *The economics of professional road cycling*. Springer.

JoE