Original Article

Performance and ranking position evolution during 20 competitive seasons in elite 100 meter sprinters

JOSÉ FERNANDO ARROYO-VALENCIA[1], CARMEN RODRIGUEZ-FERNANDEZ[2], ADRIÁN CASTAÑO-ZAMBUDIO[3], MARÍA JOSÉ MARTINEZ-PATIÑO[4]

[1]*University Institution National Sports School, Santiago de Cali, Colombia*
[2]*University of Seville, Spain*
[3]*Rey Juan Carlos University, Spain*
[4]*University of Vigo, Spain*

ABSTRACT

The literature contains several researches seeking to analyse and predict the behaviour of 100-meter dash performance through different mathematical models. Although when analysing the historical records in their entirety these simple models fit largely to their behaviour of the historical series, these approximations are not valid when the focus is on the analysis of accumulated times over the past 2 decades. For this reason, this work proposes new alternatives such as polynomial gradient or smooth models capable of explaining with greater accuracy what has happened during the last 20 years for this modality. Therefore, in order to analyse the distribution of competitive marks relative to the top five and bottom five in the ranking over a period of 20 seasons, a total amount of 428 records corresponding to the marks obtained by international level male athletes who conformed the IAAF world ranking in the 100 m race during the 20 indicated seasons were considered for this goal. The main findings of this research conclude with the lack of fitting between the simple approaches (linear or exponential models) and the reported decline in the records -therefore better performance- throughout the analysed period. In return, this work reveals the existence of a tendency towards overall reduction of time records, denoting a positive evolution of the "competitive health" of the discipline. These evolutions, however, seem to be influenced by the position in which athletes qualify, thus showing greater reductions for athletes classified in the bottom five than for those classified in the top five.
Keywords: Athletics; Running; Sports performance analysis; IAAF world ranking.

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Corresponding author. *Facultad de Ciencias de la Educación y el Deporte, Universidad de Vigo, A Xunqueira s/n, 36005 Pontevedra, Spain. https://orcid.org/0000-0003-2721-9240*
E-mail: mjpatino@uvigo.es
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INTRODUCTION

Human desire to transcend has been one of the defining elements of our species throughout history. Sprint running have brought this battle against ourselves and against the chrono to its maximum expression within the sportive field. For this reason, the 100-meter or hectometre is the most expected and followed event in the modern Olympic program, being the one that receives the most audience (Moravec et al., 1988).

The 100-meter dash race has been held at the Olympic Games since the first edition in 1896 for men and since 1928 for women. The finals of the 100-meter Olympic Games are among the most popular sporting events in athletics, which arouses a high media interest, reaching audiences of more than 35 million people worldwide to see the 100-meter final in the 2016 Olympic Games won by Usain Bolt.

This discipline, which encompasses one of the highest complexities in terms of both technical and conditional requirements, has not only aroused interest, but has also been reflected in spectacular audience ratings. As a result of this media interest, it is widely acknowledged that world record holders of 100 metres and their respective Olympic champions, or world champion, are awarded the title of "the fastest man or woman in the world".

Despite the reported increase in the difficulty of achieving increasingly competitive records, the men's world record has been broken on numerous occasions in recent years. The IAAF has reported this milestone on 12 occasions since 1968, when electronic timekeeping was first introduced at the Olympic Games.

A large number of scientific publications included in the field of sports sciences have analysed the evolution of this discipline with the intention of deepening the competitive health of the discipline.

In this way, authors such as (Kuper & Sterken, 2007; Prendergast, 2001) conducted tracking studies focused on the analysis of marks obtained over the past years in order to model the WR behaviour through regression equations. Nevertheless, despite the fact that a wide range of studies have proved that predicting the evolution of the WR in running and swimming related disciplines is possible, the fitting of these models tends to overestimate the improvements (Berthelot et al., 2015; Okičić, Madić, Dopsaj, & Đorđević, 2007; Shaw, 2012; Lippi et al., 2008) and is not able to contemplate the irruption of individuals that deviate (i.e. Usain Bolt) in an abrupt way from these tendencies.

Nevertheless, given the complexity of this objective due to the marked multifactorial character of the outcome, these models undoubtedly provide valuable information on the "*state of competitiveness*" of the discipline. Thus, in relation to the predictive models developed so far, different factors have been considered (mainly physiological) and approaches, usually mathematical or probability, but no model has managed to accurately predict a specific athletic performance. In any case, these models seem to show a greater fit, that is, to be more effective, the shorter the time (or distance) to be covered by the athlete in competition; in this way, sprint events are the most prone to this type of modelling (Liu, Paul, & Fu, 2012).

Accordingly, this study attempts to analyse the distribution of competitive marks relative to the top five and bottom five in the ranking over a period of 20 seasons.

METHODS

This study adopted an observational, follow-up and retrospective design based on the best scores obtained by international athletes in the 100m event that have made up the world ranking for two decades.

The reference database used in this research is developed by the IAAF (http://www.iaaf.org). The results included in this database correspond to competitions that are directly organised by the IAAF, that have an official IAAF area licence or those competitions that have a national licence and that have been proposed by the member federations for promotion to E category.

In addition, a global qualification system in which athletes obtain points (ranking score) according to a combination of result, place and category of the competition in question has been incorporated. Under this consideration, there are three computable parameters to establish the world ranking in each test (in this case the 100 m):

a) Score related to the result in the test (result score). This score is calculated on the basis of the latest edition of the IAAF scorecards produced in conjunction with Elite Ltd. (All-Athletics). In the case of 100 m, this score may be altered according to the existing wind speed.
b) Score related to the place obtained by the athlete in competition (placing score). This score is only obtained in the finals (not in qualifying series, quarterfinals or semi-finals), and also depends on the category of the competition being contested. In this sense, it is necessary to indicate that there is a total of ten competition categories considered by the IAAF.
c) Performance score. It is obtained by aggregating the two previous parameters:

Performance score = result score + placing score

In this way, the final ranking is based on a ranking score which is calculated through the average of the performance scores taking into account the participation of each athlete in several competitions during a given period of time, in this case between 12 and 18 months before the final and annual publication of the ranking.

Inclusion criteria

Using the world ranking as a reference, the data were selected and extracted using various inclusion according to the 100 m test. Thus, the inclusion criteria were as follows:

- Age of the athlete: between 18 and 40 years old.
- Sex of the athlete: male.
- Type of track: open air.
- Timing: electronic.
- Wind speed: regular (less than or equal to 2 m/s in favour).
- Study interval: between 1998 and 2017 (both included).

In order to avoid possible bias in the selection of records, the extraction process was developed by the principal investigator himself as well as by two independent investigators trained in the process. In this sense, it is important to note that the comparison (triangulation) between the numbers of records selected and extracted by the three researchers was the same.

Thus, the sample of the present study was conformed by a total of 428 records corresponding to the marks obtained by international level male athletes who conformed the IAAF world ranking in the 100 m race during the 20 indicated seasons (1998 - 2017). Generally, 20 records were included for each of the seasons reviewed; however, it is necessary to specify that the IAAF incorporated more records in the ranking of the years 2005, 2007 and 2008 (n = 21); 2010, 2015, 2016 and 2017 (n = 22); 1999 (n = 23); 2006 (n = 24) and 2001 and 2003 (n = 25). In any case, all these records were also included in the study.

With the database employed in this study, a statistical model was developed in order to achieve the predictive tools pursued in this research. To more accurately represent the relationship and possible interaction between the different factors studied in this paper, polynomial gradient mathematical models as well as smooth models (models that adjust the estimation to the data without following a particular mathematical function) were used.

RESULTS

The mathematical models of polynomial gradient, as well as smooth models (models that adjust the estimation to the data without following a specific mathematical function) reflect both the evolution of the mean times of the records of the last 2 decades (Figure 1) and the influence of the final position on the behaviour of this evolution (Figure 2).

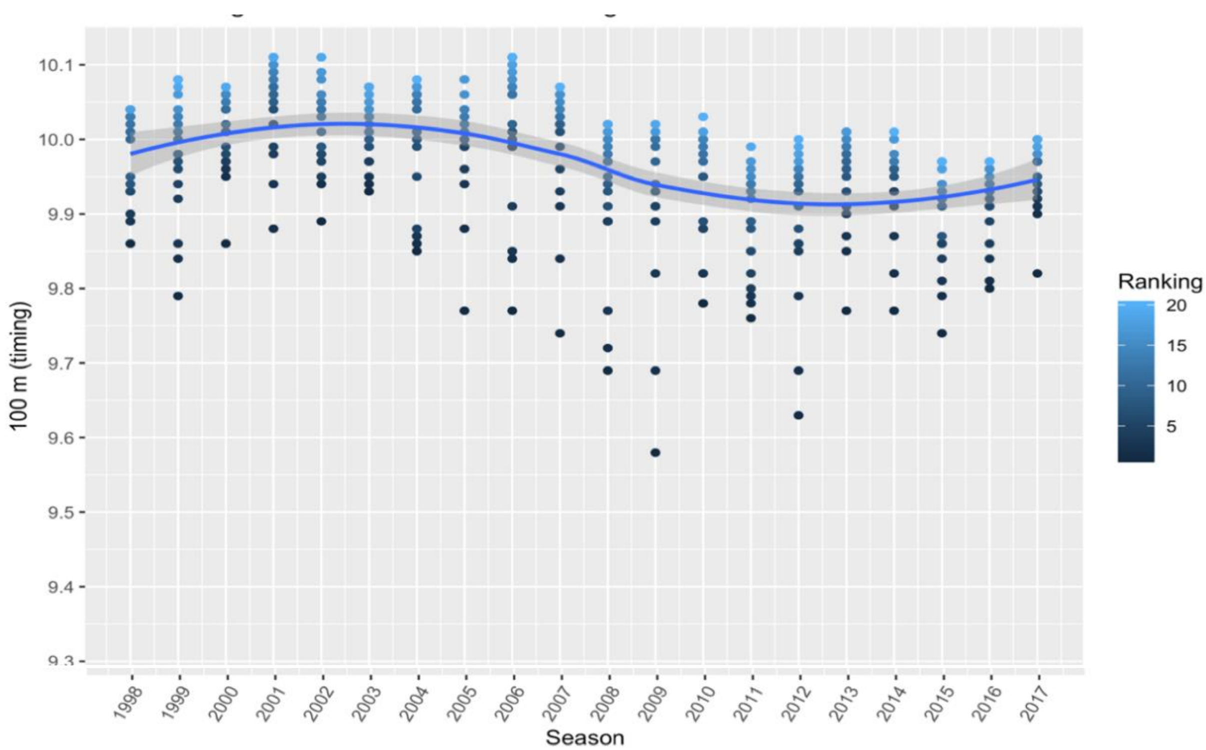

Figure 1. Explanatory gradient model of the general evolution of the ranking throughout the different seasons.

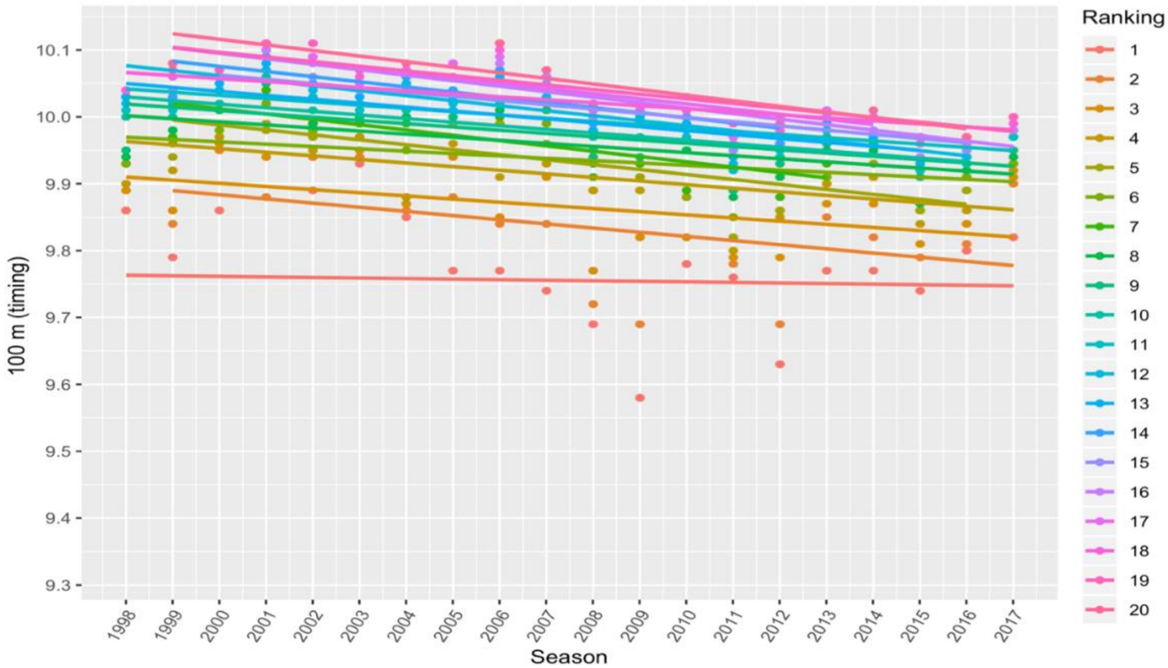

Figure 2. Explanatory linear model of the evolution of the mark in the different rankings throughout the year under study.

DISCUSSION

The main findings reported in this work indicate the absence of linear or exponential relationships that fit the decrease of records throughout the analysed period. Although these functions exhibit adjustability when the analysis is performed on the evolution of these records since 1912, authors such as Shaw (2012) already referred to these approximations as "unrealistic" given the differences existing in the evolution of the record when the last 20 years are compared to the previous 80.

These "simple" mathematical models, moreover, only consider records and their evolution over time to subsequently establish their associations with no regard to other factors that might influence the prediction (Nevill & Whyte, 2005). It is for this reason that the employment of this kind of models for the purpose of analysing and predicting the behaviour of these marks entails some implications such as the progressive decline of world record times to infinity or that world record running speeds will continue to increase (Whipp & Ward, 1992), which would suggest that no limits to the athletic performance during the 100 meter dash races exist.

In contrast to this type of association, more complex models that try to integrate biological components into the factors that interact in their predictions claim that humans may have reached their peak of performance or might be very close to them (Berthelot et al., 2015; Denny, 2008; Nevill & Whyte, 2005).

Despite the lack of association between records behaviour and simple mathematical functions, this work does report a trend towards the overall reduction of records. The data provided by this work seem to indicate a positive evolution of the "competitive health" of the discipline, reflected in the evolution of the records analysed for the last two decades. Interestingly, records observed between the 1998 season and the 2002 season reported a slight increase in average race times from 9.98 seconds to 10.02 seconds (+0.04%). However, from this season up to 2012 a positive and constant progression is observed until reaching a mark of 9.90 (-0.08%) seconds after which it stabilizes according to the defined function. The exhaustive analysis of this large database not only shows decreases reflected in the analysis of mean time of the 100 meters dash event pointing to an evident greater competitive demand, but also provides novel and interesting information relating to the effect of the position analysed on the behaviour of this evolution studied.

In this way, a marked influence of the position on the percentage of improvement of the marks throughout the analysed period can be observed. Thus, decreases of up to 0.59% can be observed for the positions of those athletes classified between 15-20th place, very evident magnitudes of change as opposed to those observed for those athletes classified between 1st-5th positions (0.52%). Thus, it seems logical that the difference in magnitude of changes observed is greater for the group with the lowest ranking due to the greater margin for this reduction. For the best positioned this decrease is much smaller, eventually showing almost imperceptible variations for the first position. An explanation for this phenomenon could be approached from the perspective provided by authors such as (Berthelot et al., 2015) who suggested that the highest athletic performance could already be achieved in many sports disciplines, while these small fluctuations in performance would be determined by contextual elements such as sociological periodicity or conditioning factors such as the use of new technologies or environmental influences (García-Manso, Martín-González, Dávila, & Arriaza, 2005; Haake, 2009).

In order to contextualize these variations in athletic performance, the inaccessibility and difficulty of intervention for this type of population should be warn. In fact, the authors of this paper are not aware of the existence of any intervention study reporting changes in the performance of athletes of international level after undergoing a specific training in order to improve sprint performance. Although in a scarce way, some evidence can be observed reporting this type of change in sprinters of lower category. Blazevich & Jenkins (2002) presented improvements of up to 4% for the time in 0-20 meters in national level athletes who took of a power-oriented training. The magnitude of these adaptations is not only far from those observed in this work (up to 8 times greater than the development achieved over two decades), but also from the annual change reported for elite athletes based on their seasonal records, where changes not bigger than ±0.2-0.4% depending on the specialty were described (Haugen et al., 2018).

The future of this discipline seems hopeful despite the withdrawal of superclass athletes such as Bolt who have contributed to the improvement of this competitiveness. Bearing in mind that the registers start from around 9.92-9.94 seconds, if the trend is reproduced in a similar way the levels of the discipline would be assured, foreseeing that some of the current sprinters such as the Americans Lyles or Coleman could beat (or approach) the world record in the next decade. If this evolution is confirmed, it would be noted that the race goes through the best level of all its history and ensures that the success and level of the test could be guaranteed in the next decade.

It should be noted that, unlike transversal observational studies, one of the advantages of tracking observational studies is their ability to evaluate, over time, the evolution of sports performance and how it may be influenced by various factors -development of new training models, establishment of new competition systems, technological advances, etc. (Costa et al., 2010). However, even if associations could be established between one or more of these factors and sports performance, the possible cause-effect relationship would still not be clearly defined; furthermore, in retrospective studies some variables may be ignored or their mediational effect may not be controlled, so their results and conclusions could certainly be limited (Liu et al., 2012). However, a multidimensional review of the factors that can affect the performance of athletes as well as ensuring a high sample size (which allows a large volume of data to be computed) are two of the main considerations to be taken into account to reduce much of the possible biases that might appear during the study.

CONCLUSSION

Regardless of the approach used for the analysis of the records from the last two decades, the 100-meter dash discipline exhibits a greater state of competitiveness than that shown in the past. In this way, the magnitude of change reported in the degree of improvement of these marks over the period studied seems to be influenced by the position belonging to the classificatory ranking.

AUTHOR CONTRIBUTIONS

José Fernando Arroyo-Valencia: research design, data collection, paper writing, paper revision. Carmen Rodríguez-Fernández: paper writing, data collection, paper revision and paper modifications. Adrian Castaño-Zambudio: paper writing, translation and adaptation of the paper. María José Martínez-Patiño: research design, paper writing, modifications of the paper and corresponding author.

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DISCLOSURE STATEMENT

The authors state that there are no conflicts of interest.

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