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Director: Fernando Emilio Valladares Fuente

Email: fernando.valladares@upr.edu.cu

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Original article

The selection of elite athletes from an early age: reflection from the perspective of complex systems

La selección de atletas élite desde edad temprana: reflexión desde la perspectiva de los sistemas complejos

A seleção de atletas de elite desde cedo: reflexão a partir da perspectiva de sistemas complexos

Juan Manuel García Manso[1*] https://orcid.org/0000-0002-4360-3384

Teresa Valverde Esteve[2] https://orcid.org/0000-0002-8712-9872

Lázaro de la Paz Arencibia[3] https://orcid.org/0000-0001-8908-042X

María José Martínez Patiño[4] https://orcid.org/0000-0003-2721-9240

[1]Department of Physical Education and Sports Education, University of Las Palmas de Gran Canaria, Spain.

[2]University of Valencia, Spain.

[3]Manuel Fajardo University of Physical Culture and Sports Sciences, Havana, Cuba.

[4]University of Vigo, Spain.

[*]Corresponding author: jgarciamanso@gmail.com

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ABSTRACT

Introduction: In this study, the suitability of selecting elite athletes from an early age was examined.
Objective: The objective of this study was to verify if the behavior identified in previous research also occurs among the world's best athletes of all time who compete in the 100-meter race.
Materials and methods: For this, and based on an analysis of the official classifications of all times for men and women of the International Association of Athletics Federations in the referred test , samples were used in absolute category (Top-1,000 up to the 12/31/2018) and sub -20 category (Top - 100 until 12/31/2003); power laws and other strategies typical of complex systems will be applied to analyze the data .
Results: The results show how, all too often, the best male and female runners in the world in the under-20 category do not evolve positively during the rest of their sports career. improving their records in the higher categories. Only 51 men out of the top 100 U-20 runners of all time managed to improve their times once they reached the senior category, and the improvements did not always show statistically significant progressions. Consequently, an excessive investment in human and material resources to identify individuals with high athletic abilities is not always the best strategy.
Conclusions: level sport at an early age can be a methodological error that should be avoided when building the sports reserves of a country or sports federation.

Keywords: 100-meter race; Black Swans; Power Laws; Enrichment Paradox; Sand Pile; Sports reserves; Dragon King.

RESUMEN

Introducción: En este estudio, se examinó la idoneidad de seleccionar atletas élite desde una edad temprana.
Objetivo: El objetivo de este estudio consistió en verificar si el comportamiento identificado en investigaciones antecedentes también ocurre entre los mejores atletas mundiales de todos los tiempos que compiten en la carrera de 100 metros.
Materiales y métodos: Para ello, y con base en un análisis de las clasificaciones oficiales de todos los tiempos masculinos y femeninos de la Asociación Internacional de Federaciones de atletismo en la referida prueba, se utilizó muestras en categoría absoluta (Top-1,000 hasta el 31/12/2018) y categoría sub-20 (Top-100 hasta el 31/12/2003); se aplicaron leyes de potencia y otras estrategias típicas de los sistemas complejos para analizar los datos.
Resultados: los resultados muestran cómo, con demasiada frecuencia, los mejores corredores masculinos y femeninos del mundo en la categoría sub-20 no evolucionan positivamente durante el resto de su carrera deportiva mejorando sus registros en las categorías superiores. Solo 51 hombres de los 100 mejores corredores sub-20 de todos los tiempos, lograron mejorar sus registros una vez que alcanzaron la categoría sénior, y las mejoras no presentaron siempre progresiones estadísticamente significativas. En consecuencia, una inversión excesiva en recursos humanos y materiales para identificar

individuos con altas capacidades atléticas, no es siempre la mejor estrategia.
Conclusiones: el deporte de nivel a edades tempranas puede ser un error metodológico que debe evitarse a la hora de construir las reservas deportivas de un país o federación deportiva.

Palabras clave: Carrera de 100 metros; Cisnes Negros; Leyes de Potencia; Paradoja del Enriquecimiento; Pila de Arena; Reservas deportivas; Rey Dragón.

RESUMO

Introdução: Neste estudo, examinou-se a adequação da seleção de atletas de elite desde tenra idade.
Objetivo: O objetivo deste estudo foi verificar se o comportamento identificado em pesquisas anteriores também ocorre entre os melhores atletas do mundo de todos os tempos que competem na prova de 100 metros.
Materiais e métodos: Para isso, e com base na análise das classificações oficiais de todos os tempos para homens e mulheres da Associação Internacional de Federações de Atletismo na prova supracitada, foram utilizadas amostras em categoria absoluta (Top-1.000 até 31/12 /2018) e sub-20 (Top-100 até 31/12/2003); Leis de potência e outras estratégias típicas de sistemas complexos foram aplicadas para analisar os dados.
Resultados: Os resultados mostram como, muitas vezes, os melhores corredores masculinos e femininos do mundo na categoria sub-20 não evoluem positivamente durante o resto de sua carreira esportiva, melhorando seus registros nas categorias superiores. Apenas 51 homens dos 100 melhores corredores sub-20 de todos os tempos conseguiram melhorar seus tempos quando chegaram à categoria sênior, e as melhorias nem sempre mostraram progressões estatisticamente significativas. Consequentemente, um investimento excessivo em recursos humanos e materiais para identificar indivíduos com altas habilidades atléticas nem sempre é a melhor estratégia.
Conclusões: o esporte de nível em idade precoce pode ser um erro metodológico que deve ser evitado na construção das reservas esportivas de um país ou federação esportiva.

Palavras-chave: Corrida de 100 metros; Cisnes Negros; Leis de Potência; Paradoxo do Enriquecimento; Pilha de Areia;Reservas desportivas; Rei Dragão.

INTRODUCTION

Undoubtedly, it is experiencing a time of significant changes in all aspects of life (Dunford, *et al.,* 2016). Sport is no stranger to this process or to the deep cross-cultural, social, political and economic disturbances it causes (Frontiera, 2010). Sport is widely recognized as one of the most important social and cultural phenomena, making it a topic of interest for the political strategies of any country (Hutchins, 2011; Fister *et al.,* 2020). In this process, athletic performance seems to be evolving continuously and sometimes prodigiously. So much so, that what previously seemed impossible to improve can be overcome at any time, reaching levels that were believed unattainable. Meanwhile, others believe that the limits of sports performance are close to being reached and that the evolution of the physical capabilities of humans is slowing down (Berthelot, *et al.,* 2015; Marck *et al.,* 2017). If this is the case and this situation prevails, a period of stagnation of records in different sports disciplines is approaching (Denny, 2008; Arroyo-Valencia *et al.,* 2021). Such positions speculate on when this will happen

and the level that constitutes the potential limit for each sport that depends very directly on the conditional (physical) capacities of the athletes (Nevill and Whyte, 2005).

In any case, whether or not it is close to the potential limit of performance, the sport still needs highly specialized athletes, better trained and with very specific biological and morphological profiles. To address this situation, the Sports Systems of many countries have developed sophisticated intervention strategies that allow them to search for and train Sports Reserves in different sports modalities. Once implemented, these strategies provide them with athletes with whom to fill the most important positions in the different sports disciplines and, if possible, achieve significant achievements in the main international competitions. This type of strategy is known as *Sports Talent Detection, Selection and Training Models* (Wolstencroft, 2002). By understanding the concept of selection of talents already poses, important academic and conceptual problems. However, this approach implies generating efficient and objective strategies to identify and select people with a special "gift" to succeed in a specific sport. With proper training, selected athletes could become talents capable of competing at the highest national or international level in their sport (Gagné, 2004). A process of this nature requires, in addition to gifted athletes, several years of training, during which athletes must overcome numerous and complicated obstacles to achieve their ultimate goal.

The focus on selecting those talents is often at the root of many of the problems that challenge that process. A project of this nature implies a significant amount of human and material resources that, if not implemented correctly, can compromise the proposed objective and the possible collateral benefits that are associated with it. Trying to select potential champions from very early ages (Malina, 2010) can lead to even more potential problems that are associated with a high rate of premature abandonment of very diverse origins (limiting injuries, delays in maturation, developmental alterations, relative age, fear of failure, lack of opportunities, changing motivations, etc.) (Wiersma, 2000; Malina, 2009; Cobley, *et al.,* 2009: Baker, *et al.,* 2010; Johnston and Baker, 2020). An even more serious fact is that often many people who do not show high abilities at an early age may be initially ignored or rejected, thus suppressing a silent potential that has not yet been manifested (Brophy and Good, 1973). This phenomenon has been previously analyzed in different sports, such as athletics (Brito, Fonseca and Rolim, 2004; Enoksen, 2011; Moesch, 2012), basketball (Sáenz-López, Feu-Molina and Ibañez, 2006) or tennis (Unierzyski and Crespo, 2007; Guillaume *et al.,* 2011).

The objective of this study is to verify if the behavior identified in previous research also occurs among the best world athletes of all time who compete in the 100-meter race. It should be clarified that it is based on the premise that this discipline is in itself a complex adaptive system whose main components, the athletes, push their organisms to critical functional states that generate emerging states of performance that present a fractal structure during the process (Garcia-Manso, *et al.,* 2008a). It is opportune to remember that when talking about complex systems, complex does not mean complicated. The term "complex" comes etymologically from the Latin word plexus (interwoven, intertwined, etc.), understood as that which cannot be separated without affecting its integrity or even conditioning its existence. That is, they are systems that are based on an interconnected dynamic structure, markedly interdependent, high sensitivity, unpredictability, self-organization, fluctuations, chaotic behavior, phase transitions, bifurcations, emergence and fractal structure.

The acceptance of this initial criterion could help explain how, and why, each subsystem of this athletic discipline (senior, U20 or junior, male or female runners) evolves in a particular way with its own characteristics as a result of the effect that cause the non-linearity of its behavior, the interaction of its components and the effects that a constantly changing environment exerts on performance. Therefore, it is considered to add conceptual and mathematical elements typical of complex systems to traditional analysis methodologies. The evolution of the best 50 runners (male and female) in the 100-meter race has also been studied to see their performance in the U20 category, the total improvement in that distance and the years they remained active until their official retirement.

The foregoing justifies, for this study, the use of a non-linear methodology that reveals if the sophisticated strategies followed to select talents in formative stages with very early ages are efficient, or if it contains a failure rate that forces us to rethink these strategies using new methodologies. that do not imply an excessively high economic, material and human cost.

For the processing of the data obtained from the empirical methods, the following sources were consulted: (Lotka, 1925; Tang, Rosenzweig, 1971; Wiesenfeld, 1988; Cohen 1988; Mendes, Malacarne and Anteneodo, 2007; Taleb, 2007; Sornette, 2009; Malina, 2009; García-Manso *et al,* 2012; Balague *et al,* 2013; De Saá, *et al,* 2013; Eliazar, 2017; Jeon and Park, 2021).

MATERIALS AND METHODS

Sample

The study was based on the all-time rankings (All-Time Ranking) of the International Association of Athletics Federations (IAAF) for the male and female senior categories (Top-1,000 until 12/31/2018; Figure 1) and male and female categories U20 (Top-100 until 12/31/2003; Figure 2) (https://www.iaaf.org). Three decades of difference between the two classifications were considered to ensure that there were no under-20 athletes who had a chance to improve their best times on dates after December 31, 2018 (Figure 1 and Figure 2).

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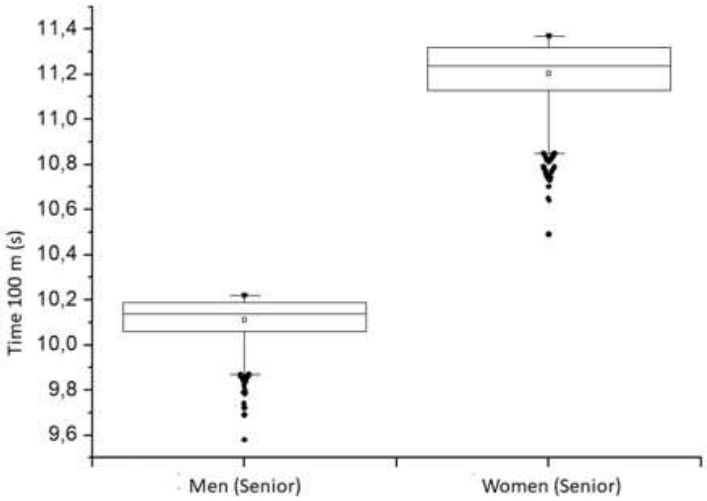

Fig. 1. - Box-plot of the absolute classification of all times (male and female) closed on 12/31/2003. On the left, the male ranking and on the right, the female ranking

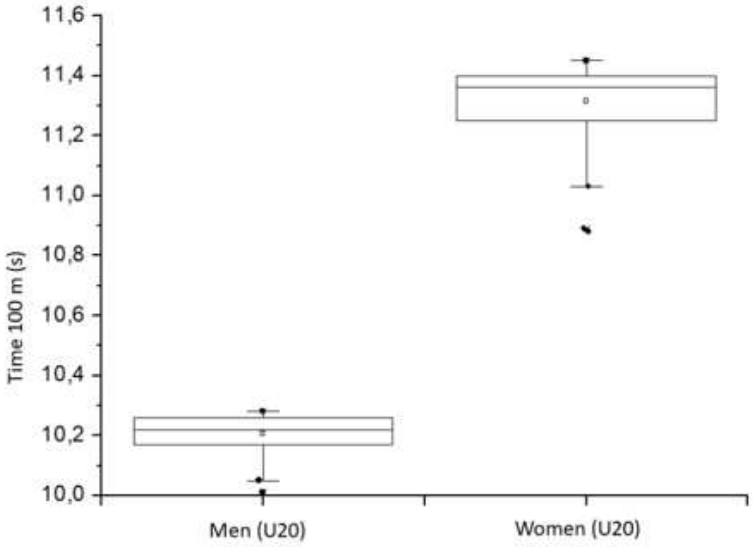

Fig. 2. - Box-plot of the U-20 category all-time ranking (male and female) closed on 12/31/2003. The U20 men's ranking is shown on the left and the U20 women's ranking on the right

Among the countries that develop strategies to create sports reserves in athletics, it is usually estimated that the under-20 athletes are those who are at the end of the stage known as learning to train to compete to move on to the stage known internationally as training to win. In other words, they are completing their initial training, which is increasingly specialized, to fully incorporate themselves into the competition stage and

evolve towards high international performance. Before the age of 15, there is a stage of acceptance and incorporation into the specialty in which the objective of the work carried out is to learn to train and adapt to the usual training system.

Data processing

Statistical analysis was performed with the programs Matlab (Mathworks, USA) and SPSS (V.19 inc., Chicago, Il). Once the rankings were prepared, each parameter (best times for male and female categories) was analyzed to verify whether the evaluated athletes showed a similar or different profile in terms of the performance of their best records. Sports systems show a very particular hierarchical structure (without scale) that can be modeled mathematically through Power Laws (PL). In this work, the PLs are used as tools to visualize the evolution of the records and the establishment of performance levels. LPs are described by simple mathematical expressions such as (Equation 1):

$$Y = cX^b \quad (1)$$

Where *X* and *Y* are two variables (observable quantities), *c* is a proportionality constant (it can also be understood as a normalization constant) and *b* is the exponent.

PLs have two fundamental properties:

1. If a double logarithm (log-log) is performed in the above equation, *log (Y) = log (c) + b log (X)* is the equation of a straight line with slope *b.* This tool has been used in the work to establish the transition zones with which to set the cutoff marks that allow characterizing the possible groups that are generated from the different performance levels.

2. They are invariant to changes of scale. Although the basic laws of nature do not change according to the scale at which they are studied, the phenomenology they present does, as does the small nuances of their scale structure.

An LP is a special mathematical relationship between two quantities, which is completely different from the normal or Gaussian distribution. Both respond to two very different ways of seeing the world which differ radically: mean and distribution *vs.* causal dynamics explained by the scale-free theory. Why should this kind of behavior matter? In a world of LPs, extreme events are the most important. Extreme events, which are often ignored in the Gaussian world, are not only more common than is thought, but also have a much larger magnitude and greater consequences.

The scaling behavior that many sports systems follow is often fractal and contains various elements, or constraints, that interact with each other to alter the system. In these circumstances, there are different levels of performance in the analyzed series with their own particular characteristics. As a fundamental objective, and in any sports discipline or modality, athletes exploit their abilities to the maximum, seeking to exceed previously established limits (breaking records) and overcoming the barriers that are usually found in the evolution of the records of any sports modality. Athletes, therefore, subject their organisms, and even their own competition systems, to extreme states of behavior similar to those known to be detected in Critical Self-Organizing Systems, in which scaling behavior patterns (PL).

At this point, the systems evaluated in this study (rankings for 100-meter races) show complex structures in which transitions and crossovers appear within the data series (best times), which are manifested in the form of avalanches in the model. *Sandpile.* This self-organization model shows how small changes in the organization and functionality of the system can generate a new qualitative and quantitative reconfiguration of the entire system, which is very interesting when it comes to understanding and analyzing the characteristics of the best runners in the world in the senior and U20 categories. It is important to understand that the process is conditioned by the limitations that intervene, that is, dynamic elements that put pressure on the event, reorienting and conditioning its evolution.

The presence of these phenomena in sport is more frequent than imaginable. This study will make it possible to detect possible differences in the runners of each ranking by performance levels, establish records where transformations or crossings occur that mark changes in brand levels, and understand the presence of atypical records that can act as attractors, or as elements of interference, in the reconfiguration of the event. Once these peculiarities in the behavior of the records have been detected, other methodological strategies could be used to confirm or refute the hypotheses. In the case of phase transitions, expressed in the fractal structure of PL, the Chow (1960) test is used to determine if the slopes of the resulting log-log trend lines are statistically significant (Equation 2).

$$CT = \frac{(Sc-(S1+S2))/k}{(S1+S2)/(N1+N2-2k)} \quad (2)$$

Where, *Sc* represents the residual sum of squares of the original series (global series), *S1* is the residual sum of squares of the first group and *S2* the residual sum of squares of the second group. *N1* and *N2* are the number of observations in each group and *k* is the total number of parameters. In this case, this test allows detecting any structural change, that is, a significant change in the records that causes the model coefficients to cease to be constant.

Another interesting aspect is the evaluation and analysis of atypical records that may act as attractors or the possibility that these atypical behaviors may have a negative effect on their evolution. Likewise, the conditions in which the result was achieved (wind assistance, height, etc.) or other causal variables that could result in atypical records (doping, measurement errors, etc.) will be evaluated. In this way, its characteristics can be observed and how they influence the evolution of the event can be established. One of the strategies to apply is the use of metaphors commonly used in complex problems. The first task is to establish if outliers or outstanding values respond to what is known as the Dragon King (DK) phenomenon or, more interestingly, to see if their presence provokes response mechanisms (Black Swans (BS)) that try to counteract them or reconfigure the content and the evolution of the classifications. The concept of DK responds to a popular metaphor that explains how a singular and atypical event, when compared to all other events linked to the system, places it on a level that is clearly different from the rest. If, as a consequence of a DK, a SB develops to dispute its preferential position, this inevitably alters the initial conditions of the series and causes a new functional and structural situation. The BS theory is a metaphor for the confrontation with unexpected events and, in the case of this study, seeks to cushion or eliminate the dominant position of an atypical athlete with respect to the other components of his ranking.

Behaviors of this nature are fundamental in the evolution of sports brands or registries. Athletes behave habitually, as different species do in nature, in a process that has been modeled on several occasions by different researchers: the Lotka-Volterra Predator-Prey Model or as Van Valen explains in the behavior of Alicia and the Red Queen in the Red Queen Hypothesis. It is necessary to point out, as will be seen with the U20 Women's Ranking, interactions present some drawbacks in this model. One is the Paradox of Enrichment, where it is proposed that the improvement of the system could be the result of an anomalous imbalance whereby one of the elements artificially breaks, or disproportionately, the natural evolution of the records (see U20 Women's Ranking).

Statistical analysis

To complete the analysis, some basic statistical tools were used to compare the different groups of athletes studied. On all occasions, after the normality test (Kolmogórov-Smirnov), non-parametric tests were used to compare means. Wilcoxon's T test was applied when comparing runners from the same group (U20 or Senior) in their different categories (men and women). The Mann-Whitney U test was used when it was necessary to evaluate different groups of runners (Under 20 male category of 2003 and 2018 or Under 20 vs. absolute groups). A value of $p < 0.05$ was taken as the limit of significance in all statistical tests. In the comparison of means, the Effect Size (ES) *d of* was also calculated. The value was considered trivial (ES: <0.20), small (ES: 0.21-0.60), moderate (ES: 0.61-1.20), large (ES: 1.21-2.00), or very large (ES: 2.0-4.00). The MATLAB numerical calculation system (MatLab v6.5, Mathwork, USA) was used for these analyses, and the Origin Pro 8 program was used to create the figures.

RESULTS

In the absolute male category, 1,000 athletes from 102 countries are included, with times between 9.58 and 10.22 seconds (ranking closed on 12/31/2018). Among the runners in the female category, 1,031 athletes from 87 countries were considered, with times between 10.49 and 11.37 seconds. Although there are many countries represented in both rankings, only a few are highly represented: USA (Men: 344; Women: 316), Jamaica (Men: 83; Women: 69); Great Britain (Men: 48; Women: 43), Nigeria (Men: 36; Women: 29), Canada (Men: 34; Women: 27) and France (Men: 28; Women: 36).

Among men three levels of runners are detected: those who could be considered elite sprinters, with times of <9.86 sec. (n = 16 athletes, y = 0.982* X0.0099, $R^2 = 0.98$), high-level sprinters, with times between 9.86 and 9.98 sec. (n = 104 athletes, y = 0.985* X0.0067; $R^2 = 0.99$; CT = 0.000), and international level runners, with times between 9.99 and 10.22 sec. (n = 880 athletes; y = 0.975* X0.0115; R2 = 0.99; CT = 0.000). In this case, the PL show solid and well-constituted levels.

In the Top-1,000 of the female senior category, a trend similar to that described above is observed. A group that is also called elite runners with times <10.80 sec. (n = 20; y = 1.025 * X0.0061; $R^2 = 0.96$), another of high-level sprinters with times between 10.80 and 10.88 sec. (n = 24; y = 1.0238 * X0.0074; $R^2 = 0.96$; CT = 0.000), and also international level runners with times between 10.89 and 11.37 sec. (n = 986, y = 1.0116 * X0.0146, $R^2 = 0.99$, CT = 0.000).

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In the case of the male sub-20 athletes, athletes who had reached a time of less than 10.29 s (100 runners) before January 1, 2004 were analyzed. From these data, two groups of runners with levels of clearly differentiated performance: those who can be considered elite runners for that category, with times of <10.11 s (n = 13; y = 1.0011 * X0.0028; R^2 = 0.92), and runners high-level with times between 10.11 and 10.29 s (n = 87; y = 0.9956 * X0 .0082; R^2 = 0.98; CT = 0.000) (Figure 3).

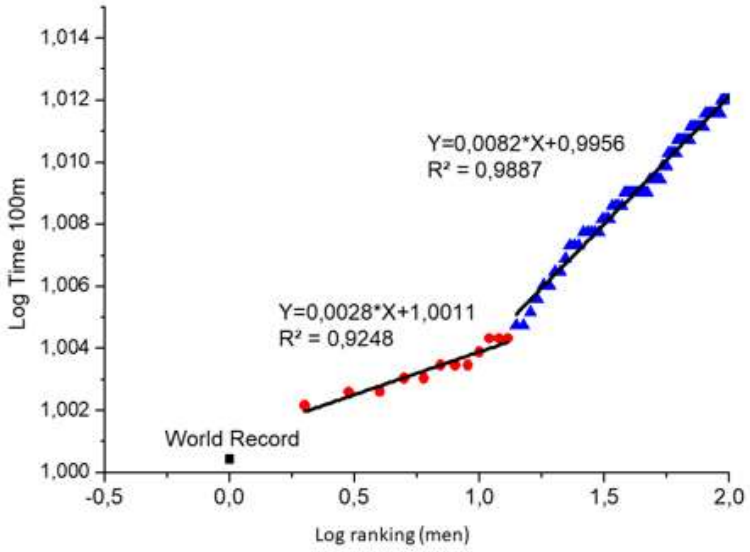

Fig. 3. - Log-Log Plot of the 100 best runners of all time in the male category U20
Note the presence of an outlier (world record) and two groups of different performance levels (Elite: lower left, High Level: upper right). Each group includes its components and the trend line that fits the times

Therefore, the 100 best of all time in the U20 category are evaluated fifteen years later (12/31/2018). While at the end of the 2003 season there were only two runners with times equal to or less than 10.05, three decades later there were already 12 athletes with those times and the world record for the category had dropped to 9.97 s (Figure 4).

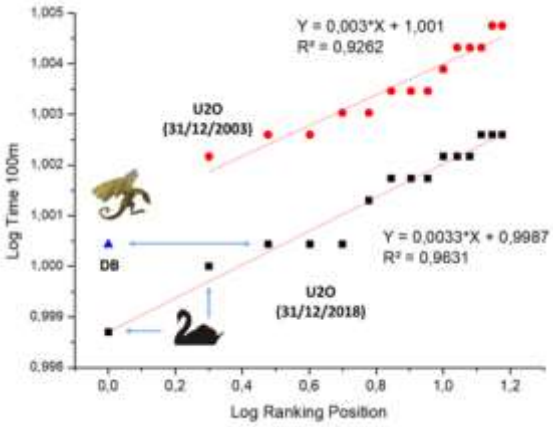

Fig. 4. - Example of Black Swans, Power Laws (PL) and Dragon King applied to the analysis of the evolutionary process of sprinting (100 meters) in the male category

U20 Note: The top shows the PL of elite U-20 runners through the end of the 2003 season (log-log) and the bottom shows elite sprinters through the end of the 2018 season (log-log). Also shown is the runner who has been considered the Dragon King and two of the Black Swans.

Unpredictable results are verified when U-20 runners are analyzed until the 2003 season. Many of these runners fail to evolve positively during the rest of their sports career (Figure 5). It should be noted that, of the top 100, only 51 runners managed to improve their best times (10.18 ±0.07 vs 10.01 ±0.12 sec, 1.8 ±1.2 %, $p < 0.001$, ES = 1.82) in later seasons. It took them an average of about five years to achieve their personal best (18.70 ± 0.80 years vs. 23.60 ± 3.30 years).

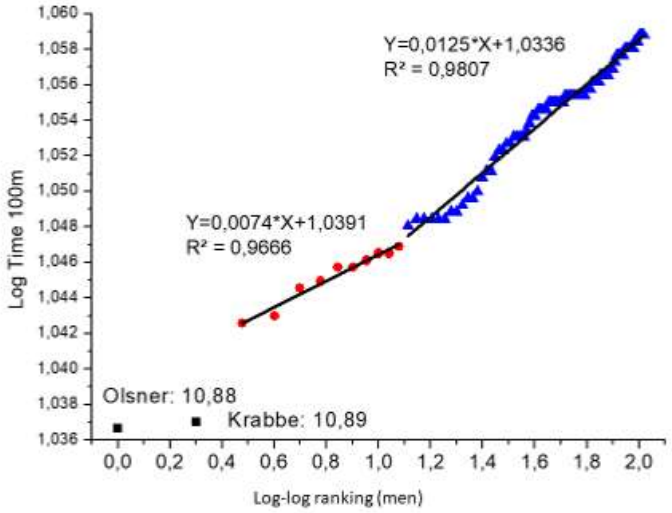

Fig. 5. - Log-Log plot of the 100 best female runners of all time in the U20 category

Note the presence of two outliers (Marlies Oelsner and Katrin Krabbe) and two groups of different achievement levels (Elite: lower left, High level: upper right). Each group includes its components and the trend line that fits the times

The other runners are organized into two groups of different performance levels (Figure 5). On the one hand, elite runners (n = 12, Times <11.15 sec, Y = 0.0074 * X + 1.0391, $R^2 = 0.97$), and on the other hand, high-level sprinters (n = 88; Time between 11.15 to 11.46 sec.; = 0.0125 * X + 1.0336; $R^2 = 0.98$). Once again, like the U-20 male runners, many of these athletes did not manage to evolve adequately in their sports career. Only 52 of them (50 %) improved their best times (Improvement: 2.5 %, 11.12 ±0.12 sec. vs. 10.84 ±0.17 sec., $p < 0.000$, ES = 3.11) and only six of them belong to the group considered as elite runners. If these athletes are compared with the absolute best athletes of all time when they were in the U20 category (47 runners available), it can be seen that the improvements are greater, although not all of them achieved records at an early age (Improvement: 4.9 %; 11.37 vs. 10.91 sec). However, this better evolution of the brands does not show differences with respect to the best of all times of the U20 (Improvements of 2.5% and 4.9%, $p = 0.089$).

DISCUSSION

In light of the data, it can be pointed out that, although it is important for athletes to start their training and specialization from an early age, an athlete does not necessarily have to stand out in the first years of their sports life, nor should they consider success premature as a goal to be achieved. In addition, everything seems to indicate that, too often, achieving high performance in sport at an early age could be a negative factor in the future evolution of the athlete. This is in line with what many authors propose (Malina, 2009; Cobley, *et al.,* 2009; Till and Baker, 2020; Güllich *et al.,* 2021). These studies suggest that an early start, hyper-specialized training, a high volume of training or frequent participation in very demanding competitions during adolescence, or the first years of specialization, are not necessarily a guarantee of success in elite sport. international when the athlete reaches adulthood.

In this work it has tried to demonstrate the effects of the aforementioned approach to select and train young athletes through the analysis of the 100-meter race in male and female athletics. Upon evaluation, it has been found that a strategy of this nature can be highly frustrating and misleading. This study has found that practically half of the athletes who achieve success in the U20 category drop out, or fail to improve their results, at later stages of their sports career. Even those who continue to practice this athletic modality mostly evolve only moderately in their records, even if their sports career is relatively long. Entering the sports elite at a very young age should not be an element of interference in their future evolution, which is why it is currently happening that success at these ages does not meet the natural evolutionary criteria that must always be respected.

The best score achieved by the Trinidadian Darrel Brown and the subsequent evolution of the event can help to understand how these runners exhibit a level of performance that results from an inadequate evolutionary process. In August 2003 in Paris, this athlete achieved an unusual record for that period (10.01 seconds, wind: 0.0 m /s). In this case, there were no anomalous circumstances that could cast doubt on the validity of the race. Therefore, it is believed that it is an outlier, that is, a disproportionate record of what could be expected among runners of these ages, whose presence could trigger a significant transformation of the competitive environment of the category (Sornette, 2009). In these types of events, the presence of a DK often provokes the appearance of rivals who quickly try to emulate and even surpass him, which could be considered a BS phenomenon.

The reasons behind the high number of dropouts of very promising athletes, if not failures, are currently unknown and certainly multidisciplinary. A study with Norwegian athletes indicated that recurrent injuries, stagnant performance, educational demands and lack of motivation might be the reasons that are often the most important. The influence of social factors, participation in other sports, work or military obligations, marriage and family were also important reasons why some of these athletes left the sport (Enoksen, 2011). Similar aspects are highlighted by Moesch (2012), when evaluating the premature abandonment of Danish elite athletes. Some authors attribute their success, or failure, to the potential abilities with which they began their sports career, that is, to the expression of their genetic potential, rather than being subjected to specialized training and excessively pushed from an early age (Kaleth and Mikesky, 2010). This basically means that you are born a champion, and there is little you can do if you don't have certain abilities from the start.

In consideration, one of the possible limitations of the work can be found in the age established as the limit for the formative stage. A priori, everything indicates that the percentage of athletes who would not reach the highest level in their adult years should be higher, but that is just speculation. However, the absence of rigorously crafted classifications makes it extremely difficult to test. One way to check the hypothesis examined in the study would be to analyze other sporting events with different characteristics (ie, middle- and long-distance running, jumps or throws).

CONCLUSIONS

In the light of this analysis, the high dropout rate of young elites can be verified, with scientific criteria, through methodological strategies that are widely used in the analysis of complex systems. Based on the data obtained, it is suggested that an excessive investment in human and material resources to identify and detect people with great sporting potential from an early age, and especially the search for the youth champion, is possibly a strategic mistake that should be considered. You must meditate and make alternative or improved proposals that do not cause such high dropouts and frustrated sports careers.

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Lázaro de la Paz Arencibia: Literature search and review, general advice on the subject matter, translation of terms or information obtained.

María José Martínez Patiño: Search and review of literature, preparation of instruments, application of instruments, compilation of information resulting from the instruments applied, preparation of tables, graphs and images, preparation of database.