

Review

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METHODOLOGICAL PRINCIPLES OF SELECTION IN SPORTS

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Abstract: The selection process in sport includes the most diverse characteristics and dimensions for assessment and evaluation. Only by adequately combining genetic, physical, morphological-functional, psychological, pedagogical and sociological dimensions, the conditions necessary to define selection as a multidisciplinary science, which can provide prerequisites for achieving the set goals are gained. If we look at selection as a limiting factor that connects a certain sport with biological sciences on the one hand, and with the humanities on the other, creating a unique professional-scientific principle within such differentiated sciences, it carries enormous difficulties. That's reason why theoretical and professional - research and practical work in selection is exposed to great risks, which require overcoming problems that constantly arise during work. Therefore, it is necessary to minimize all the demarcations that exist in different fields, while increasing the cohesiveness between the principles that operate within the framework of different scientific disciplines. The end result of this approach should be the synthesis of different knowledge and their transfer into one general, comprehensive framework. In this paper will be presented the methodological principles of selection in sports from the perspective of: models and model characteristics, tests as selection monitor instruments, prognosticate and evaluation of physical abilities testing results, growth and the process of maturing, psychosocial characteristics with special reference to genetic basis of physical abilities and morphological characteristics.

Keywords: selection, models, prognosticate, genetic, morphological characteristics physical abilities

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Introduction

Selection in the function of achieving top sports results implies the cohesion of competitive potential and a stable sports personality. The problem of selection is a current topic that is at the top of the priority list in all development projects in the field of sports and on which the production of "qualified" sports personnel largely depends (Ivanović and Gajević, 2024). Sports performance in a large number of sports disciplines depends on a variety of individual characteristics, including body size and composition, physical and cognitive abilities, technical and tactical skills, as well as psychological characteristics (Ribeiro et al., 2019). Identifying young people who represent the best combination of these qualities and selecting those with great potential to become future top athletes is a constant challenge for researchers and coaches (Brown, 2001; Ribeiro et al., 2019). Scientific evidence has shown that sports talent can be identified (Issurin, 2017; Ribeiro et al., 2019), and that top performance depends on a combination of genetics, training process and environmental factors (Brown, 2001; Ribeiro et al., 2019). Precisely because of this, this paper will briefly present the basic methodological principles of selection in sports from the perspective of: models and model characteristics, tests as selection monitor instruments, prognosticate and evaluation of physical abilities testing results, growth and the process of maturing, psycho-social characteristics with special reference to genetic basis of physical abilities and morphological characteristics.

Models and model characteristics

In the initial stages of the selection process, the most important thing is to find answers to those questions that are common to both the methodology of research work and the methodology of practical work. To determine an adequate model is the first problem that every coach faces. Designing and using a database of model characteristics of top athletes, i.e. indicators of their abilities, traits and knowledge, is the basis of successful management of the training process in the second phase. These data are obtained on the basis of monitoring and quantitative evaluation of the success of top athletes and monitoring the development of sports results in certain stages of long-term sports preparation. By applying appropriate diagnostic procedures, it is possible to determine what qualities characterize top athletes who achieve the highest sports results in a specific sport, as well as what should distinguish athletes who have yet to achieve top sports results (Ivanović, 2014; Ivanović, 2020). On the basis of analyses, the short-term and operational structure of the athletes' preparations is determined, directing the training work mostly to those dimensions in which the athlete lags the most behind the parameters of the model. Given that selection is an integral part of the training process, the

model could be presented as a kind of "measure" that determines the basic and initial task in identifying talents, or in "rougher" terms - the selection of high-ranked athletes, that is, the elimination of low-ranked athletes. With one very important note... that elimination by no means implies any negative connotations related to the athlete's aspiration to play a certain sport, and even less his thwarting of those aspirations through playing another sport or form of physical activity.

Tests as tools of selection in order to monitor, prognosticate and evaluate the results

Although coaches in accordance with their profession may instinctively focus on assessing and monitoring the level of physical abilities, for a holistic approach in youth development, it is imperative to consider psycho-social characteristics as well (Abbott et al., 2002; Lloyd et al., 2016). If measured correctly, these elements can provide coaches with relevant information about the abilities of young prospects. In the case of competitive sports, the essential tasks of long-term development of athletes are constant searches (experiments) with more and more effective training means, methods and loads that will be included in each stage, i.e. transitive state. Among other things, this is not possible without systematic and specific diagnostics (testing), control and monitoring during the entire sports career, as well as in all smaller periods and cycles. Collecting and processing information on the basis of which decisions are made is one of the most important aspects of a coach's work. The basic information on which decisions of special importance for the management of the training process are based are information on all indicators and factors on which the competitive result depends and with which the coach will have an insight into the state of preparedness of his athletes. At the same time, with an individual approach, the coach evaluates the morphological characteristics of the athlete, his physical abilities, and does not neglect the psychological and psychosocial features of the personality. It is obvious that the coach includes himself in his role as a pedagogue, doctor, psychologist... and that when approaching the selection, he puts himself in the position of a researcher who is obliged to evaluate his results at different stages of the training process, to determine in a timely manner complex cause-and-effect relationships and to optimally adapt not only to expected, but also to unexpected situations.

The question is often raised whether these tests will be effective enough to help coaches make the right decisions regarding the future success of their talented potential athletes. The importance and effectiveness of selection depends on the coach's ability to accurately assess the course, development and definitive level of the athlete's ability at some future point in time. As it is not at all an easy and simple task, it is not

surprising that in this process it is necessary for the trainer to exclude any arbitrary assessment and in making decisions use information based on scientifically proven facts. Therefore, it is fully justified that forecasting is defined as a professional-scientific-methodological principle that strives for the most accurate and reliable assessment of individual elements of the selection, as well as the selection as a whole. For the purpose of practical application, selection can be viewed as a function of two groups of traits, those that cannot or cannot be significantly influenced, and traits that can be significantly influenced. In this light, the coach has the obligation to predict as accurately as possible the development and definitive characteristics of the traits from the first group and to prognosticate the development of traits from the second group, with continuous improvement and development of those traits under the influence of the programmed training process. When working with younger age groups, it is necessary to include one more criterion in the process of assessing abilities and prognosticate development. Prognosticate needs to be based on an adequate assessment of the growth of juvenile traits, traits and abilities that have not yet established a full and true measure in relation to the growth and development of a young organism. In addition to all this, in order for prognosticate to be successful, it is necessary for the coach to have information about the standard values of the average values of characteristics and abilities that are typical for the appropriate age and a certain sport branch. Deviations from average values classify young athletes as accelerants, those who show extremely fast development of morphological - motoric - functional abilities in relation to their age, and retardants, those who lag behind average values in terms of the level of development of these abilities. In other words, it is necessary for the trainer to reconcile chronological age with biological age in the estimating process. Based on all of the above, it can be concluded that the selection has its full meaning only when it is not based only on the assessment of current characteristics and abilities, but observes and evaluates them in conjunction with estimating the growth that should be brought by the training process. In this way, long-term and continuous development work enables, among other things: 1) monitoring of growth in terms of general psychophysical abilities, 2) progress in terms of specific abilities related to the requirements of a certain sport, as well as 3) assessment of the psychological profile of a young athlete and its harmony with specifics chosen sport.

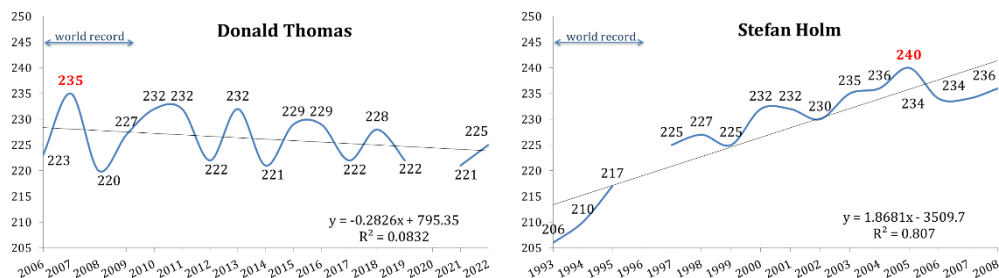
Genetic basis of physical abilities and morphological characteristics

The problem of determining the relative share of genotypic variance in the total variability of anthropological characteristics has not yet been unified. In general, the rule applies that the greater the genotypic part of the variance of that dimension, the smaller the influence on a dimension, and vice versa, the greater the exogenous influence,

the smaller the genotypic variance (Bjelica and Fratrić, 2011). And how much genetics actually influence the achievement of top results in sports and how much talent in sports or any other field is actually innate is a question that is increasingly intriguing to a large number of scientists. Therefore, there are more and more genetic studies that try to reach results that would predict the future potential of an athlete. At the moment, there is practically no sure answer to this question, so it can be said that there are as many arguments in favor of this thesis as there are arguments against it. If we only start from Eriksson's theory that 10,000 hours of dedicated and adequate practice are necessary to achieve "mastery in sports" (Ericsson et al., 1993), in the available literature we would come across numerous supporters but also numerous opponents "decisive influence" of the long-term directed training process on the one hand, and talent and genetic inheritance on the other hand. A frequently used example in the available literature for the discussion of supporters of one and the other thesis is the development paths to the top sports results of two high jumpers, Stefan Holm and Donald Thomas (Ivanović and Gajević, 2024). In those thesis Holm is often presented as a "product" of hard work and decades of dedication and discipline over a period of 20 year until the World Championship in Osaka, where he was fourth at the end of his career, and Thomas, who with a year of "more serious work" became the best on the planet in the same competition, presenting them as models of the "10,000 hours" and "pure talent" theories. In order to be able to discuss this issue at all... at the beginning, a few words about both competitors. Holm is a retired Swedish high jumper, 181 cm tall. His personal records are 2.37 m (outdoor, 2008) and 2.40 m (indoor, 2005). At the age of eight, inspired by watching the jumping legend Patrik Sjöberg on television, he stops training football and starts high jumping. Holm's big breakthrough on the world athletics scene came at the age of 24 (after 16 years of high jumping, more than half of his life) in 2000, when he placed fourth at the Sydney Olympics with a jump of 2.32m. He won the gold medal in 2004 at the Summer Olympics in Athens. Holm jumps 2 meters or more in as many as six different techniques. With a height of only 1.81 m, he shares the unofficial world record for the jump over his own height (59 cm) with the American jumper of the 1970s, Franklin Jacobs. He himself often said in interviews that he is too short to jump high. Holm finished fourth at the 2008 Summer Olympics in Beijing with a jump of 2.32m. In the same year, Holm ended his 20-year career with second place at the World Athletics Final in Stuttgart. On the other hand, we have the Bahamian high jumper Thomas, who started high jumping, we can say accidentally, at the age of 22, as a student at Lindenwood University in Miami, where he played basketball. Because of his enormously vertical jump, an athletic trainer invited him to try a track and field event high jump once. The jump was over 2m, which diverted him to start systematically training this athletic discipline. At the first significant competition at the 18th Commonwealth Games in Melbourne in 2006, he won fourth place with a jump of 2.23m, and the following year at the World Championships in Osaka he

became the world champion with a jump of 2.35m, which is also his personal record. By all accounts, Holm's biggest limitations or "flaws" are actually Thomas' biggest strengths and vice versa. Body height, hamstring length, and vertical jump height most likely contributed significantly to Thomas' great high jump results. On the other hand, Holm's ideal technique compensated for obvious deficiencies in the field of mainly physical predispositions and influenced the achievement of top results. In addition, during of a 15-year competitive career, the trend of the growth of achieved results (highest jump height in a calendar year) at major international competitions is completely different for these two competitors (Graph 1). Holm jumped 206 cm as a junior European champion (at 17 years of age, 9 years of sports experience in the high jump, in 1993) and only 11 years later he achieved a personal record by jumping 240 cm or 34 cm more. Throughout Holm's entire career, a significant positive increase in jump heights can be seen at the level of 80.70% probability, including the "career decline", i.e. the last 3 competitive years when a significant drop in results was noticeable. Unlike Holm, Thomas jumped 223 cm in one of the first official major competitions (in 2006, at the age of 22), and less than a year after that, he managed to improve his result by 12 cm and jump 235 cm, which is his best result ever. After that there is a stagnation and a decline in the results of this competitor with a positive increase at the level of only 8.32% probability (Graph 1).

Graph 1. *The best results at major international competitions of Holm and Thomas (Ivanović and Gajević, 2024)*



Based on everything previously stated about the development paths of these two top competitors, instead of drawing conclusions about the "decisive influence" on the one hand of a long-term directed training process, and of talent and genetic inheritance on the other hand, it may be more expedient to ask the following questions (Ivanović and Gajević, 2024): 1) Didn't both high jumpers have more than 10,000 hours of dedicated practice before achieving top results? (Holm exclusively in high jump, Thomas in basketball and high jump); 2) Do all people progress equally quickly under the influence of a specialized training process?; 3) Is the long-term training process in basketball or the short-term training process in athletics primarily responsible for the top result in the high jump of Thomas? (judging on the basis of the facts presented above about the

height of the vertical jump and the unconventional technique in the high jump)?; 4) Could Thomas' top result be more "valuable" if he had stayed in basketball?; 5) Could the top result of Thomas be more "valuable" if he had learned the high jump technique in earlier age categories? Or maybe it's better to ask the question: How much more valuable would Thomas' results have been if his high jump talent had been recognized in the youngest age categories?; 6) Following on from the previous question, could the "quickly" reached plateau in the maximum jump height of Thomas be avoided?; 7) Is a plateau in advancement possible despite the continuous training process?; 8) Are sports potential and talent stable innate qualities or are they constantly transformed during maturation?; 9) What would Holm's result ranges be if he was not one of the lowest top high jumpers in the world, that is, that genetics did not "get involved"?; 10) To what extent does the stimulating environment (support, encouragement, opportunities) influence the achievement of top results?; 11) If Holm was not one of the shortest top high jumpers and if Thomas had started playing athletics instead of basketball, would Javier Sotomayor of 2.45m from 1993 still hold the world record? ...

And what is actually known so far about the role of genetic markers in sports from the available literature? Sports genomics, a relatively young scientific discipline, began to develop rapidly after the discovery of the first genetic marker associated with sports performance - a polymorphism in the angiotensin converting enzyme (ACE) gene (Glišić et al., 2016). To date, over 200 genetic markers associated with physical activity have been identified (Bray et al., 2009). Research results show that in relation to different types of sports activities (endurance sports vs. strength sports), the genetic profiles that can influence the achievement of top sports results also differ (Eynon et al., 2011). Out of at least 120 genetic markers that are considered to be able to influence top performance in sports, 77 are associated with success in endurance sports, and 43 with success in strength sports (Glišić et al., 2016). However, a positive correlation with sports performance was determined for only 9% of genetic markers in a small number of studies (Glišić et al., 2016). As top sports achievement is influenced by numerous factors and is not a simple sum of all determinants, a large number of studies point to the polygenetic structure of different abilities, so the latest research is increasingly exploring predictive algorithms through genotype results. Using bioinformatic approaches to identify the individual and combined contribution of a group of genetic variants to elite athletic status, Williams and Folland (2008) determined the likelihood of people with a theoretically "optimal" polygenic profile for endurance sports (Williams & Folland, 2008). They quantified the "optimal" profiles using the "genotype score" (ranging from 0 to 100, with "0" being the worst genotype combination and "100" the best genotype combination), a simple algorithm that results from the best accumulation of a combination of 23 possible polymorphisms that explain individual variation in endurance performance. They predicted that the probability of a Caucasian

individual on the planet with a "perfect" genotype score was extremely low (0.0005%), indicating that for example in the United Kingdom (UK population ~60 million) there would be approximately three such individuals. Using a similar model, but limited to seven well-studied polymorphisms associated with endurance capacity in Caucasians, Ruiz et al (2009) determined the genotype score of 46 world-class Spanish male elite athletes who were either Olympic finalists (in events from 5,000 m to marathon) or "Tour de France" finalists. The results of this research showed that the genotype score of the group of elite endurance athletes was significantly higher than for the general Spanish population (70.2 ± 15.6 vs. 60.8 ± 12.1), which indicates an overall more "favorable" polygenic profile in elite athletes. However, none of the elite world-class athletes in the study had an optimal genotype score (that is, score = 100), and only the top three Spanish endurance athletes (who were also among the best in the world) had the best possible score of up to six polymorphisms (genotype score ~ 93). More interestingly, the top three finishers in the Tour de France had only three genotypes associated with endurance, with a genotype score of ~57.

Conclusions

The search for talent and the ability to evaluate young perspective athletes most often involves the measurement, analysis and evaluation of physical abilities and motor skills. Considering the multiple developmental stages of athletes, when using tests to assess physical ability, it is necessary for coaches to take into account that human action is based on the dynamic interrelationships of the individual, the task being performed and the environment in which that specific task is performed (Lidor et al., 2009). Although the results of the research established the connection between several genes with elite sports performance, these relations are not strong enough to be predictive. Therefore a large number of authors believe that the use of genetic testing for the purpose of recommendations for individualized training and especially in the identification and selection of talents is not just premature (Guth & Roth, 2013), but also not scientifically justified (Glišić et al., 2016; Williams & Wackerhage, 2009). The material collected over decades and the results of scientific research confirm that the hereditary background is decisive for the appearance and development of some physical abilities, for some it is significant, for others it is of no greater importance. It is obvious that genetic factors affect the motor skills, physiological and psychological profile of an athlete, while environmental factors - training process, upbringing, climate factors, diet, stimulating optimal environment... have a huge importance (Paranosić and Savić, 1977; Eynon et al., 2011). However, it would be quite wrong if we tried to schematize hereditary principles when evaluating or prognosticating some of the physical abilities. Training is the main factor in establishing optimal opportunities to perfect a certain

trait to the maximum limits that the genetic background has framed or even limited. It can be concluded that the abilities and traits that are essential for achieving top sports results are determined by genetic factors, environmental factors and their interaction.

Author Contributions

Conceptualization, J.I.; A.G. **Resources**, A.G.; **Methodology**, J.I.; A.G. **Investigation**, J.I.; A.G. **Data curation**, J.I.; **Formal Analysis**, J.I.; A.G. **Writing – original draft**, J.I.; A.G.; **Writing – review & editing**, J.I.

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