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Anthropometric parameters of elite male runners sprint: are body height and body weight good predictors of results

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Abstract

Purpose. Athletic sprint runs are cyclical movements of maximum intensity. Speed, reaction time, agility and explosiveness are of special importance in sprinters. The main goal of the research is to determine the influence of Body height (BH) and Body weight (BW) with the best achieved results of in sprint disciplines (60m,100m,200m).
Material and methods. In study included 40 competitors, top male sprinters (BH=180,45±6,88cm; BW=78,83±7,69kg). Their achieved best results in sprint disciplines were analyzed (60m, 100m, 200m). Pearson correlation coefficient was used to determine the relationship between body height and body weight and the results of sprint disciplines. Also a univariate model of regression analysis was applied and the relevant coefficients were calculated. The level of acceptance of statistical significance was set to $p<0.05$.
Results. The simple regression analysis did not show a statistically significant influence of body height and body weight on the result of sprint running. Low correlations (BH vs. 100m = -0.306), (BW vs. 100m = -0.226) and (BH vs. 200m = -0.221) and insignificant correlations with an inverse relationship between results and anthropometric measures are mainly evident.
Conclusion. Body height and body weight did not have a statistically significant effect on the results of the 60m sprint, while their influence is evident in the 100m, and especially in the 200m (but without statistical significance). This influence on the result of running 100 and 200m is a consequence of the exceptional motor-functional abilities of the sprinter to show greater force in the last phase of the rebound. Otherwise in the sprint, the rear rebound phase is much more important than the front rebound phase. A long step with the body weight (muscle) of the sprinter produces a higher rebound force, which with a big frequency of steps and good tecnique guarantees a good result.
Key words: body height, body weight, influence, elite sprinters, short distances

Анотація

Ратко Павлович, Ілона Михайлович, Нікола Радулович, Сініша Ніколіч. Антропометричні параметри елітних спринтерів: довжина і маса тіла є інформаивними показниками прогнозу результатів

Мета. Легкоатлетичний спринтерський біг - це циклічні рухи максимальної інтенсивності. Особливе значення для спринтерів мають швидкість, час реакції, спритність і вибуховість. Основною метою дослідження є визначення впливу зросту тіла (РТ) та маси тіла (МТ) на найкращі досягнуті результати у спринтерських дисциплінах (60м,100м,200м).

Матеріал і методи. У дослідження було включено 40 спортсменів, найкращих чоловіків-спринтерів (ЧД=180,45±6,88см; МВ=78,83±7,69кг). Проаналізовано їхні найкращі результати у спринтерських дисциплінах (60м, 100м, 200м). Коефіцієнт кореляції Пірсона використовувався для визначення зв'язку між ростом і масою тіла та результатами спринтерських дисциплін. Також було застосовано одновимірну модель регресійного аналізу та розраховано відповідні коефіцієнти. Рівень прийняття статистичної значущості був встановлений на p<0,05.

Результати. Простий регресійний аналіз не показав статистично значущого впливу росту та маси тіла на результат спринтерського бігу. Низькі кореляції (ЧД проти 100 м = -0,306), (ЧД проти 100 м = -0,226) і (ЧД проти 200 м = -0,221) і незначні кореляції з оберненим зв'язком між результатами та антропометричними показниками в основному очевидні.

Висновок. Зріст і маса тіла не мали статистично значущого впливу на результати спринту на 60 м, тоді як їхній вплив очевидний на 100 м, і особливо на 200 м (але без статистичної значущості). Такий вплив на результат бігу на 100 і 200 м є наслідком виняткових моторно-функціональних можливостей спринтера проявляти більшу силу в останній фазі відскоку. В іншому випадку в спринті фаза відскоку ззаду набагато важливіша, ніж фаза відскоку спереду. Довгий крок з вагою тіла (м'язами) спринтера створює більшу силу відскоку, що при великій частоті кроків і хорошій техніці гарантує хороший результат.

Ключові слова: зріст, маса тіла, вплив, елітні спринтери, короткі дистанції

Аннатоция

Ратко Павлович, Илона Михайлович, Никола Радулович, Синиша Николич. Антропометрические параметры элитных бегунов-мужчин в спринте: рост и масса тела являются информативными показателями прогноза результатов

Цель. Атлетический спринтерский бег представляет собой циклические движения максимальной интенсивности. Скорость, время реакции, ловкость и взрывная сила имеют особое значение для спринтеров. Основной целью исследования является определение влияния роста (ВТ) и массы тела (МТ) на лучшие результаты в спринтерских дисциплинах (60 м, 100 м, 200 м).

Материалы и методы. В исследование были включены 40 спортсменов, лучших спринтеров-мужчин (ВН=180,45±6,88см; ВТ=78,83±7,69кг). Проанализированы достигнутые ими лучшие результаты в спринтерских дисциплинах (60 м, 100 м, 200 м). Для определения связи между ростом и массой тела и результатами спринтерских дисциплин использовали коэффициент корреляции Пирсона. Также была применена одномерная модель регрессионного анализа и рассчитаны соответствующие коэффициенты. Уровень приемлемости статистической значимости был установлен на уровне p<0,05.

Результаты. Простой регрессионный анализ не показал статистически значимого влияния роста и массы тела на результат спринтерского бега. В основном очевидны низкие корреляции (ЧД против 100 м = -0,306), (ЧД против 100 м = -0,226) и (ЧД против 200 м = -0,221) и незначительные корреляции с обратной зависимостью между результатами и антропометрическими показателями.

Вывод. Рост и масса тела не оказали статистически значимого влияния на результаты спринта на 60 м, в то время как их влияние очевидно на 100 м и особенно на 200 м (но без статистической значимости). Такое влияние на результат бега на 100 и 200 м является следствием исключительных двигательно-функциональных способностей спринтера проявлять большую силу в последней фазе отскока. В противном случае в спринте фаза отскока сзади намного важнее, чем фаза отскока спереди. Длинный шаг с весом тела (мышцы) спринтера дает более высокую силу отскока, что при большой частоте шагов и хорошей технике гарантирует хороший результат.

Ключевые слова: рост, масса тела, влияние, элитные спринтеры, короткие дистанции

Introduction

Athletic sprint runs are cyclical movements of maximum intensity in which the success criteria are the reaction time, frequency and stride length [1]. These sprint disciplines are the best example of an lactate anaerobic mechanism where energy is provided by creatine phosphate resynthesis and releases a large amount of energy that allows muscle work. Speed, reaction time, agility and explosiveness, as factors of speed-explosive properties are of special importance in sprinters because they are an important condition for fast performance of several simple and complex movements and reaction speed in the training process and competitions. In this regard, points out that the function of improving speed-explosive properties is important not only for the development of anthropological characteristics, but also for increasing the intensity of muscle work in a specific regime of motor activity of athletes to adapt to specialized functional structures of situational ability present in individual sports [2].

Sprint running is characterized by maximum intensity (over 11m/s) and activity duration of 6.5sec. up to 23 sec. The achieved result depends on the speed of physiological parameters such as neuromuscular reaction and inter and intarmuscular coordination. The final result of running the whole track depends on the reaction speed at the start (latent time), starting acceleration (quickly reaching the appropriate speed), speed endurance (ability to maintain the same speed until the end of the track). As the main parameters that decide in the result performance, most authors state latent time (depends on neuromuscular activity), running speed (on the section), stride length and stride frequency [3].

Research conducted by some authors [4-7] agrees that the result in the sprint depends on the position in the starting block, i.e. positions of the center of gravity of the body, the time of the initial reaction and the initial acceleration. According to Pavlović [8], the optimal coherence between the start of the sprint and the starting acceleration are specific motor problems that the athlete must integrate in terms of temporal and spatial parameters into a unipolar movement of a cyclic character.

Initial acceleration is a complex cyclic movement defined by the progression of the frequency and length of the steps, the duration of the contact and flight phases, the position of the center of gravity at the moment of contact with the ground, propulsion in the flight phase and the forces overcome in the first step [9]. All these parameters are conditioned by the functioning of the CNS, motor abilities, energy processes, morphological characteristics and muscle structure [10-13] and have been widely examined in the literature in different populations and different contexts [14-18].

Acceleration speed or acceleration phase is the first phase of effective running, when the sprinter from the resting phase comes in the phase of maximum running speed in the shortest possible time. Its motor equivalent is the speed power of sports, which at the level of muscles corresponds to the force-speed relation. It correlates with fast individual movement, maximum strength and frequency of movement [19]. The importance of starting acceleration is greatest in the shortest races, up to 60m [20], and 100m [21] it decreases proportionally with the extension of the running distance.

Research Pavlović [22] on a sample of World Championship finalists (Edmonton, 2001-Doha, 2019) in the disciplines 100m, 200m, 400m confirmed that the latent time of reaction significantly affected the result in the 100m run in men while in other disciplines the impact was not significant. Martin, & Buonhristiani [23] also deny the influence of reaction time on sprint resulsts. It turns out that the result depends on the length and frequency of the steps, as a consequence of the height and muscle mass of the sprinters and their speed endurance.

It turns out that the result depends on the length and frequency of the steps, as a consequence of the height and active mass of the sprinters and their speed endurance. Top sprinters reach their maximum speed between 50 and 60 meters, and there are some who reach about 70 meters, although there are very few of them. According to Pavlović [24], Usain Bolt achieved a WR of 9.58sec in the 2009 WCh final in Berlin. He reached a maximum speed of 12.35 m / s at 70 meters. At the Olympics games in London in 2012, he achieved 9.63 sec and reached a maximum speed of 12.42 m / s in the 80-meter. As the main parameters that are decisive in the result performance of running at 100m, most authors state latent time (depends on neuromuscular activity), running speed (on the section), stride length and stride frequency. The inverse relationship between frequency and stride length has been confirmed by a number of authors, depending on the body height and active weight of runners [25-28]. The length of the steps depends on the height and weight of the sprinter, and the frequency depends on the speed of neuromuscular regulation, ie the development of the CNS.

A study by Salo, & et al. [29] showed that there is great variation in performance among elite athletes and, in general, reliance on stride frequency or stride length is a very individual phenomenon. Athletes who rely on stride frequency need to keep their nervous system ready for a quick change of legs, and athletes who rely on stride length require more concentration to maintain levels.

This requires excellent physical preparation from the runners, excellent performance technique and the appropriate degree of speed, as well as fast endurance, which is manifested in the last 20 meters from the finish line. The main reason is the speed endurance and mobility of anaerobic mechanisms of runners [30].

In study Paruzel-Dyja, et al., [31] discuss which of the stride parameters (length or frequency) has the greatest impact on 100-m results on a sample of men and women elite sprinters taking part in the 2003 World Championships in Paris. The research revealed that stride frequency decided about the results of the elite female sprinters, while the stride length was the most important stride parameter in male sprinters. Taller male sprinters obtained better 100-m run results. Body mass and body height significantly influenced the stride parameters – the bigger the body mass and height, the longer the strides and the lower stride frequency of the competitors.

The main goal of the research is to determine the influence and possible correlation of Body height (BH) and Body weight (BW) with the best achieved results of in sprint disciplines (60m, 100m, 200m).

Material and Methods

Participants in study

The research included 40 competitors, top male sprinters (Body height=180,45±6,88cm; Body weight=78,83±7,69kg). Their achieved best results in sprint disciplines were analyzed (60m, 100m, 200m). The criteria for inclusion in the study were that the male sprinter was achieved the best personal result in the sprint disciplines (Table 1). The results are taken from the IAAF website http://athletedata.weebly.com/select-event.htm

Table 1

Personal best result

Athlete	60m PB (s)	100m PB (s)	200m PB (s)
Usian Bolt	N/A	9.58	19.19
Tyson Gay	6.55	9.69	19.58
Yohan Blake	6.75	9.69	19.26
Asafa Powell	6.50	9.72	19.90
Justin Gatlin	6.45	9.74	19.86
Nesta Carter	6.52	9.78	20.25
Maurice Greene	6.39	9.79	19.86
Steve Mullings	6.59	9.80	19.98
Donovan Bailey	6.51	9.84	20.42
Bruny Surin	6.45	9.84	20.21
Leroy Burrell	6.48	9.85	20.12
Adekotunbo Olusoji Fasuba	6.49	9.85	20.52
Mike Rodgers	6.48	9.85	20.24
Richard Thompson	6.51	9.85	20.18
Carl Lewis	6.60	9.86	19.75
Frank Fredericks	6.51	9.86	19.68
Ato Boldon	6.49	9.86	19.77
Francis Obikwelu	6.53	9.86	19.84
Keston Bledman	6.62	9.86	20.73
Linford Christie	6.47	9.87	20.09
Obadele Thompson	6.56	9.87	19.97
Shawn Crawford	6.47	9.88	19.79
Walter Dix	6.58	9.88	19.53
Ryan Bailey	6.58	9.88	20.10
Michael Frater	6.62	9.88	20.63
Travis Padgett	6.55	9.89	20.32
Darvis Patton	6.50	9.89	20.03
Ngonidzashe Makusha	6.60	9.89	21.57
Nickel Ashmeade	6.62	9.90	19.85
Dennis Mitchell	6.53	9.91	20.09
Leonard Scott	6.46	9.91	20.34
Derrick Atkins	6.70	9.91	20.35
Daniel Bailey	6.54	9.91	20.51
Churandy Martina	6.58	9.91	19.85
James Dasaolu	6.47	9.91	21.90
Andre Cason	6.41	9.92	20.70
Jon Drummond	6.46	9.92	20.03
Tim Montgomery	6.46	9.92	20.52
Seun Ogunkoya	6.52	9.92	20.50
Tim Harden	6.43	9.92	20.54

Design and statistical analysis

For the purposes of this research, defined body height and body weight as an independent variable while the results of running 60m, 100m, 200m were defined as dependent variables. First, the central and dispersion parameters (Mean, SD, Min, Max, Range, CI ±95,00%; CV%) were calculated for all variables, while the Pearson correlation coefficient was used to determine the relationship between body height and body weight and the results of sprint disciplines. The level of acceptance of statistical significance was set to $p<0.05$. The obtained correlations are containsed in tables and graphs. In order to more accurately confirm the results defined by the research goal and to determine the influence of body height and body weight on the result performance, a univariate model of regression analysis was applied and the relevant coefficients were calculated. The statistical package STATISTICA, version 10.0 (STA999k347150-W) was used for data processing.

Results

The results of the basic statistical parameters and Simple Regression Analysis are contained in Table 2 and Figure (1-7). The average result of the 60m sprint was 6.53sec. in the range of 6.39 sec. (M. Greene) up to a maximum of 6.75 sec. (J. Blake) and a score range of 0.36sec. The average recorded result of running at 100m is 9.85sec. with the best world record result of 9.58 sec. (U. Bolt) up to a time of 9.92 sec. which has been reported in as many as five sprinters (A. Cason, J. Drummond, T. Montgomery, S. Ogunkoya, T. Harden). The range between the best and the weakest result was 0.34 sec. The 200m running discipline defined an average score of 20.16 sec. from the minimum and the best result of the world record - U. Bolt (19.19 sec.) to the weakest result 21.90sec. (J. Dasolu) in the range of 2.71 sec. The values of the coefficient of variation are very low values in all disciplines, which is a consequence of the selected elite sample of sprinters and their best achieved times (Table 2). On the other hand, the analyzed degree of correlation and influence of sprinter body height and body weight with their result success cannot confirm with certainty the statements that justify the hypothesis of statistically significant influence of these anthropometric parameters on sprint result (Table 1, Figure 1 - 6). Low correlations ($R_{Height-100m}$= -0.306), ($R_{Weight-100m}$= -0.226) and ($R_{Height-200m}$= -0.221) and insignificant correlations with an inverse relationship between results and anthropometric measures are mainly evident. However, the obtained results of simple regression analysis did not show a statistically significant influence of these anthropometric parameters on the result of sprint running.

The inter correlation coefficient (ICC) of sprinter body height and body mass defines a direct linear model (Body height vs. Body weight = 0.647; p = 0.000) (Figure 7).

Table 2

Results of statistical analysis

Disciplines	Mean±SD (Min.-Max.)	Range	CV%	Discip lines	Symple regression analysis			
					R	R^2	F	p<0.05
60m	6.53±0.08 (6.39-6.75)	0.36	1.16	60m	0,095	0,009	0,343	0,562
				100m	-0,306	0,093	3,915	0,055
100m	9.85±0.08 (9.58-9.92)	0.34	0.77	200m	-0,221	0,049	1,955	0,170
				60m	-0,043	0,002	0,071	0,791
200m	20.16±0.52 (19.19-21.90)	2.71	2,57	100m	-0,226	0,051	2,037	0,162
				200m	-0,097	0,009	0,360	0,552

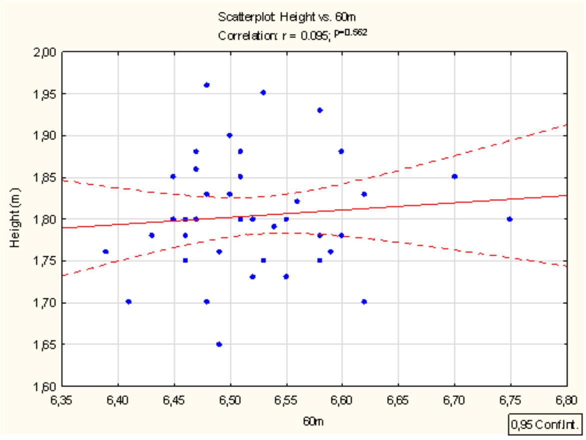

Fig. 1. Correlations Body height vs. 60m

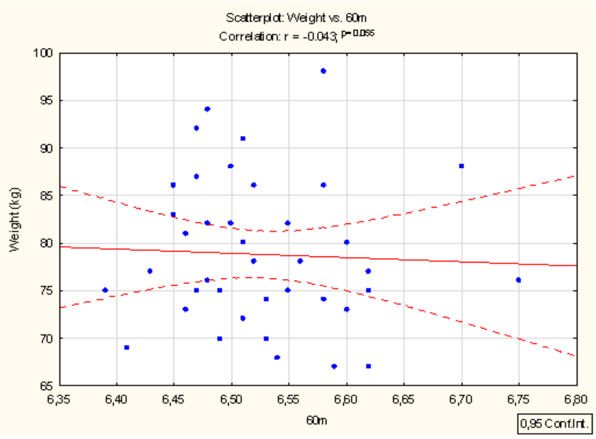

Fig. 2. Correlations Body weight vs. 60m

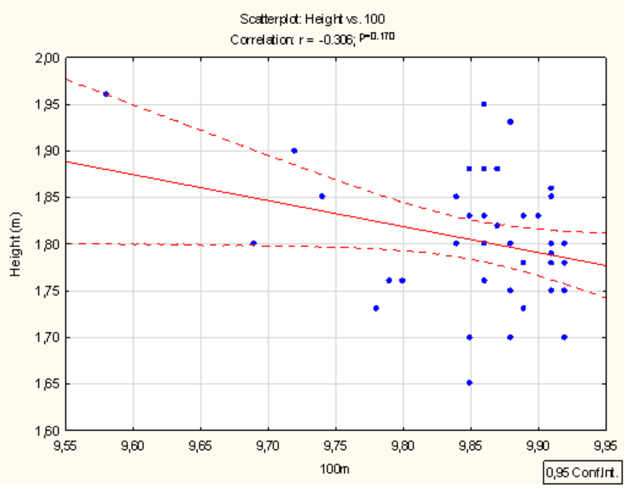

Fig. 3. Correlations Body height vs. 100m

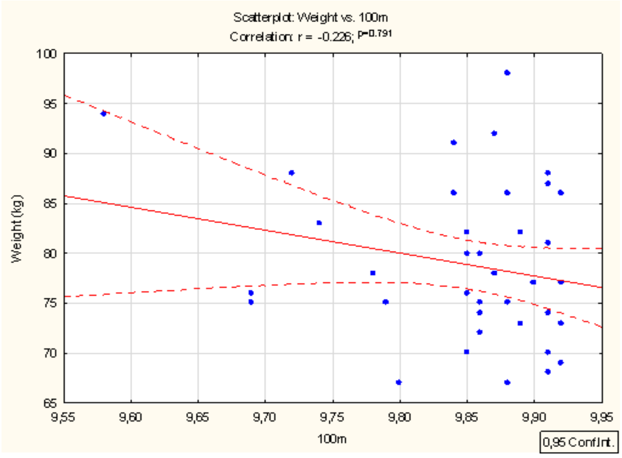

Fig. 4. Correlations Body weight vs. 100m

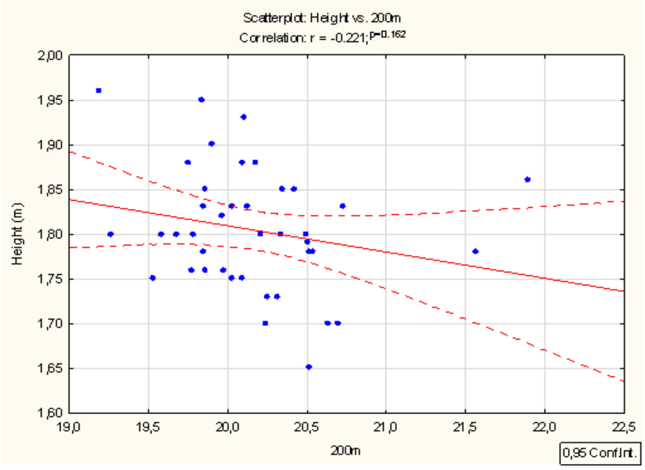

Fig. 5. Correlations Body height vs.200m

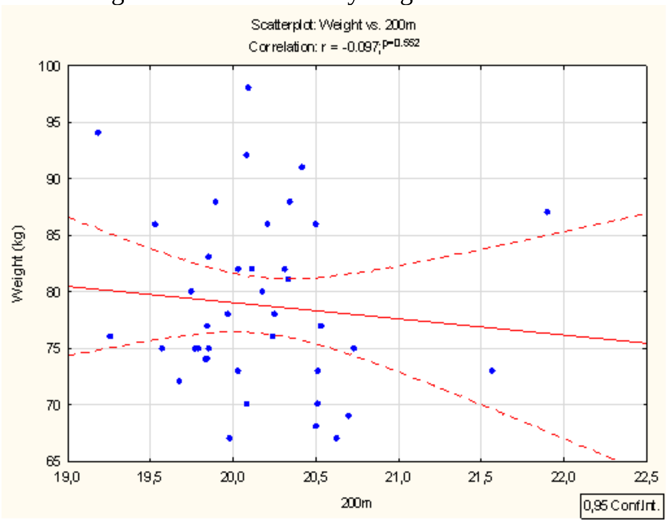

Fig. 6. Correlation Body weight vs. 200m

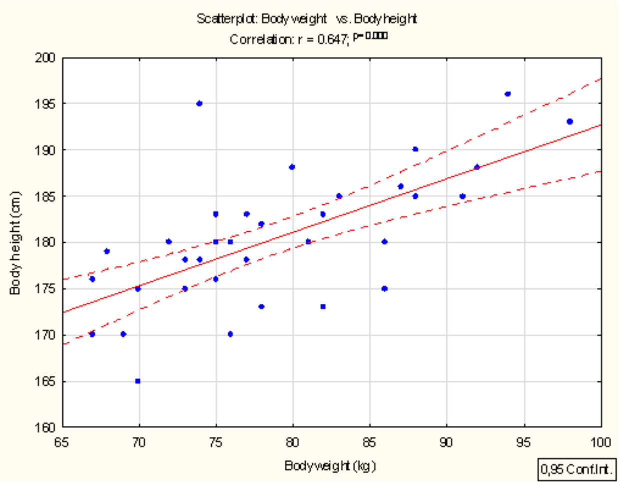

Fig. 7. Correlations Body weight vs. Body height

Discussion

The current study aimed to examine the correlations and influences of body height and body weight with the best personal results of 40 elite sprinters in running 60m, 100m, 200m. The height and weight of the sprinters did not prove to be good indicators of the results of the 60m run. The results in the 100m and 200m had low inverse correlations with the height and weight of the sprinters, but without statistical significance. Running at 200m was largely subject to the influence of height and weight of the sprinter, which can be explained by the ratio of length and frequency of steps and speed endurance of runners, type and structure of muscles, energy function.

Athletic sprint disciplines are one of the segments within athletic competitions that attract a lot of attention from the audience and the public. The results achieved in these disciplines are exact and represent the maximum individual capabilities of competitors in terms of technical, tactical and motor-physiological potentials. The technique and tactics of sprinters are manifested in all segments of running on the track and depend on the length of the track. Also, morphological and motor-physiological potentials occupy an important place, which are manifested during the start, starting acceleration, running on the track and the finish [22]. Athlete's running speed is a product of the frequency and length of steps, together with the reaction time, it has a significant impact on the result of sprinting. Athletes face problems in practice where the inverse relationship between frequency and stride length at maximum effort is defined. It follows that increasing one parameter can usually lead to decreasing another [9, 31].

Some studies claim that stride length is the most important variable for the development of maximum speeds, while others claim that it is stride frequency [29, 32-35] and depend on body height, body weight or length of lower extremities. Running on short tracks belongs to cyclic movements of maximum power and is characterized by relatively short action. According to the structure of movement, start and start acceleration (acceleration), running on tracks (max. Speed), finish (deceleration) can be divided. The result of running also depends to a large extent on the correct performance of each of these elements [25, 36, 37]. Parameters that affect the result in sprint running can be classified as one that is important for a successful start, starting acceleration, reaching and maintaining maximum speeds.

The start and the first steps are especially important for the sprinter, and great concentration of attention, mental stability, coordination of movements and appropriate strength and speed are necessary. In the starting acceleration, the contact time of the sprint step is shortened, and the flight time is lengthened. As the contact time shortens, so does the type of power. In the initial acceleration, where there is a relatively long contact time, the most important biomotor ability is the explosive power of concentric modalities. In the following phases of sprint running, the contact time is shortened, which results in a significant increase in the importance of elastic energy [38]. At the beginning of sprint running, the ability to produce high concentric force and to generate high speed during acceleration is of primary importance [39].

Maximum strength is significantly associated with sprint performance [40]. The sprinter needs strong leg and back extensor muscles. According to Frye [41] the technical model of the initial phase of acceleration is achieved by sprinter footprint, which requires tilting the body forward where the size of the athlete's tilt is directly proportional to the strength of the upper body. Morphological parameters play a significant role in this constellation of relationships. In the current study, their influence in sprint running 60 meters did not show significant, which is in line with the findings of the study [20]. However, in running 100m, the relationship has changed. The inverse function is evident, which supports the fact that taller and heavier sprinters achieved a better result (longer activity time). As it is a matter of time units (sec.), This hypothesis cannot be accepted because a longer running time represents a weaker result. This is evident based on the grouping of runners' results from 9.85 to 9.93sec. (Figure 3, 4). However, in the 200m run, the ratio of height and weight of sprinters also recorded an inverse function, with the distribution of results more grouped in half numerically lower values (Figure 5.6), which defines their better result (shorter running time) compared to 100m. This can be explained by the fact that in sections longer than 100 m, lactate-lactate mechanisms are activated, and speed endurance comes to the fore (Bolt, Lemaitre, …). Due to the appearance of fatigue, the rhythm of running changes, ie the length of the running step increases at the expense of less step frequency. In these situations, a significant share of running speed has height and body weight, which was shown in this study and is consistent with previous findings of the study [31]. It follows that the relationship between stride length and stride frequency is an individual phenomenon of each sprinter, which is evident in this study, and confirms previous studies [42]. However, despite such assumptions, the main reason lies in the energy properties of muscle sprinters and their connection with higher centers in the motor zones of the brain. It is reasonable to conclude that stride length is more associated with increased force production, and stride frequency with rapid force production during contact and rapid leg change that requires neural adaptations. According to Čoh [43] sprint speed is a product of speed and stride length, they are interdependent and individually conditioned by the processes of central movement regulation, morphological and physiological characteristics, motor abilities and energy factors. Elite sprinters are characterized by an optimal amount of muscle mass as well as biochemical energy processes in the efficiency of the muscles involved in sprinting and intramuscular coordination of agonists and antagonists.

The influence of biological attributes (body weight, body height or leg length) on stride length and frequency cannot be a simple explanation for achieving higher levels of sprint speed and elements that distinguish faster sprinters from slower ones [42]. However, according to [44, 45] anthropometric characteristics typical of sprinters may partially affect relative muscle strength and stride length, which is useful for achieving superior performance. The length of the sprint step mainly depends on the height of the body or the length of the leg and the force developed by the extensors of the hip, knee and ankle joints in the contact phase, as it induces a repulsive impulse in the contact phase [46].

On the other hand, the speed of steps depends on the functioning of the central nervous system at the cortical and subcortical levels and is strongly genetically determined [47] and the relationship between both parameters is individually defined and automated. In particular, joint structure and muscle architecture are fundamental to sprinting, especially in determining the functional roles of muscles during movements in which they are rapidly shortened [48]. Anthropometric traits are known in the literature as determinants of athletic performance [49, 50]. Higher lean mass and reduced adiposity, less ectomorphism and greater strength improve race performance in sprinters, and successful sprinters tend to be homogeneous in body height and body weight.

Conclusions

The study aimed to determine the influence of body height and body weight of 40 elite sprinters on the results in running 60m, 100m, 200m. Simple regression analysis and determined regression coefficients were applied. Pearson's intercorrelation coefficients were also calculated. Body height and body weight did not have a statistically significant effect on the results of the 60m sprint, while their influence is evident in the 100m, and especially in the 200m (but without statistical significance). This influence on the result of running 100 and 200m is a consequence of the exceptional motor-functional abilities of the sprinter to show greater force in the last phase of the rebound. Otherwise in the sprint, the rear rebound phase is much more important than the front rebound phase. A long step with the body weight (muscle) of the sprinter produces a higher rebound force, which with a big frequency of steps and good tecnique guarantees a good result.

Conflict of interest

The authors declare that there is no conflict of interest

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