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Influence of Ethnic Origin on Predictive Parameters of Performance in Sprint Running in Prepubertal Boys

Abstract

Afro-American and Caribbean athletes have long dominated sprint running, although the reasons for their disproportionate success remain unclear. The studies of sprinting ability in blacks versus whites have shown contradictory results. This study compared the anthropometric measurements and the physical test results (vertical jump and sprint) of Caucasian and Afro-Caribbean prepubertal boys. Seventeen healthy untrained prepubertal boys, 8 Caucasians and 9 Afro-Caribbeans (11.49 ± 0.74 years) performed vertical jump tests (a countermovement jump according to the Sargent method, using Abalakov material) and short sprints (30 m). Age, height, weight, and fat mass percentage were also recorded. The sprints were filmed to determine the number of strides over the 30 m. No significant difference was noted for sprint performance between the Caucasians and Afro-Caribbeans (respectively, 5.59 seconds ± 0.44 vs. 5.51 s ± 0.50). The predictors of sprint performance differed between the two groups: the vertical jump test was the main predictor for the Caucasian group, whereas the stride number/height ratio was the main predictor for the Afro-Caribbean group. This last group had better ratio (0.14 ± 0.15 vs. 0.16 ± 0.02, $p < 0.05$) and better jump test results (36.77 cm ± 2.90 vs. 31.12 cm ± 4.76, p < 005). The prepubertal Afro-Caribbeans seemed to be endowed to run faster but they did not. We hypothesize that they were unable to use their greater leg strength to develop an optimal stride. Further study is needed to investigate what occurs at other maturational stages.

Key words
Sprint performance · predictive variables · prepubertal boys · ethnic predisposition

Introduction

The determinants of sprint performance have been clearly established: high performance in the sprint is essentially due to the combination of muscular strength [12,21] and technical mastery [8], which permits track and fields sprinters to express maximal power output [16]. In fact, muscular strength is necessary not only to run fast, but also to maintain a high level of leg coordination [9]. Moreover, although an optimal ratio between stride length and frequency is important during the three essential phases of sprinting (acceleration, maximal velocity, and deceleration) [30,43], the greatest sprinters seem to privilege stride length [17,24].

Athletes of West-Central African origin, including African-Americans and West Indians, have long dominated international sprint and jump events [33], although the explanation for their disproportionate success remains unclear. Research into ethnic and racial influences on sprint performance has never been conclusive. Differences concerning growth and physical performance between black and white children were demonstrated [25], and some studies have shown that in both male and female children, blacks perform better than their white counterparts in

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30- to 50-m dashes [20,27,31]. Other investigations, however, showed no differences [42]. Concerning other factors, some authors have shown that bone density is higher [36,44] and fat mass percentage is lower in blacks [19,29], but it seems that muscular architecture is not influenced by ethnic origin [1].

Training produces not only metabolic and structural changes [16,32], but also changes in the enzymatic activities of anaerobic metabolism [5] and the regeneration capacities of anaerobic energy [18]. It thus seems important to test young subjects who are not under training effects to determine whether ethnic origin has an impact on sprint running. In the present study, we hypothesized that sedentary black children would run faster than sedentary white children and would display greater muscular strength and/or sprinting skill (i.e., greater stride length).

Materials and Methods

Subjects

Seventeen voluntary boys (8 Caucasians and 9 Afro-Caribbeans) were recruited to take the tests. Informed parental consent was obtained. The children were questioned about their physical activities and none were involved in athletic training or sports competition. They were all in stage 1 of Tanner's puberty classification [37]. All tests were performed during a physical education class at school. The study was approved by the University Ethics Committee.

Experimental procedure

Anthropometry, puberty ratings

Height and body mass were measured with a wall meter and a calibrated balance, respectively. The percentage of body fat was obtained from skinfold thickness measured at four sites (biceps, triceps, suprailiac and subscapular) with a calliper (Calliper Holtain, Ltd, Crymyych, UK), as described by Durnin and Rahaman [13]. Sexual maturation was evaluated from the puberty stages of Tanner [37]. To determine the stage, five illustrations were shown to the children, as described by Taylor et al. [38].

Tests

The subjects participated in a standardized protocol consisting of a vertical jump test and a 30-m sprint test.

Countermovement test

The jump test was performed using an ergo jump (Jump-MD, Takei, Japan). The performance was calculated by the unwinding of thin cord tethered at the waist. The amount of cord unwound automatically appeared on a digital screen fixed in the belt. The jump height was given with a precision of 1 cm. The subjects were asked to perform a countermovement jump in which they began in a standing position, dropped into the semi-squat position and immediately jumped as high as possible. The jumps were performed without the help of the arms, which remained at the sides. Each subject performed three jumps. The time needed for regeneration of adenosine triphosphate and creatine phosphate varies from 20 s to 5 min, depending on the authors [15]. Therefore, to ensure that the recovery time was sufficient and the same for all subjects, we separated the jumps by 6 min intervals. The highest jump of each subject was selected. Alactic anaerobic power (AAP) was estimated using the generalized Sayers equation [34].

$$AAP = (51.9 \cdot \text{jump height}) + (48.9 \cdot \text{body mass}) - 2007$$

Jump height in cm, body mass in kg, AAP in watts.

Sprint performance and analysis

The sprint tests were performed individually in one lane of a synthetic track. The distance was delimited by two markers (height: 30 cm) on the start line and two others on the finish line. Before beginning the test, the subjects performed a warm-up of about 20 min, consisting of a slow run, stretching and some specific exercises. Both experimental groups performed the same warm-up.

The number of strides in each sprint test was quantified from a video recording (Fig. **1**). Every 30-m sprint was filmed with a digital video camera (VL-WD250 S, Sharp, Malaysia – speed: 1/1000 to 1/10000 s) positioned at a 14° angle to the sprint start. The camera was located about 20 m from the start line with a lateral distance of 5 m from the lane (Fig. **1**). The filming analyse consisted of counting the number of strides during the sprints using the camera's view by view function. A stride is a bound between a right and left contacts with the ground. A stride is identified at each foot contact with the ground. The view by view function of the camera allowed to count precisely the number of strides.

The performance time was assessed using photo-electric cells (Globus Tecnica e sport, Italy) placed on the start and finish lines. The subject stood 1 m behind the line. When he was ready, he began to run. When he crossed the start line, the chronometer started, and when he crossed the finish line, it stopped. All children were told to run as fast as possible without stopping before the finish line. The children all wore their usual sports shoes.

The stride number/height (SN : H) ratio

Stride characteristics are important parameters of sprint performance in adult athletes [24]. Sprinting speed is the product of stride length and stride frequency [11]. Stride length is best improved by increasing the force against the ground during the drive phase. The resulting reaction drives the body's center of

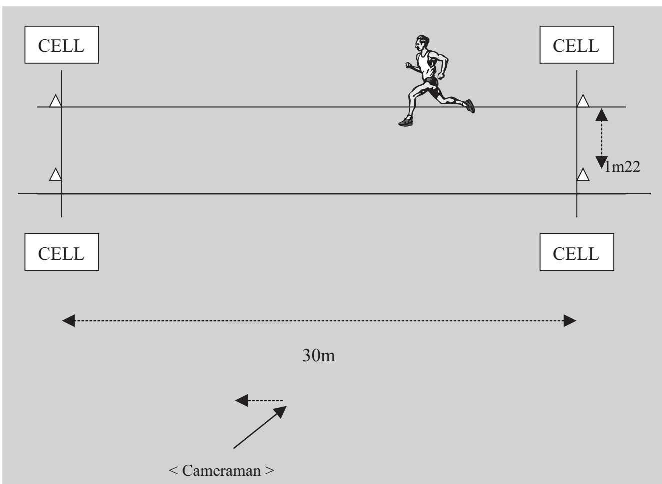

Fig. **1** Illustration of the sprint test.

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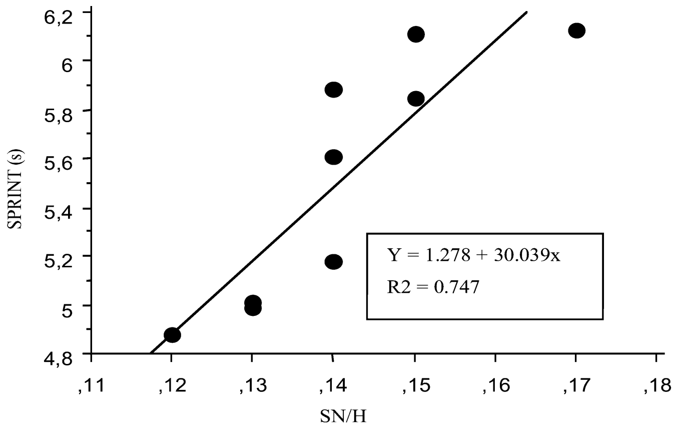

Fig. **2** Sprint vs. SN/H – Afro-Caribbean group; s = seconds.

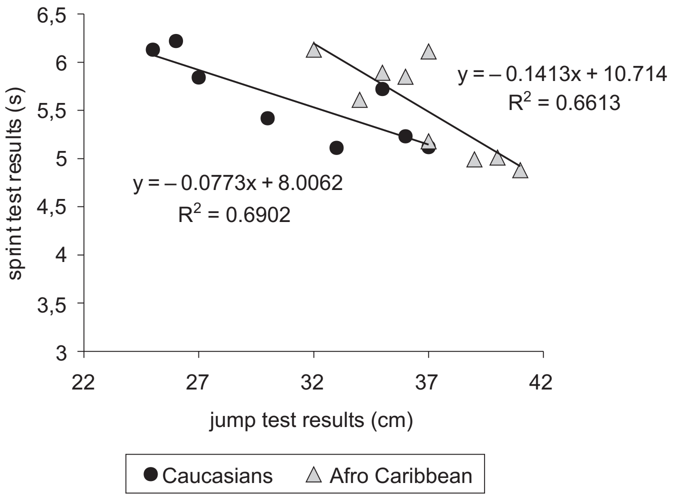

Fig. **3** Sprint vs. jump test for the two groups; s = seconds.

mass farther forward, thus lengthening the stride naturally. Stride length is thus increased by exerting more force during high speed movement which requires additional strength, power, and flexibility. Since stride length is also influenced by height, it is important to consider the stride characteristics in relation to height for comparison of relative data. We thus used the SN/H ratio (i.e., stride number divided by the height) to compare normalized data.

Statistics

The results are expressed as mean ± SD. Each variable was tested for normality using the Skewness and Kurtosis tests with acceptable Z values not exceeding plus or minus 1. With the assumption of normality confirmed, parametric tests could be performed. Simple and stepwise multiple regressions were used to predict the performance from the anthropometric and physiological variables and SN/H ratio were compared using an unpaired Student's *t*-test. Statistical significance was fixed at the $p < 0.05$ level. Analysis was performed using a statistical software package (Systat).

Results

Best predictors of performance

Although regression analysis showed that the best predictor of sprint performance in the Afro-Caribbean subjects was SN/H ($R = 0.86$, $p < 0.05$) (Fig. **2**), performance was highly correlated with the jump test results for both the Caucasian subjects ($R = 0.83$, $p = 0.011$) and the Afro-Caribbeans ($R = 0.81$, $p < 0.05$) (Fig. **3**).

The use of multiple regressions, however, did not demonstrate better correlation.

Influence of ethnic origin

ANOVA analysis revealed no significant difference between the prepubertal Caucasian and Afro-Caribbean boys concerning sprint performance, height, age, fat mass percentage, AAP, or stride number (Table **1**).

Nevertheless, two significant differences ($p < 0.05$) were found between the two groups: jump test performance and the SF/H ratio were higher for the Afro-Caribbean group (Table **1**).

Discussion

The important findings of the present study were 1) the lack of difference in sprint performance between the Caucasian group (CG) and the Afro-Caribbean group (ACG), 2) a high correlation between sprint performance and jump test performance in both CG and ACG, and 3) a biomechanical parameter (i.e., the stride number/height ratio) as the best predictive parameter of sprint performance in the ACG.

Table **1** Comparison between Caucasian group (CG) and Afro-Caribbean group (ACG)

	Sprint (s)	*SN*	*Jump test (cm)*	*Height (cm)*	*SN/H*	*Age (year)*	*AAP (watts)*	*FM%*
CG	5.59 ± 0.44	22.87 ± 2.41	31.12 ± 4.76*	141.37 ± 8.32	0.16 ± 0.02*	11.20 ± 0.96	1598.61 ± 628.21	19.68 ± 8.13
ACG	5.51 ± 0.50	20.94 ± 1.74	36.77 ± 2.90*	147.38 ± 6.98	0.14 ± 0.15	11.74 ± 0.37	1989.69 ± 568.32	19.61 ± 4.66

SN: stride number; SN/H: stride number/height; AAP: alactic anaerobic power; FM%: fat mass percentage. * $p < 0.05$

The literature shows contradictory results regarding differences in sprint performance and ethnic origin. Some studies have reported that black children have better results in sprint running than their white counterparts [20,27], and others have reported no difference [42]. Milne et al. [27] reported that Black American boys of school age performed better than their white counterparts in sprint tests (30 m) and vertical jumps. The authors suggested that black subjects may undergo earlier motor development. Capute et al. [6] also showed that black children attained motor developmental milestone earlier than white children (although for younger children). Our results are surprising because the Afro-Caribbean children did not run faster than the Caucasians, despite better results in the jump test, which is an important predictor of performance in sprint running [12,35]. We propose three hypotheses to explain our findings: 1) we did not test enough subjects, 2) the vertical jump performance difference between groups was not big enough to result in a difference in sprint performance, and 3) at the prepubertal stage, the children were not able to turn their vertical jump performance (a physical ability) into better sprint performance (which depends on both technical and physical abilities).

Regression analysis showed that sprint performance was correlated with jump test performance for the two groups. It is well known that the vertical jump reflects leg explosivity, which is a predictor of sprint performance [12], particularly in the acceleration phase [28,35]. The ACG had better results for the jump ($p < 0.05$) so they should have run faster, but this was not the case. Concerning our first two hypotheses, we think that more subjects need to be tested to determine whether the jump test has a threshold, above which sprint running performance significantly increases. However, it is possible that the difference in motor development between black and white children tends to decrease with age, given the lack of difference between our two groups in sprint performance. For example, a longitudinal study by Laska [22] showed that, although there were anthropometrical differences between black and white youth Cuban, the degree of difference significantly decreases in the last years of the study. This might be the case for motor development, particularly in regard to sprint running, in prepubertal boys. Our last hypothesis concerns the difficulty of applying jump ability to sprint performance. Given the role of technical skill in sprint performance, we suspect that improvement in the sprinting of the Afro-Caribbean children will be related to the development of the capacity to exert the explosive properties of the muscles.

In this study, however, we measured only the 30-m sprint performance. Measuring lap times (from 5 to 10 meters for example) would have been an indicator of acceleration capacity, which is important since the relationships between strength characteristics and sprinting performance seem to vary at different moments of sprint running [47]. We found no difference in sprint performance whereas differences in acceleration times might have occurred as shown by Cometti et al. [10]. These authors showed a more highly significant correlation between vertical jump height and 10-m sprinting.

The best predictor of sprint performance in the ACG was the SN/H ratio, which indicated that, in proportion to height, the subjects with the fewest number of strides ran the fastest. This is an important parameter of sprint performance in adult athletes [24]. As previously noted, sprinting speed is the product of stride length and stride frequency, and maximal speed is reached only when these components are in correct proportion. During the running stride, the leg cycles through three different phases: the drive phase, when the foot is in contact with the ground; the recovery phase, when the leg swings from the hip while the foot clears the ground; and the support phase, when the runner's weight is on the entire foot [11]. Stride length is best improved by increasing the force against the ground during the drive phase and is increased by exerting more force during high-speed movement.

The finding that the ACG had a better SN/H ratio than the CG reinforces the hypothesis that prepubertal Afro-Caribbeans are endowed to run faster but are not able to exert their leg strength to obtain an optimal stride. Several specific maximal leg strength tests exist but a strong relationship has also been shown by several authors [3,4,40] between maximal leg strength and vertical jump performance, so jump performance in this study was taken as a strength indicator. Although Lee [23] demonstrated better coordination in black children versus whites, our Afro-Caribbean children seemed unable to express their maximal leg strength during the drive phase of the stride length, at least at the prepubertal stage.

Concerning maximal leg strength, changes in muscular strength in relation with increased testosterone level have been shown to occur during maturation [41]. Some studies have even demonstrated a trend toward ethnic influence on testosterone levels during maturation [14], although Wright et al. [46] showed no influence at the prepubertal stage. As we tested prepubertal boys, further research is necessary to observe what occurs during other maturational stages.

Like stride length and leg strength, fat mass percentage is also a predictive parameter of athletic performance: a great performance is due in part to an optimal fat mass percentage (FM%) that varies with the sport [2], as has been specifically demonstrated for sprint running [32]. In our study, FM% was not a predictor of performance and did not differ between our two populations. This finding conflicts with many results that have more often shown a lower FM% for black populations, both adults and children [19,29,36]. However, a long history of interbreeding characterizes French Afro-Caribbeans, and they are thus certainly not representative of the populations of previous studies.

In conclusion, the Afro-Caribbean boys had higher results for the parameters involved in sprinting performance (vertical jump and stride length) but were not able to run faster than their white counterparts (on 30-m dashes), at least at the prepubertal stage at which they were observed. Further investigations are necessary to determine whether these Afro-Caribbean children will continue to show better vertical jump performance and a better SN/H ratio, and whether their sprint performance will improve with maturation. Further studies with more subjects are necessary to confirm the results of the present study.

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