# PHYSIQUE, ANAEROBIC POWER AND PULMONARY MEASURES OF BOTSWANA TRACK ATHLETES

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**Abstract:**

This study profiled the physique (anthropometry, body composition and somatotypes), leg power and pulmonary measures of Botswana track athletes gathered in a sports camp for the All Africa Games held in Johannesburg, South Africa. The intention was to provide coaches and trainers with the necessary data that enabled them to adjust their training programmes to improve the performance parameters in which shortfalls were noticed. The sample of participants comprised thirteen (13) male athletes, who competed in the sprinting and relay events at the All Africa Games. Their mean age was 24.3 ± 2.8 years. The components of physique assessed included stature, body mass, body fat percentage, body mass index and somatotype ratings of endomorphy, mesomorphy and ectomorphy. Anaerobic power measurements included peak, minimum and average power (W) and power drop (W/s). The pulmonary functions test included vital capacity (VC), forced expiratory volume ($FEV_1$), $FEV_1$ percentage, maximum expiratory flow (PEF), forced vital capacity (FVC) and forced expiratory flow (FEF) at 25, 50 and 75% of FVC. Data were analysed using descriptive statistics. The results for physique revealed a mean body mass value of 65.3 ± 9.2 kg, mean stature of 174.2 ± 8.1 cm, mean body density (BD) value of 1.08643 ± 3.9 gm/cc, a mean body fat percentage value of 5.6 ± 1.6%, a mean body mass index value of 21.5 ± 2.7 $kg \cdot m^{-2}$ and mean somatotype value of 1.36 ± 0.6, 3.81 ± 1.4 and 3.21 ± 1.3 for endomorphy, mesomorphy and ectomorphy, respectively, indicating that the athletes were ectomorphic-mesomorphs. The athletes' mean leg power outputs were 651.75 ± 1.4W, 313.68 ± 1.06W, 486.84 ± 1.34W, -1.92 ± 0.6W/s for peak power, minimum power, average power and power drop, respectively. The athletes' mean pulmonary measures were 3.2 ± 0.67, 1.92 ± 0.78, 59.12 ± 1.2 and 3.07 ± 0.93 for VC, $FEV_1$, $FEV_1$% and FVC, respectively. It was concluded that the physique values were typical of similar athletes involved in sprint events. However, the athletes' pulmonary and peak leg power outputs were very low compared to values from athletes in similar events, hence requiring training adjustments.

***Key words:*** *Botswana athletes, anthropometry, body composition, somatotypes, pulmonary functions test, power output*

## KÖRPERBAU, ANAEROBE KAPAZITÄT UND ATMUNGSMESSUNGEN BEI BOTSWANISCHEN LÄUFERN

**Zusammenfassung:**

Diese Studie untersuchte den Körperbau (die Anthropometrie, die Körperzusammensetzung und die Somatotypen), die Beinkraft und Atmungsmessungen bei botswanischen Läufern, die am Trainingslager für die in Johannesburg, Süd Afrika, stattfindenden All Africa Games teilnahmen. Die Absicht dieser Studie war, sowohl den Trainern als auch den Konditionstrainern die erforderlichen Daten verfügbar zu machen, damit sie ihre Trainingsprogramme ändern und die niedrigen Leistungsparameterwerte verbessern können. Die Studie umfasste dreizehn (13) Sportler, die an Sprints und Staffelläufen in All Africa Games teilnahmen. Ihr Durchschnittsalter betrug 24,3 ± 2,8 Jahre. Die gemessenen Körperbaueigenschaften bezogen sich auf Körperhöhe, Körpergewicht, das Prozent des Körperfetts, Körpermassenindex und die Einschätzung von Somatotypen, d.h. ob es sich um einen endomorphen, mesomorphen oder ektomorphen Typ handelt. Die Messungen von anaeroben Kapazität wurden in der höchsten, minimalen und durchschnittlichen Schnellkraft (W), sowie im Kraftrückgang (W/s) gegliedert. Der Test der Atemfunktionen umfasste Vitalkapazität (VC), Atemvolumenstoßtest ($FEV_1$), Prozent des $FEV_1$, maximalen Ausatmungsdurchfluss (PEF), Vitalkapazitätstoßtest (FVC) und Ausatmungsdurchfluss-Stoßtest (FEF) bei 25%, 50% und 75% des Vitalkapazitätstoßtest. Die Datenanalyse wurde mit Hilfe der deskriptiven Statistik vorgenommen. Die Ergebnisse der Körperbaumessungen zeigten den durchschnittlichen Körpergewicht von 65,3 ± 9,2 kg, die durchschnittliche Körperhöhe von 174,2 ± 8,1 cm, den durchschnittlichen Körperdichte (BD) von 1,08643 ± 3,9 gm/cc, das durchschnittliche Prozent des Körperfetts von 5,6 ± 1,6 %, den durchschnittlichen Körpermassenindex von 21,5 ± 2,7 kg·m$^{-2}$ und den durchschnittlichen Somatotypen-Wert von 1,36 ± 0,6, 3,81 ± 1,4 und 3,21 ± 1,3 d.h. für den Endomorphen, Mesomorphen und Ektomorphen; daraus folgt, dass die Sportler Ektomorphe-Mesomorphen sind. Der durchschnittliche Beinkraft-Output betrug 651,75 ± 1,4W, 313,68 ± 1,06W, 486,84 ± 1,34W, -1,92 ± 0,6W/s für die höchste, minimale und durchschnittliche Schnellkraft, sowie für den Kraftrückgang. Die durchschnittlichen Atemmessungen waren 3,2 ± 0,67; 1,92 ± 0,78; 59,12 ± 1,2 und 3,07 ± 0,93 für VC, $FEV_1$, $FEV_1$% und FVC. Daraus lässt sich folgern, dass die Körperbauwerte typisch für ähnliche Sportler waren, die an Sprint-Disziplinen teilnahmen. Die Atemvolumenwerte und die höchsten Beinkraft-Werte dagegen waren sehr niedrig im Vergleich zu Sportlern in ähnlichen Sportdisziplinen; deshalb sind Änderungen im Trainingsprogramm erforderlich.

***Schlüsselwörter:*** *botswanische Sportler, Anthropometrie, Körperzusammensetzung, Somatotypen, Atemtest, Kraft-Output*

## Introduction

The superior performance of today's athletes is the result of an intricate and useful blend of many factors and considerations. This blend, according to MacDougall and Wenger (1991), involves genetic endowment, selection criteria, training and favourable health status, carefully and deliberately integrated through the application of sport science disciplines like physiology, psychology, nutrition, biomechanics to mention just a few. Profiles of top elite athletes are the target of other aspiring athletes who try to reach them through training (Meckel, Atterbom, Grodjinovsky, Ben-Sira, & Rotstein, 1995; Sharma & Dixit, 1985; Thorland, Johnson, Cisar, Housh, & Tharp, 1987). Similarly, physical-performance profiles have also been used to predict performances in various sports, based on established relationships (Blazevich & Jenkins, 1998; Brandon, 1999; Nummela & Rusko, 1995). Apart from using these characteristics to predict performance in competitions, they have also been used to select athletes into sports camps for further training towards competitions.

Various levels of physical and performance characteristics have been used as indicators of success in sport. One of the typical changes arising from regular physical training, particularly for competitive sports, is a higher ratio of active body mass (fat-free mass) in comparison to fat tissue (Pavlik, 2000; Strojnik, Apih, & Demsar, 1995; Tilinger, 1997). This was corroborated by a study on young ice hockey players, in which Dzurenkova, Novotna, Hajkova and Marcek (2000) reported a positive influence of physical activity on body composition. In most cases the increased muscle mass is reflected in predominant mesomorphy. Elite and successful male sprinters range in height from 157 cm to 190 cm and in weight from 63.4 to 90.0 kg (Radford, 1990). Majority of successful sprinters have tended to be predominantly mesomorphic. However, the high muscle mass found in sprinters may be due to a genetic predisposition or training effects or a combination of both (Boros-Hatfaludy, Fekete, & Apor, 1986; Owolabi & Oduyale, 1989; Strojnik, Apih, & Demsar, 1995; Torok, Duey, Bassett, Howley, & Mancuso, 1995). It is generally acknowledged that while heredity may predispose an athlete to certain physiological capacities, the realisation or manifestation of these potentials in the phenotype is highly dependent on favourable enviromental factors and training (Mero, Jaakkola, & Komi, 1991; Mero, Komi, & Gregor, 1992).

Generally, athletes tend to carry a smaller percentage of body fat than their non-athletic counterparts. Indeed, the established inverse relationship between the percentage of body fat and athletic performance has necessitated the inclusion of a body fat assessment in the physiological preparation and evaluation of athletes. Meckel, Atterbom, Grodjinovsky, Ben-Sira and Rotstein (1995), in a study on the physiological characteristics of 100-metre sprinters being classified into fast, average and slow groups, found the fast group to be significantly superior in the Wingate anaerobic test performance and to carry a significantly lower percentage of body fat than the slow group.

Any physical performance output that involves maximum muscular contraction within 2 to 60 seconds is primarily dependent on the anaerobic energy system. The anaerobic energy system is the energy pathway that does not depend on oxygen to provide the energy for an on-going physical exertion. The anaerobic energy system is dependent on the muscles store of ATP – PC (phosphagens) (alactic energy) and muscle glycogen (lactic energy). The two acknowledged indicators of anaerobic performance are anaerobic power (maximal muscular contractions completed in up to 10 seconds) and anaerobic capacity (maximal muscular contractions sustained and completed in up to 60 seconds). While anaerobic power determines the alactic capacity of the athlete, anaerobic capacity determines the lactic capacity of the athlete.

Although pulmonary ventilation and diffusion may not be a limiting factor in the track performance of athletes with healthy lungs, the functional lung capacities may be limited by factors such as airway obstruction or impairment and inappropriate training. Successful performance in competitive track events is also dependent on the optimum presence of specific physical and motor performance attributes. These include stature, anthropometry, body weight and composition, somatotype, muscle strength and flexibility. Particularly in track events, where the body has to be moved over a space in a minimum time, the importance of muscle mass, body anthropometry, percentage of body fat, flexibility and strength cannot be over emphasised.

Botswana, to date, has not made a significant mark on the world-map of track-and--field athletics. There was a need to carry out a profile study of this nature with the main objective being that coaches and trainers design and re-design their training programmes in preparation for the All Africa Games held in Johannesburg, South Africa. It was therefore a modest scientific beginning of pre-camp assessments of the physique, anaerobic power and pulmonary functions of Botswana's elite track athletes. Also, these much-needed data enriched the country's track-and-field athletics data bank. Finally, it was believed that the data from this study would be used, for international comparative studies on similar athletes, by other researchers.

## Methods

### Subjects

Thirteen male athletes, aged 24.3 ± 2.8 years, participated in the study. They were selected into the national team based on their previous performance records at national, regional and continental athletic championships. The evaluation was done at the invitation of the Botswana National Sports Council in preparation for the All Africa Games in Johannesburg, South Africa.

### Testing protocol

The tests administered on the athletes were kinanthropometry / anthropometry (including somatotypes), anaerobic power and pulmonary function tests. These tests were administered to ascertain the level of readiness of the athletes within the preparation program for the continental athletic championship. All the athletes were involved in sprint races (100m, 200m and relay sprinting events). The kinanthropometric assessments involved the use of restricted profiles (Norton, Whittingham, Carter, Kerr, Gore, & Marfell-Jones, 1996) which, in addition to stature and body mass, consisted of nine skinfolds (triceps, subscapula, biceps, iliac-crest, supraspinale, abdominal, front thigh, medial calf and mid-axilla), five girths: arm-relaxed and arm-flexed, waist (minimum), gluteal (hip) and calf (maximum) and two breadths (humerus and femur). These profiles were assessed according to the protocol of the International Society for the Advancement of Kinanthropometry (1999). For the same-day test-retest reliability, three successive measurements, per site, were taken on each athlete. The athletes' anaerobic power output was assessed using the short-term Wingate Anaerobic Test (Wan T) described by Bar--Or (1981). Pulmonary (lung) functions in the athletes were assessed with the single-breath spirometry, using the standardized procedure by the American Thoracic Society (ATS) (1995).

### Data collection

Prior to reporting at the sports training camp, the participants were measured for all the tests at the Human Performance Laboratory, University of Botswana. They were duly informed of all the test protocols and evaluation procedures prior to the assessment. They then signed the informed consent forms. Their ages (in years), stature (in cm) and body mass (in kg) were recorded, followed by measurements of skinfolds, skeletal diameters and circumferences (in cm). Skinfolds were taken at carefully designated sites with a Harpenden skinfold caliper model 203, with a constant tension of $10.1 g \cdot mm^{-2}$ at all thicknesses. Skeletal diameters were measured to the nearest millimetre at the designated sites using a broad-blade anthropometer, whereas the circumferences were measured to the nearest centimetre using the 2-meter-long, retractable, flexible steel tape.

The Withers, Craig, Bourdon and Norton's (1987) equation was used to compute body density (BD) from the anthropometric data, while lean body mass was determined using the equation by Withers, Laforgia, Heymsfield, Wang, and Pillans (1996). Percentage of body fat was derived from the equation proposed by Siri (1961), while body mass index (BMI) was determined from the measures of stature and body mass using the equation developed by Abernethy, Olds, Eden, Neill, and Baines (1996). The Heath-Carter method of somatotyping, in which anthropometry is used to estimate the criterion somatotype was used to determine the somatotypes of the athletes. The three components of somatotypes were compared using the equations for a decimalised anthropometric somatotype (Carter & Heath, 1990). The resulting somatotype values were then displayed on a standard somato-chart.

The Wingate Anaerobic Test (Wan T) was used to determine leg power over a 30-second period of super-maximum bicycle riding. Anaerobic power output variables of peak power, minimum power, average power and power drop were determined over six 5-second periods (Amusa, Toriola, Dhaliwal, & Mokgwathi, 1998; Bar-Or, 1981; Dotan & Bar-Or, 1983). For the determination of the athletes' lung function, the Erich Jaeger Masterscope Spirometry / flow volume model 780854 was used for the measurement of slow and forced expiration values as well as maximum voluntary ventilation (Jaeger News, 1996). The standardized diffusion capacity method advanced by the American Thoracic Society (ATS) (1995) was used to determine lung function variables of vital capacity (VC), forced vital capacity (FVC), forced expiratory volume after one second ($FEV_1$), forced expiratory volume after one second in a percentage of VC ($FEV_1$%) and forced expiratory flow at 25%, 50% and 75% of FVC.

## Data analyses

Data were analysed using simple descriptive statistics of mean, range and standard deviation.

# Results

Data on the age, stature, body mass, lean body weight, body density, percentage of body fat, body mass index and somatotype values are shown in Figures 1 and 2.

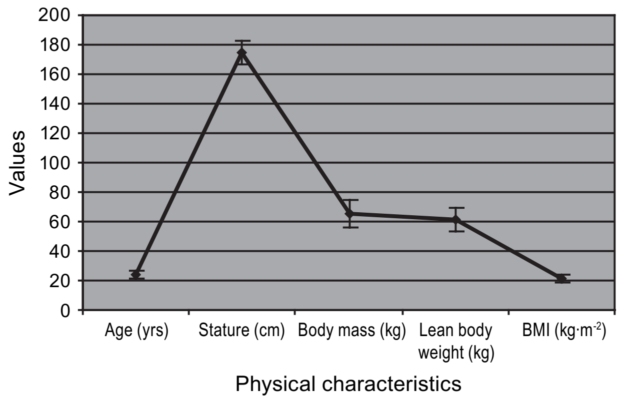


*Figure 1. Mean ± SD of selected physical characteristics of the athletes (N=13).*

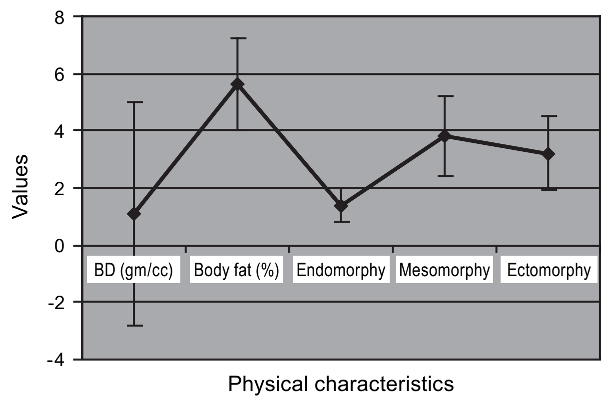


*Figure 2. Mean ± SD of selected physical characteristics of the athletes (N=13).*

Shown in Figures 3 and 4 are the data on the anaerobic (leg) power of the athletes.

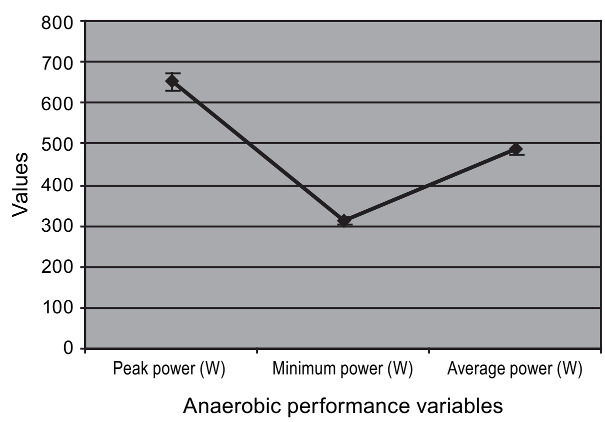


*Figure 3. Mean ± SD of selected anaerobic power output of the athletes (N=13).*

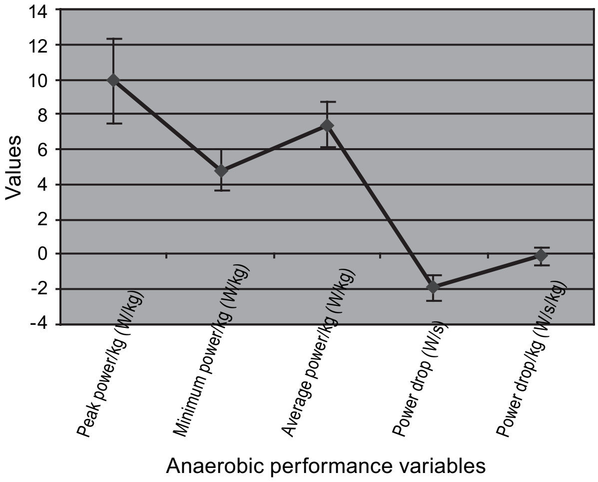


*Figure 4. Mean ± SD of selected anaerobic power output of the athletes (N=13).*

Shown in Figures 5 and 6 are data on the selected single breadth variables of the athletes.

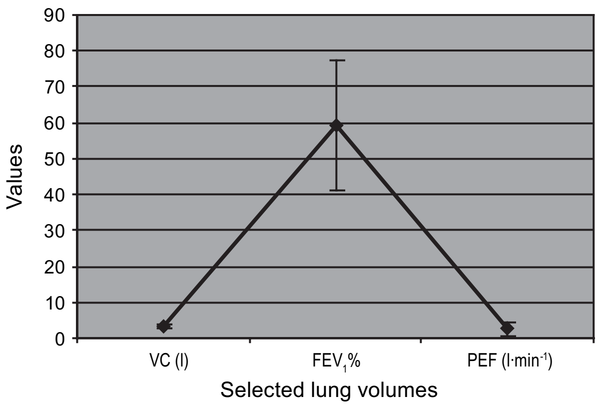


*Figure 5. Mean ± SD of selected single breath variables of the athletes (N=13).*

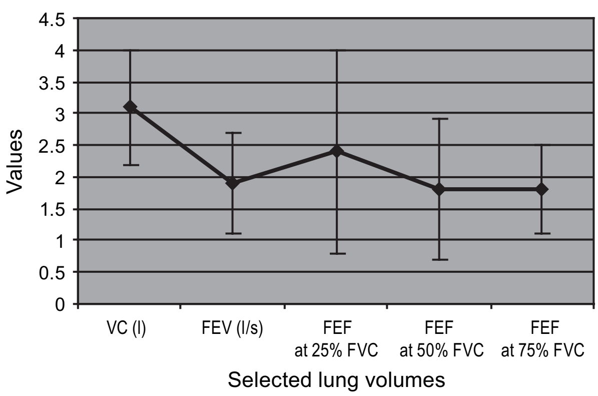


*Figure 6. Mean ± SD of selected single breath variables of the athletes (N=13).*

## Discussion and conclusions

This is a descriptive study intended to ascertain the level of preparedness of thirteen Botswana sprint athletes for the All Africa Games, in terms of the various performance parameters required for success at the Games. Additionally, since they were to move into an intensive training session in the sports camp, the assessment was necessary to enable the coaches and trainers to focus on the possible performance characteristics requiring improvement, before the commencement of the Games. It was intended that the design and re-design of training programmes would be influenced by the outcome of this study. However, where possible, reference was made on how these athletes compared with their counterparts elsewhere in terms of the variables assessed.

The athletes' mean age of 24.3 ± 2.8 years compares favourably with the 25.6 ± 6.5 years for other African athletes studied during the 6$^{th}$ All Africa Games (De Ridder, Monyeki, Amusa, Toriola, Wekesa, & Carter, 2000) and athletes elsewhere (Norton, Olds, Olive, & Craig, 1996). Age is a crucial factor in physical fitness and performance. The younger the athletes, the fitter they are likely to be and the better their performances in comparison to older athletes in the same sport. The importance of stature in the determination of ultimate success in elite sports has been well substantiated (Ackland, Schreiner, & Kerr, 1997; Cox, Miles, Verde, & Rhodes, 1995; Norton, Olds et al., 1996; Khosla & McBroom, 1988).

The mean height of 174.2 cm reported for the athletes also compares favourably with the 174 cm reported for athletes in different events at the 1972 and 1976 Olympics (Norton, Olds et al., 1996) and the 173.5 cm for elite African athletes (De Ridder et al., 2000). Height may play an important role in athletic success. For example, shortness in stature is particularly advantageous in acceleration when changing direction. This favours shorter sprinters with a relatively lower moment of inertia or movement resistance. The minimum height of 157.0 cm reported for the athletes in this study may perhaps be a favourable factor.

Again, the mean body mass of 65.3 ± 9.2 kg reported for the athletes in this study compares favourably with values reported for similar sprint athletes elsewhere (De Ridder et al., 2000; Ford, 1984; Khosla, 1968; Norton, Olds et al., 1996). These athletes had a mean body fat percentage of 5.6% ± 1.6. Body fat is related to body mass. Track events, in general, involve athletes for whom low body fat mass is a norm. This low body fat mass is considered desirable for athletic competition since higher fat values negatively affect success in track events. The observed athletes were involved in events requiring speed and explosive power. Therefore, excess body fat could increase body mass and decrease acceleration (Norton, Olds et al., 1996; Quinney, 1990). The athletes were within the weight and body fat limits that allowed for optimum mobility.

Body mass index (BMI) has been referred to as the traditional measure of obesity and also as an index of weight relative to stature (Abernethy, Olds, Eden, Neill, & Baines, 1996; Pounder, Carson, Davison, & Orihara, 1998). BMI is influenced, to an equal degree, by the body's lean and fat components (Hawe, 1996), suggesting that it is as much a measure of lean tissue as it is of fat. Whatever the views are about BMI, the fact remains that excessive BMI could have serious health and performance implications (Amusa & Onyewadume, 2001). The athletes in this study had a mean BMI of 21.5 ± 2.7 $kg \cdot m^{-2}$. This was an expected BMI result as these were elite national athletes.

The technique of somatotyping has been employed in appraising the profile of athletes in various sports (Carter, 1996). In employing this technique, the magnitude of each of the three components of physique is always expressed in a three-number rating, representing endomorphy, mesomorphy and ectomorphy in that order. With the mean somatotype rating of 1.4 ± 0.6 – 3.8 ± 1.4 – 3.2 ± 1.3, the observed athletes may be referred to as low on endomorphy and moderate on mesomorphy and ectomorphy. These values are similar to the 1.5 ± 0.5 – 3.4 ± 0.9 – 4.1 ± 0.9 reported for athletes in similar events by De Ridder and associates (2000). These athletes could be described as being ectomorphic-mesomorphs.

Track athletes are frequently required to generate high power output during a performance. The peak power (W) represents the phase of the activity when the athletes are at their peak performance. In some instances, they are expected to sustain this high power output a bit longer. Indeed, successful sprinters are characterised by their ability to produce very large power outputs very rapidly (Radford, 1990). This ability may be due to their possession of a high percentage of fast twitch (type II) fibres in their running muscles (Mero, 1985; Sadoyama, Masuda, Miyata, & Katsuta, 1988; Torok et al., 1995). High anaerobic power (alactacid) and capacity (lactacid) thus seem very crucial in successful track performance. This is because these functional capacities are related to the metabolic and contractile properties of the contracting muscles.

With a mean peak leg power output of 651.75 ± 1.4W and a range of 304.3 - 972.10W, the majority of the athletes reached their peak power output too soon at the 20-second point of the test. While this may be desirable for athletes with the highest value, it was proper that athletes recording low values should be given extra strength and speed training in order to improve their peak power. Peak power was expected between the $15^{th}$ and the $20^{th}$ second points of the test, thereby causing the power-drop (the difference between the highest and lowest power outputs) to be very minimal. As the low trend was also manifested in the minimum power, average power, power drop and power drop per kilogram values, coaches and trainers must make modifications in their training programmes. To improve the performance variables, the maximum power generated between the $20^{th}$ and $25^{th}$ second points of the test should be sustained over the next few seconds to ensure the running speed does not drop too sharply. This must be the target of the remedial training if both coaches and athletes desire improvement and success at competitions.

The degree of leg strength that backs up leg speed directly determines the capability of an athlete to accelerate during sprinting events. The decrease in speed, often associated with the last phase of sprinting events, is largely due to local muscular fatigue. According to Nossek (1982), the decrease in speed as a result of muscular fatigue, manifests itself in low-level performers soon after short intensive performances of about 10s duration and indicates a lack of speed endurance quality. Therefore, to improve this anaerobic endurance capacity, coaches and trainers must adjust their training programmes to ensure repetitions of fast sprints.

There is a need to evaluate and monitor respiratory functions and their capacities as athletic events and training have been reported to elicit characteristic changes in trained athletes (Veda, Yanagidaira, Takeoka, Koshihara, & Yonemura, 1980). Measurement of lung volumes has proven to be a valuable guide in establishing the pulmonary functions as well as being a diagnostic tool in determining cases of abnormal lung functioning in individuals (McArdle, Katch, & Katch, 1996). This information can guide coaches, trainers and athletes as to which sport, or competitions athletes are best suited, or prepared, for respectively. Vital capacity can be a good indicator of the preparedness of an athlete for competitions. For most sports, high values of vital capacity are beneficial (McArdle et al., 1996). Wilmore and Haskell (1972) reported vital capacities as high as 7.6 L for a professional football player and 8.1 L for an Olympic gold medallist in cross-country skiing. Therefore, the maximum values of 4.4 L and 4.4 L, for VC and FVC, respectively, for the observed athletes were not encouraging. Higher vital capacity values are required as athletes would then have an excellent ability to move large volumes of oxygen through air passages. In sprinting track events, this large volume can be a very beneficial reserve as the athletes might have the opportunity of breathing only a few times before the end of the race. Low values, as obtained in this study, can reflect, not only airway resistance but also, poorly conditioned or poorly functioning ventilatory muscles (Plowman & Smith, 1997). The $FEV_1$ and $FEV_1$% values provide information, not only on the total volume of air moved through the lungs, but also on the rate of flow of that movement. The advantage of these variables ($FEV_1$, $FEV_1$%, VC and FVC) is that their values can be used as screening tests prior to any serious competition or even selection for sports camps. Hence, for the observed athletes, it was strongly recommended that the coaches and trainers plan and execute a training programme designed for the development of the lung function variables.

The assessment of various performance parameters of the athletes in this study, was not just to evaluate their present physical fitness levels and readiness for pending competitions, but also to provide useful information to coaches and trainers in the design and re-design of training programmes used during the sports camping period. It was evident in this study that the athletes exhibited very low pulmonary function and peak leg power outputs. Recommendations were given to their coaches and trainers to re-design their training programmes for optimal benefits.

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# TJELESNA GRAĐA, ANAEROBNA SNAGA NOGU I RESPIRACIJSKI PARAMETRI TRKAČA IZ BOCVANE


## Sažetak

### Uvod

Vrhunska sportska postignuća današnjih sportaša rezultat su djelovanja mnogih, vrlo različitih faktora: genskih predispozicija, selekcije, treninga, zdravstvenog statusa, primjene znanstvenih spoznaja (primjerice, fiziologije, psihologije, nutricionistike, biomehanike, da spomenemo samo neke). Profili uspješnih sportaša modeli su koje treningom žele dosegnuti drugi. Ti se profili očituju u različitim razinama razvijenosti tjelesnih karakteristika i sportskih rezultata. Cilj je ove deskriptivne studije dati profil tjelesne građe (antropometrija, sastav tijela i somatotip), snage nogu i respiracijske parametre trkača iz Bocvane koji su se pripremali za Sveafričke igre. Namjera je bila pružiti trenerima podatke na temelju koji bi oni mogli planirati i programirati trening u pripremnom razdoblju kako bi poboljšali sportske rezultate svojih sportaša.

### Metode

Uzorak ispitanika činilo je 13 sprintera (muškaraca), članova reprezentacije Bocvane, prosječne dobi od 24,3±2,8 godine. Komponente tjelesne građe procijenjene su sljedećim antropometrijskim mjerama: tjelesna visina, tjelesna težina, postotak potkožnoga masnog tkiva (devet kožnih nabora, pet opsega i dva promjera), a izračunat je i indeks tjelesne mase (BMI) te je procijenjen somatotip. Mjere anaerobne snage obuhvatile su maksimalnu, minimalnu i prosječnu snagu (W) te pad snage (W/s). Testovi plućnih funkcija obuhvatili su mjere vitalnoga kapaciteta (VC), forsiranog ekspiracijskog volumena u 1 s ($FEV_1$ i $FEV_1\%$), vršni ekspiracijski protok (PEF), forsirani vitalni kapacitet (FVC) i forsirani ekspiracijski protok (FEF). Za analizu podataka upotrijebljena je deskriptivna statistika.

### Rezultati

Podaci o dobi, visini, težini, mišićnoj tjelesnoj masi, tjelesnoj gustoći, postotku masnoga tkiva, indeksu tjelesni mase i somatotipske vrijednosti prikazane su na slikama 1 i 2. Podaci o anaerobnoj snazi nogu prikazani su na slikama 3 i 4. Parametri jednog respiracijskog ciklusa prikazani su na slikama 5 i 6.

### Rasprava i zaključak

Podaci o bocvanskim sprinterima promatrani su kao apsolutne vrijednosti , ali su i uspoređeni s podacima o drugim vrhunskim atletičarima. Nema razlike između bocvanskih i drugih sprintera u dobi, tjelesnoj visini, tjelesnoj težini, postotku masnoga tkiva, BMI, a slični su i po somatotipu. Bocvanski su atletičari postigli puno lošije rezultate u mjerama anaerobnog kapaciteta od poželjnih i očekivanih, a osobito su bili loši rezultati u mjerama pada snage. Stoga su treneri upozoreni da posvete osobitu pozornost treningu jakosti, brzine i brzinske izdržljivosti. Nisu bile ohrabrujuće ni vrijednosti postignute u mjerama respiracijskih funkcija, što je govorilo o slaboj kondicijskoj pripremljenosti sprintera. Na temelju dobivenih rezultata trenerima je preporučeno kako da prilagode program treninga ne bi li poboljšali pripremljenost svojih sportaša.