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Anthropometric characteristics and 20-m sprint times among Malaysian University athletes

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Resumen

Introducción: El objetivo de este estudio fue evaluar las características antropométricas de atletas de nivel universitario de Malasia y explorar las relaciones potenciales entre las medidas antropométricas y el rendimiento en el sprint lineal de 20 m. **Método:** Participaron en el estudio cuarenta atletas masculinos de nivel universitario malasios asociados con universidades de Malasia y que compiten regularmente en competencias a nivel estatal. Se realizaron mediciones antropométricas de masa corporal, estatura, 8 sitios de pliegues cutáneos, 3 circunferencias y 2 anchuras. Se calculó el somatotipo, el % de grasa corporal y la suma de pliegues cutáneos. Se realizó una prueba de sprint lineal de 20 m para evaluar la aceleración y la velocidad de carrera. **Resultados:** El análisis de comparación por pares reveló que los lanzadores tuvieron diferencias significativas en endomorfia con los atletas que compiten en sprint, kárate y media distancia ($p< 0,05$), en mesomorfia con los atletas que compiten en larga distancia, media distancia, velocistas, futbolistas y kárate ($p < 0,05$), y en ectomorfia con atletas que compiten en media distancia y kárate. Se encontró que el coeficiente de correlación de Pearson entre el porcentaje de grasa corporal y el tiempo de sprint era 0,374 ($p = 0,025$, de dos colas), lo que indica una correlación positiva estadísticamente significativa entre las dos variables. **Conclusión:** El físico está altamente correlacionado con las características físicas adecuadas para los eventos deportivos específicos y el desarrollo de las funciones atléticas requeridas en cada deporte y determina el éxito dentro de cada deporte. El porcentaje de grasa corporal influye en la capacidad de un individuo para acelerar y correr al máximo, y las características antropométricas afectan en última instancia el rendimiento.

Palabras Clave: Composición corporal, Sprint lineal, Deportes de equipo, Deportes de combate, Correr

Abstract

Introduction: The aim of this study was to evaluate the anthropometric characteristics of the Malaysian University level athletes and to explore potential relationships between the anthropometric measures and 20-m linear sprint performance. **Method:** Forty male Malaysian University level athletes associated with Malaysian Universities and regularly competing in state level competitions took part in the study. Anthropometric measurements were performed for body mass, stature, 8 skinfold sites, 3 girths, and 2 breadths. Somatotype, body fat % and sum of skinfolds were calculated. A 20-m linear sprint test was performed to assess acceleration and running speed. **Results:** The pairwise comparison analysis revealed that throwers had significant differences in endomorphy with athletes competing in sprinting, karate, and middle distance ($p < 0.05$), in mesomorphy with athletes competing in long distance, middle distance, sprinters, footballers and karate ($p < 0.05$), and in ectomorphy with athletes competing in middle distance and karate. The Pearson correlation coefficient between Body Fat Percent and Sprint Time was found to be 0.374 ($p = 0.025$, two-tailed), indicating a statistically significant positive correlation between the two variables. **Conclusion:** Physique is highly correlated with the physical characteristics and the development of the athletic functions required in each sport and is a determinant of success. Body fat percentage influences the ability of an individual to accelerate and run maximally.

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Keywords: Body Composition, Linear-sprint, Team-sports, Combat sports, Running

Introduction

Success in sports is a multifaceted outcome influenced by various factors, extending from discipline-specific skills to morphological characteristics. Previous studies have consistently underscored the importance of morphological variables in determining athletic performance. For instance, Brocherie et al. (2014) conducted a study revealing that low adiposity and muscle power-related fitness and anthropometric factors are related to sprint performance and sprint decrement during a repeated sprint ability (RSA) test. Similarly, Dessalew et al. (2019) found that both male and female runners with lighter body weight, shorter/average body height, and smaller body size, shorter thigh, smaller circumferences (arm, thigh, and calf) exhibited enhanced race performance.

Disparities in the physical attributes observed among athletes engaged in various disciplines are the effect of a conscious process of optimizing the human body (Norton, 1996). The characteristic body proportions and body shapes of practitioners of a given sport are a consequence of vying for optimal performance by selecting the athletes most physically-suited for achieving optimal performance, complemented by rigorous training interventions (Malousaris et al., 2008). Body dimensions and body types (somatotype) are influenced not just by the practiced discipline but also by the competitive level, style, event format, or athlete position. Among numerous examples, young karate and taekwondo practitioners exhibit greater ectomorphy than older practitioners who present more endomorphy (Carter et al., 2005). Elite handball players when compared with their counterparts in lower league are taller and heavier while possessing greater lean body mass and less fat (Massuça & Fragoso, 2011). A similar trend was observed in male and female basketball players (Carter et al., 2005; Viviani, 1994). In a cross-disciplinary analysis, highly-ranked long-distance and marathon runners are distinguished by lower levels of mesomorphy and endomorphy, coupled with exceptionally high ectomorphy compared to practitioners of other sports (Bale et al., 1985, 1986; Vernillo et al., 2013).

Considering the importance of body composition and somatotype on overall performance (Franchini et al., 2007) there is a need to establish findings within the Malaysian athletic population. Many authors have empathised the importance of somatotype to identify and classify the sport specialisation (Sterkowicz-Przybycień et al., 2011). To the authors' knowledge, there is no previous study reporting on the anthropometric characteristics and somatotype of Malaysian athletes. Thus, the present study aimed to evaluate the anthropometric characteristics of the Malaysian State level athletes and to explore potential relationships between the anthropometric measures and 20-m linear sprint performance.

Material and Methods

Subjects

Forty male State level athletes (age 22.4 ± 1.2 yrs, body mass 66.7± 11.7 kg, body stature 171.4 ± 6.8 cm, and BMI 22.7 ± 3.8) volunteered to take part in this study. Only student athletes who were associated with Malaysian Universities and regularly compete in State competitions were eligible to take part in the study. Players habitually trained a minimum of three times per week at any time of the day. No one had a history of recent musculoskeletal injuries before participating in this study, everyone was free from illness, and no one was taking any dietary supplements or pharmaceutical drugs that could affect performance during the study. Verbal explanation of the experimental procedure was provided to everyone which included: the aims of the study, the possible risks associated with participation and the experimental procedures to be utilised. All players gave their written informed consent, and no participants were lost during the study. All the procedures used were reviewed and approved by the Human Ethics Committee and conformed to the recommendations of the Declaration of Helsinki.

Anthropometric Measurements

Anthropometric measurements were performed following the protocol developed by the International Society for The Advanced of Kinanthropometry (ISAK manual 2019). Anthropometric variables collected included body mass, stature, 7 skinfold sites ((biceps, triceps, subscapular, supraspinale, abdominal, front thigh, and medial calf), 5 girths (upper arm flexed, upper arm relaxed, waist, gluteal and medial calf), and 2 breadths (humeral and femoral epicondyles). Body stature was measured to the nearest 0.1 cm using a stadiometer (Holtain Ltd., Crymych, United Kingdom) and body mass to the nearest 0.1 kg using a calibrated weighing scale (Essae DS-215, Bangalore, India). Skinfold thickness was recorded to the nearest 0.2 mm at a constant pressure of 10 g·mm−1 using a calibrated Holtain skinfold caliper (Holtain Ltd., Crymych, United Kingdom). Girths were determined to the nearest 0.1 cm using a flexible anthropometric tape (Anthroflex, Minneapolis, USA). Skinfolds were measured three times at each site in a rotation system, and a third measure was taken if required. All measurements were conducted by accredited ISAK

L1 and ISAK L2 practitioners with a depth of experience in taking measures. Somatotype of every athlete was calculated using the Heath-Carter method (1990).

Skinfolds

Sum of 7 Skinfolds = biceps + triceps + subscapular + supraspinale + abdominal + front thigh + medial calf

Somatotype

The Heath-Carter [1967] method was followed for somatotype rating. The following equations were used for calculating somatotype components:

Endomorphy = $-0.7182 + 0.1451 \times \sum SF - 0.00068 \times \sum SF\ 2 + 0.0000014 \times \sum SF\ 3$

where ∑SF = (sum of Triceps, Subscapular and Supraspinale skinfold) multiplied by (170.18/Height in cm).

Mesomorphy = 0.858 × Humerus breadth + 0.601 × Femur breadth + 0.188 × corrected Arm girth + 0.161 × corrected Calf girth − Height × 0.131 +4.5

Three different equations are used to calculate Ectomorphy according to the height -weight ratio (HWR):

1) If HWR is greater than or equal to 40.75 then, Ectomorphy = 0.732 × HWR − 28.58
2) If HWR is less than 40.75 and greater than 38.25 then, Ectomorphy = 0.463 × HWR − 17.63
3) If HWR is equal to or less than 38.25 then, Ectomorphy = 0.1

X-Coordinate = Ectomorphy – Endomorphy

Y-Coordinate = 2 x Mesomorphy – (Endomorphy + Ectomorphy)

Linear 20-m Sprint Test

Acceleration and maximum running speed were determined during the 20-m linear sprint test, a relevant performance parameter in most sports. The athlete was required to run a single maximal sprint over a 20-m distance. Sprint times were recorded using timing gates (Microgate, Bolzano, Italy) with set 1-m apart, 1-m height and 1-m from the starting line. The position of the timing gate was standardized following the guidelines set by the manufacturer. The starting position was standardised for each sprint, placing the dominant foot at the front. All athletes repeated the test 3 times with a 1-min passive recovery period to ensure results were reliable. The time of the best 20-m linear sprint was used for further analysis.

Statistical Analysis

Data are presented as the mean ± SD and the Statistical Package for the Social Sciences (SPSS), version 28, for Windows were used. Descriptive statistics were used to estimate the basic functional status of the athletes with the mean, SD, and range (minimum and maximum values) calculated for measured parameters. To determine the differences in somatotype components between sports, a one-way ANOVA was performed. Assumptions of ANOVA, including normality and homogeneity of variances, were checked, and met. Tukey's HSD test was used as a post-hoc test to further identify which specific sports differ significantly from each other. The level of significance was set to $p \leq 0.05$.

Results

Table 1 presents the descriptive statistics of demographic data (age, height, weight, BMI), anthropometric measurements (skinfolds, girths, breadths, height-weight ratio, sum of skinfolds), somatotype body components (endomorph, mesomorph, ectomorph) and percent body fat. Table 2 and Table 3 provide an inferential statistical analysis comparing somatotype components across the different sports which displayed significance.

The pairwise comparison analysis revealed significant differences in the endomorph component for middle distance running and throwers ($p = 0.040$; 95% CI: -7.80 to -0.12), for sprint and throwers ($p = 0.047$; 95% CI: -8.33 to -0.03), for karate and throwers ($p = 0.033$; 95% CI: -7.00 to -0.19). Additionally, significant differences were found in the mesomorph component for long distance running and throwers ($p = 0.001$; 95% CI: -6.92 to -1.31), for middle distance running and throwers ($p = 0.001$; 95% CI: -6.54 to -1.35), for sprint and throwers ($p = 0.049$; 95% CI: -5.62 to -0.01), for football and throwers ($p = 0.002$; 95% CI: -5.63 to -0.89), for karate and throwers ($p = 0.000$; 95% CI: -6.06 to -1.46), for rugby and throwers ($p = 0.010$; 95% CI: -5.24 to -0.50). Moreover, significant differences were found in the ectomorph component for middle distance running and throwers (p = 0.016; 95% CI: 0.40 to 5.92), for karate and throwers (p = 0.006; 95% CI: 0.63 to 5.52).\

Table 1. Proportionality and kinanthropometric descriptive characteristics

Parameters	LDR (n = 3) M (SD)	MDR (n = 4) M (SD)	Sprint (n = 3) M (SD)	Throwers (n = 4) M (SD)	Football (n = 6) M (SD)	Karate (n = 7) M (SD)	Muay Thai (n = 3) M (SD)	Rugby (n = 6) M (SD)
Demographics								
Age (Years)	22 (0)	22 (0)	23 (1.73)	22.75 (1.50)	22.67 (1.63)	22 (0)	22 (0)	23.17 (1.84)
Height (cm)	175.33 (4.73)	170.50 (6.56)	168.17 (8.52)	169.58 (4.50)	169.50 (4.42)	173 (11.68)	172 (2)	172.58 (7.17)
Weight (kg)	63.67 (1.15)	57.75 (7.93)^{d}	59.5 (12.01)	84.85 (20.52)^{bf}	69.17 (9.04)	60.64 (7.63)^{d}	72.33 (5.03)	67.4 (8.86)
BMI (kg/m^2)	20.73 (0.93)^{d}	19.8 (1.45)^{d}	20.87 (2.11)^{d}	29.28 (5.43)^{abcfh}	24.13 (3.59)	20.26 (1.43)^{d}	24.43 (1.12)	22.73 (3.51)^{d}
Body Fat (%)	8.63 (1.70)	8.61 (2.15)^{d}	6.98 (0.30)^{d}	17.02 (4.98)^{bcf}	15.05 (3.53)	8.62 (1.45)^{d}	12.73 (5.49)	13.04 (5.02)
Skinfolds								
Triceps (mm)	12.30 (5.89)	6.85 (1.77)^{d}	6.15 (1.73)	25.16 (11.51)^{bf}	19.71 (11.34)	8.71 (4.40)^{d}	14.3 (5.89)	14.37 (7.90)
Subscapular (mm)	12.77 (5.35)	14.1 (6.24)	12.07 (6.19)	23.79 (9.31)	25.01 (7.07)	11.87 (5.53)	19.57 (14.58)	19.69 (10.56)
Biceps (mm)	6.58 (3.88)	3.98 (1.43)	4.73 (1.58)	16.78 (6.85)^{f}	10.28 (7.62)	3.93 (0.56)^{d}	13.23 (4.47)	10.53 (10.06)
Supraspinale (mm)	6.85 (4.42)	4.9 (0.85)^{d}	5.3 (1.28)	23.46 (10.04)^{b}	14.57 (9.05)	9.04 (6.27)	14.83 (7.65)	11.4 (8.95)
Abdominal (mm)	6.53 (3.78)^{e}	10.5 (6.82)^{e}	6.6 (1.14)^{e}	21.53 (7.91)	23.78 (2)^{abc}	12.97 (6.53)	15.92 (8.38)	17.63 (8.12)
Front Thigh (mm)	11.75 (5.06)	12.45 (10.04)	6.6 (0.44)	23.8 (10.98)	19.78 (6.5)	9.29 (5.07)	17.03 (9.07)	20.99 (10.02)
Medial Calf (mm)	7.35 (3.34)	8.48 (6.69)	5.1 (1)	19.56 (6.97)^{f}	15.77 (7.68)	5.57 (1.09)^{d}	14.92 (6.80)	15.43 (6.94)
Sum of Skinfolds (mm)	57.57 (16.15)	57.28 (20.45)^{d}	41.83 (2.84)^{d}	137.3 (47.43)^{bcf}	118.63 (33.56)	57.46 (13.78)^{d}	96.6 (52.22)	99.53 (47.79)
Girths								
Arm Relaxed (cm)	27.33 (0.58)^{d}	25.88 (2.17)^{dg}	27.17 (4.19)^{d}	33.35 (3.08)^{abcef}	27.83 (1.91)^{d}	26.71 (1.55)^{d}	31.8 (1.93)^{b}	29.5 (2.24)
Arm Flexed (cm)	30 (1)^{d}	29.13 (2.66)^{dg}	30.5 (4.33)^{d}	37.88 (3.2)^{abcefh}	31 (1.97)^{d}	29.57 (1.40)^{dg}	35.67 (1.15)^{bf}	32.58 (2.25)^{d}
Calf (cm)	37.67 (3.62)	35.13 (2.59)	35.97 (3.16)	41.25 (4.73)	38.07 (2.97)	35.57 (1.48)	38.33 (2.52)	37.25 (2.91)
Breadths								
Humerus (cm)	6.47 (0.76)	6.2 (0.58)	6.37 (0.76)	7.2 (0.73)	6.35 (0.36)	6.34 (0.77)	6.33 (0.21)	6.3 (0.47)
Femur (cm)	8.27 (2.05)	8.7 (0.61)	9.07 (1.50)	10.13 (0.76)	9.23 (0.6)	9.07 (0.35)	9.1 (0.53)	9.57 (0.63)
Ratio								
Height-Weight Ratio	43.91 (1.03)^{d}	44.20 (0.87)^{d}	43.23 (0.8)	38.87 (1.94)^{abf}	41.42 (2.1)	44.08 (1.68)^{d}	41.30 (0.5)	42.55 (2.74)

Body Components								
Endomorphy	3.12 (1.16)	2.57 (0.66)[d]	2.35 (0.42)[d]	6.53 (2.06)[bcf]	5.6 (1.89)	2.93 (0.99)[d]	4.61 (2.26)	4.33 (2.29)
Mesomorphy	3.41 (2.06)[d]	3.58 (0.8)[d]	4.71 (1.88)[d]	7.52 (1.51)[abcefh]	4.26 (0.44)[d]	3.76 (0.76)[d]	5.24 (0.43)	4.65 (1.12)[d]
Ectomorphy	3.56 (0.75)	3.77 (0.64)[d]	3.06 (0.58)	0.61 (0.49)[bf]	1.91 (1.21)	3.69 (1.23)[d]	1.66 (0.36)	2.6 (1.97)

Note: M = Mean; SD = Standard Deviation; LDR = Long Distance Running; MDR = Middle Distance Running. a, b, c, d, e, f, g, h = significantly different to Long Distance Running, Middle Distance Running, Sprint, Throwers, Football, Karate, Muay Thai, Rugby respectively.

Table 2. ANOVA table with statistical significance ($p<0.05$) in bold

		Sum of Squares	df	Mean Square	F	sig.
Endomorphy * Sport	Between Groups (Combined)	69.067	7	9.867	3.576	**0.007**
	Within Groups	77.263	28	2.759		
	Total	146.330	35			
Mesomorphy * Sport	Between Groups (Combined)	49.442	7	7.063	5.609	**0.000**
	Within Groups	35.261	28	1.259		
	Total	84.703	35			
Ectomorphy * Sport	Between Groups (Combined)	38.472	7	5.496	3.869	**0.005**
	Within Groups	39.771	28	1.420		
	Total	78.243	35			

Note: df = degree of freedom; sig. = significance.

Table 3. Multiple comparisons (Tukey HSD) comparing somatotypes and sport showing significant differences.

Dependent Variable	(I) Sport	(J) Sport	Mean Difference (I-J)	SE	Sig.	95% CI	
						Lower Bound	Upper Bound
Endomorphy	THROWERS	MDR	3.960*	1.175	**0.040**	0.119	7.801
		SPRINT	4.183*	1.269	**0.047**	0.034	8.332
		KARATE	3.596*	1.041	**0.033**	0.191	7.001
Mesomorphy	THROWERS	LDR	4.116*	0.857	**0.001**	1.313	6.919
		MDR	3.943*	0.794	**0.001**	1.348	6.537
		SPRINT	2.813*	0.857	**0.049**	0.010	5.615
		FOOTBALL	3.261*	0.724	**0.002**	0.892	5.630
		KARATE	3.761*	0.703	**0.000**	1.461	6.061
		RUGBY	2.869*	0.742	**0.010**	0.500	5.238
Ectomorphy	THROWERS	MDR	-3.160*	0.843	**0.016**	-5.916	-0.404
		KARATE	-3.076*	0.747	**0.006**	-5.519	-0.633

Note: LDR = Long Distance Running; MDR = Middle Distance Running; SE = Standard Error; Sig. = Significance; CI = Confidence Interval

* The mean difference is significant at the .05 level

Figure 1 illustrates the individual positions of each sport on the somatotype chart.

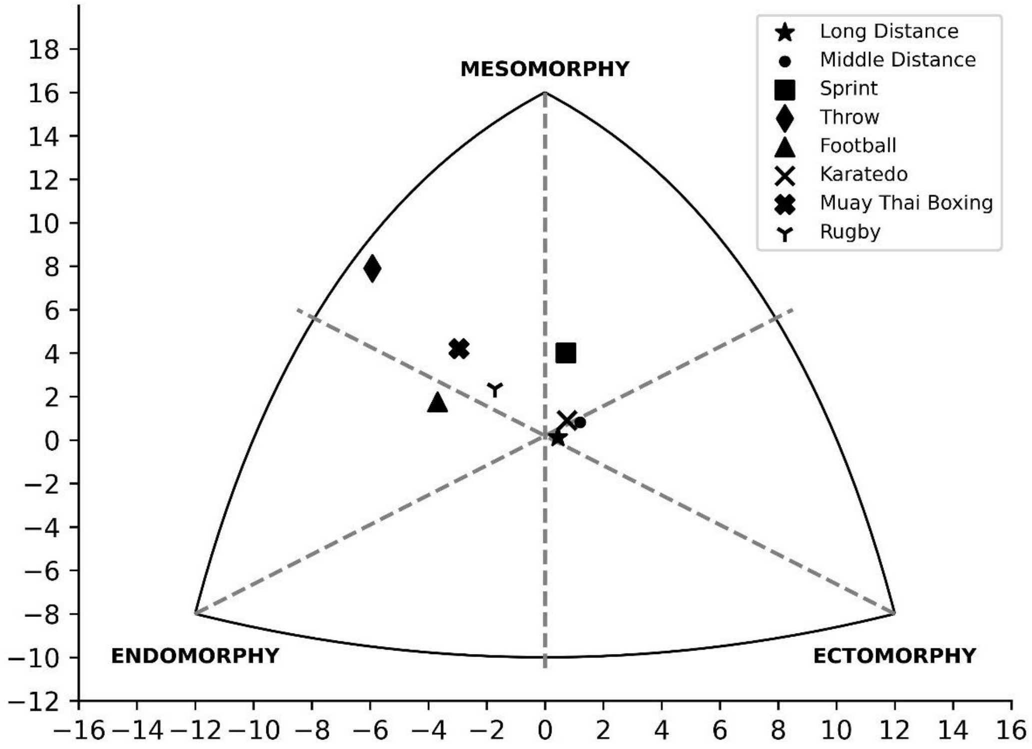

Figure 1. Somatoplot displaying the differences between sports.

To examine the relationship between Body Fat Percent and Sprint Time, a Pearson correlation analysis was conducted. The Pearson correlation coefficient between Body Fat Percent and Sprint Time was found to be 0.374 (p = 0.025, two-tailed), indicating a statistically significant positive correlation between the two variables.

Table 4. Correlation between Body Fat Percentage and Sprint Time

		Body Fat Percent	**Sprint Time**
Body Fat Percent	Pearson Correlation	1	0.374*
	Sig. (2-Tailed)	-	**0.025**
Sprint Time	Pearson Correlation	0.374*	1
	Sig. (2-Tailed)	**0.025**	-

Note: *. Correlation is significant at the 0.05 level (2-tailed)

Discussion

The aim of the study was to evaluate the anthropometric characteristics of the Malaysian University level athletes and to explore potential relationships between the anthropometric measures and 20-m linear sprint performance. This study shows the anthropometric characteristics of each athlete and the findings revealed significant differences between endomorph, mesomorph, and ectomorph components for different sports (Table 1, Table 2, and Table 3). Additionally, we observed a moderately positive association between body fat percent and sprint time (Table 4).

Physique is highly correlated with the physical characteristics suitable for the specific sports events and the development of the athletic functions required in each sport. Therefore, it is very likely to be a key factor in determining the level of performance depending on the type of event. Differences have previously been noted in body structure and body composition in athletes competing in individual and team-sports (Abraham et al., 2010). Among the track and field athletes the mesomorphic somatotype is prevalent athletes leaning towards the endo-mesomorphic and meso-ectomorphic characteristics, depending on the type of activity. The mesomorphic component is bound to muscle strength, which is necessary for top results for runners, jumpers, and throwers (Carter & Heath, 1990). Our study found that the throwers differed in endomorphy, mesomorphy and ectomorphy with most of the other sport disciplines. It has previously been established that throwers require specific physiques compared to other sport disciplines to be successful to meet physical demands and athletes selected are done so according to specific morphological characteristics (Lozovina, & Lozovina, 2008). Thorland et al. (1981), attempted to determine and differentiate the body characteristics of Junior Olympic Athletes in track and field and other events. He found that the most frequent differences within either the male or female Junior Olympic samples was in performers in throwing events (shot put, discus, and javelin), who were taller, heavier, fatter, and of unique somatotype when compared to all or most other competitors, with similar findings observed in our study.

Previous studies have found that lean body mass and body fat % are closely related to sprinting performance in several sports such as soccer (Zanini et al., 2020), futsal (Damayanti, & Adriani, 2021), skiing (Aktas, 2023), and badminton (Akdogan et al., 2022). Higher body fat % negatively influence the ability of an individual to accelerate and run maximally, as it negatively affects power-to-weight ratio, agility and performance in sprinting. Carrying excess body fat affects the ability to generate explosive speed and power, thus decreasing muscle efficiency (Ben Mansour et al., 2021). The aerodynamics associated with increased body fat % results in additional resistance and drag, resulting in a decrease of efficient movement when sprinting maximally, slowing the individual down. Nevertheless, sprinting performance has a structural basis, with previous research showing that sprint performance is associated body mass. A study performed by Weyand et al. (1985) observed that when comparing runners with a similar stature and body fat %, the individuals who had larger body mass where able to run faster. Sprint performance is highly dependant on the ability of the human body to generate power and achieve a high ratio between body mass and power (Thorstensson et al., 1977), with muscle mass a major role player on the ability to exert maximal force (Perez-Gomez et al., 2008).

Conclusion

In conclusion, differences in morphological variables between athletes competing in different sporting disciplines ultimately determine athletic performance, and success in different sports is highly dependent on the interaction of several factors (Pullinger et al., 2019a, 2019b). The development of specific skills related to the sport directly affect performance, with certain body composition characteristics affecting the potential of certain performance variables.

Practical Applications

Understanding that different sports require different skillsets and are dependent on anthropometrical characteristics can assist coaches in better understanding the needs of successful performance and assist with long-term development. Sport Science practitioners can assist with the design of individualised training programmes to ensure that the anthropometric characteristics and somatotypes of each athlete is considered.

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