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RELATIONSHIP BETWEEN BODY COMPOSITION AND 100-M RUNNING TIME IN AN ELITE FEMALE SPRINTER: A 7-YEAR RETROSPECTIVE STUDY

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Abstract

Aim of the study: To report on the relationship between body composition and 100-m running time in an elite female sprinter using 7 years of data.

Methods: The subject was a 3-time participant in the Track and Field World Championship and a 2-time participant in the Asian Games. Since track and field in Japan is a spring (May–June) and autumn (September–October) sport, we recorded her best 100-m time in both seasons. During the study, her personal best and mean season best times were 11.39 sec and 11.59 sec, respectively. Subcutaneous fat and muscle tissue thicknesses were measured by ultrasound in each season. Body density was estimated from FTH using an ultrasound-derived prediction equation, and the body fat percentage (BF%) and fat-free mass (FFM) were calculated. Total and segmental (arm, trunk, thigh, and lower leg) skeletal muscle mass (SMM) was estimated from MTH using prediction equations.

Results: There was a positive correlation between 100-m sprint time and fat mass and BF% (r = 0.64, P = 0.04 and r = 0.67, P = 0.02, respectively). A regression expression between BF% and 100-m time was: 100-m time [sec] = 9.92 + 0.11·BF%. Total and lower body SMM did not correlate with the 100-m time (r = 0.04, P = 0.91 and r = 0.05, P = 0.87, respectively).

Conclusion: Thus, BF% was a strong predictor of 100-m sprint performance in an accomplished elite female runner. Using a regression formula, we determined that 1% excess body fat is nearly equivalent to a 0.11-sec reduction in 100-m sprint time.

Key words: *B-mode ultrasound, body fat, skeletal muscle mass, running speed*

Introduction

Theoretically, a lower fat mass should decrease the amount of work needed to move the body, thereby giving leaner athletes a performance advantage. Cross-sectional studies have demonstrated that there is a relationship between sports performance and body composition [1-4]. Body fat has been found to be inversely associated with sprint running performance in both humans [1-3] and horses [4]. In addition, Cureton and Sparling [5] examined the effect of excess body fat on running performance and concluded that the addition of external weight significantly reduced running performance. On the other hand, fat-free mass (FFM) and skeletal muscle mass (SMM) have been positively associated with sprint running [3,6] and other sports performance [7]. However, there are very limited longitudinal studies available on body composition and sports performance, especially in elite human athletes. This case report presents the findings of a 7-year retrospective study that examined the relationship between body composition and 100-m running performance in an elite female sprinter.

Case Report

A female sprinter who was 24 years old and 1.57 m in height at the beginning of the study was the subject of this 7-year case report. She was the national champion in Japan for 7 consecutive years (1998–2004) in 100-m sprint events. She also was a 3-time participant in the Track and Field World Championship and a 2-time participant in the Asian Games. Besides sprint running to improve her sprinting techniques and power, she performed moderate- to high-intensity (50%–90% of one repetition maximum, 1–3 times per week) resistance training as well as cycle power training throughout the study period.

Methods

Table 1 summarizes the general characteristics of the athlete. Because track and field in Japan is a spring (May–June) and autumn (September–October) sport, we recorded the subject's best time in both seasons each year. As described previously [8], both subcutaneous fat and muscle tissue thicknesses were measured

Table 1. *Changes in body composition and sprint performance*

	Weight kg	Fat %	FFM kg	Totam SMM kg	100-m time sec
1998, Nov	52.0	16.8	43.3	17.0	11.54
1999, Dec	52.3	16.1	43.9	18.3	11.73
2000, Apr	52.8	16.3	44.2	18.5	11.56
Dec	50.4	15.4	42.6	16.9	11.52
2001, Mar	53.5	15.6	45.2	19.5	11.56
Dec	52.6	16.4	44.0	18.8	11.77
2002, Jun	51.4	15.6	43.4	18.8	11.61
Dec	54.6	16.3	45.7	17.9	11.67
2003, Mar	53.1	15.6	44.8	20.0	11.45
Dec	54.3	17.5	44.8	17.5	11.71
2004, Apr	52.3	14.7	44.6	17.8	11.39
Mean	52.7	16.0	44.2	18.3	11.59
SD	1.2	0.8	0.9	1.0	0.12

Abbreviations: FFM, fat-free mass; SMM, skeletal muscle mass.

throughout the body by B-mode ultrasound (SSD-500, Aloka, Japan) during each season. Body density was estimated from the subcutaneous fat thickness using an ultrasound-derived prediction equation [8]. We have reported previously that the standard error of the estimate (SEE) of body density using ultrasound equations is ~ 0.006 g/mL (about 3% body fat) in the normal Japanese population [8]. Body fat percentage (BF%) was calculated from body density using an equation from Brozek et al [9]. FFM was derived by subtracting fat mass from total body mass. Total and segmental (arm, trunk, thigh, and lower leg) SMM was estimated from the muscle thickness using an equation from Sanada et al [10]. Lower body (thigh plus lower leg) SMM and relative SMM (eg, lower body / total SMM) were also determined.

Statistical Analysis

All data were analyzed using SPSS v.17.0 for Windows (SPSS Inc., Chicago, IL). Statistical significance was set at $P < 0.05$.

Results

The Pearson product-moment correlation coefficient was computed to assess the relationship between the subject's best 100-m sprint time and body composition. There was a significant correlation between her 100-m sprint time and BF% ($r = 0.67$, $P = 0.02$) and total fat mass ($r = 0.63$, $P = 0.04$) (Figure 1). A regression expression between BF% and 100-m time was:

$$\text{100-m sprint time [sec]} = 9.92 + 0.11 \cdot \text{BF\%}.$$

However, there were no significant correlations between FFM and 100-m time ($r = 0.04$, $P = 0.89$) and between total SMM and 100-m time ($r = 0.04$, $P = 0.91$). Absolute and relative lower body SMM also

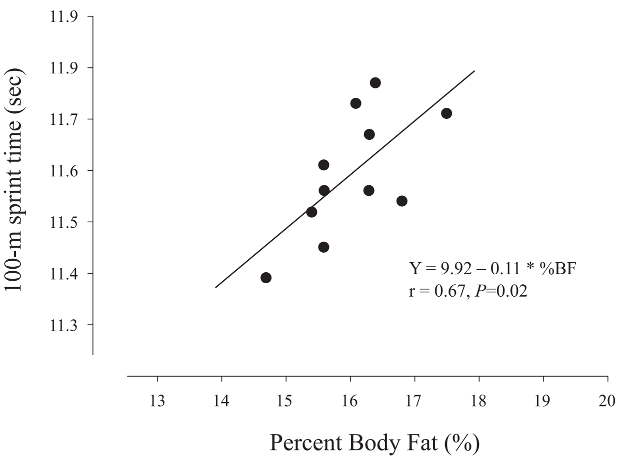

Figure 1. *Relationship between 100-m sprint time and percent body fat in an elite female sprinter*

did not correlate with 100-m time ($r = 0.05$, $P = 0.87$ and $r = 0.21$, $P = 0.52$, respectively).

Discussion

In this case report, our results showed that 100-m sprint running performance was associated with BF%, but not with muscle mass, in an elite female sprinter. Previously, several cross-sectional studies reported the relationship between BF% and sports performance, such as sprint [1-3] and endurance running time [11], basketball performance time [12], triathlon race time [13], and skating speed [14]. In contrast, some studies have reported weak or no significant correlations between BF% and swimming [14,15] or shot put [16] performance. It is clear that the ability to perform non–gravity-dependent sports is less affected by BF% than weight-bearing exercise. Experimental studies found that the addition of external weight to the body using a weighted vest systematically decreased running performance during a 12-min run and with maximal treadmill run time [5,17]. Additionally, in cross-sectional studies, sports performance was only slightly affected by body fat in athletes with homogeneous body fat percentages. Our findings suggest that 1% excess body fat was equivalent to a 0.11-sec reduction in the 100-m sprint event. Interestingly, the predicted 100-m sprint time using the regression formula would be 9.92 sec if the subject's body fat had been zero. Since the American College of Sports Medicine recommends a 12% minimum of body fat for female athletes [18], the predicted 100-m sprint time for our subject with 12% body fat would be 11.24 sec.

The results of our 7-year retrospective study indicated that there were no significant correlations between 100-m sprint time and absolute and relative SMM in an elite female sprinter. Perez-Gomez et al [3] reported that there were no significant correlations between 30-m sprint time and the absolute lean mass of the lower extremities in women and men. However, several studies have reported a significant positive correlation between sprint running performance and site-specific muscle size, such as the upper portion of the thigh [6], the adductor magnus and semimembranous muscles [19], and the quadriceps and psoas major muscle [20]. It is not clear whether there were changes in site-specific muscle size during the 7 years of data that our study examined and if these changes had a positive effect on our subject's sprint performance. Our results suggest that a change in fat mass has a greater impact than a change in muscle size in an accomplished elite female sprinter with a relatively small change in FFM.

In conclusion, BF% was a strong predictor of 100-m sprint performance in an elite female sprinter. Using a regression formula, we estimated that 1% excess body fat is nearly equivalent to a 0.1- sec reduction in 100-m sprint time.

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