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Anthropometric characteristics of top-class Kenyan marathon runners

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***Aim*. This study aims to: 1) describe the current anthropometric profiles of Kenyan marathon runners and 2) establish a set of reference values useful for future investigations on athlete selection, talent identification, and training programme development.**

***Methods*. The participants were 14 male top-class Kenyan marathon runners (mean [*s*] age 27.71 [3.75] yrs, height 171.21 [6.12] cm, body mass 57.71 [4.02] kg, marathon personal best 02h 07min 16s (01min 55s); training volume: 180-220 km·wk^{-1}; high:low intensity training ratio: 1:2). The anthropometric profiles included the measurement of skinfolds, and segment lengths, breadths, and girths. To estimate body density (BD) multiple regression equations were calculated using the sum of 7-skinfolds method and then converted to percentage of body fat (%BF). The somatotype, somatotype dispersion mean (SDM), somatotype attitudinal mean (SAM), and height to weight ratio (HWR) as well as the skinfolds extremity to trunk ratio (E:T) were also calculated.**

***Results*. The mean (*s*) of BD, %BF, SDM, SAM, HWR and E:T were 1.13 (0.02), 8.87 (0.07) %, 4.58 (3.62), 0.51 (0.09), 44.32 (1.06), and 0.36 (0.11), respectively. The mean (*s*) endomorphy, mesomorphy, and ectomorphy were 1.53 (0.32), 1.61 (1.81), and 3.86 (0.78), respectively.**

***Conclusion*. Top-class Kenyan marathon runners seem to have ectomorphy as dominant, with endomorphy and mesomorphy more than one-half unit lower. Despite population comparisons would be required to identify any connection between specific anthropometric dimensions, these reference data should be useful to practitioners and researchers, providing useful information for talent identification and development and for the assessment of training progression in marathon.**

Key words: Running - Anthropometry - Body size.

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Since the Olympic Games held in Mexico City in 1968, Kenyan runners have reached unparalleled success in middle- and long-distance events.[1, 2] This phenomenon has been described by Manners as "the greatest geographical concentration of achievement in the annals of sport".[3] Even more profound is the Kenyan dominance in the marathon scenario, where Kenyan senior men have demonstrated a large dominance compared to Caucasian and other East-African runners (*e.g.*, Ethiopia).[2] Accordingly, through the years several studies have been conducted to proposed explanations for such a superiority suggesting that environmental factors,[1] psychological advantage,[4] and favorable physiological characteristics [5, 6] all contribute to achieving superior marathon performances. Despite these, little is known about the anthropometric characteristics of Kenyan marathon runners.

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The interest in anthropometric characteristics, body composition and somatotype has increased over the last decades both in health promotion [7, 8] and different sports. The latter with the purpose to indicate whether an athlete would be suitable to compete at the highest level in a specific sport.[9-16] Although some studies have incorporated small selection of anthropometric measures as part of wider investigations into Kenyan marathon runners,[17-19] few to date have reported a range of directly measured and derived variables in Kenyan distance runners,[16] without taking into consideration the marathon athletes. Therefore, there is no comprehensive data set on the current anthropometric characteristics of Kenyan marathon runners. Thus, the quantification of morphological characteristics of elite athletes can be a key point in relating body structure to sports performance.

Consequently, the aim of this study was twofold: 1) to describe the current anthropometric profiles of Kenyan marathon runners and 2) to establish a set of reference values useful for future investigations on athlete selection, talent identification, and training programme development.

Materials and methods

Design and protocol

This is an observational study where we investigated the anthropometric characteristics of top-class Kenyan marathon runners.[20] This by means of the measurement of skinfolds, segment lengths, breadths, and girths according to previous works.[21-23] All variables except body mass and height were measured on the right side of the body in triplicate with the median value used as the criterion. To estimate body density (BD) multiple regression equations were calculated using the sum of 7-skinfolds method [24] and then converted to percentage of body fat (%BF).[25] The somatotype, somatotype dispersion mean (SDM), somatotype attitudinal mean (SAM), height to weight ratio (HWR) and skinfolds extremity to trunk ratio (E:T) were calculated using the method and equations of Carter and Heath.[21]

Participants

All examinations were performed during the training stages for the autumn competitive season on 14 male top-class Kenyan marathon runners (mean [*s*] age 27.71 [3.75] yrs, height 171.21 [6.12] cm, body mass 57.71 [4.02] kg, marathon personal best 02h 07min 16s [01min 55s]; training volume: 180-220 km·wk^{-1}; high:low intensity training ratio: 1:2). They all came from a group of eight small tribes called Kalenjin, in the Rift Valley Province. Each of these athletes read an information sheet outlining the purpose, procedures, and benefits of the study and provided written consent to participate. The protocol was approved by the local Human Research Ethics Committee in agreement with the Declaration of Helsinki on human investigation.

Data collection

Measurements were performed following the standardised techniques adopted by the International Society for the Advancement of Kinanthropometry (ISAK) [26, 27] and in a resting state. All anthropometric measures were taken by the same experienced investigator. All variables except body mass and height were measured on the right side of the body in triplicate with the median value used as the criterion.[23]

Digital standing scales (Model HF8000, Philips, Eindhoven, The Netherlands) were used to determine body mass to the nearest 0.1 kg. Stretch height was recorded during inspiration using a stadiometer (SECA, Hamburg, Germany) to the nearest 0.1 cm. The anthropometric profile also included the measurement of eight lengths using a large sliding calliper (PCE Italia s.r.l.), 11 girths using a flexible steel tape (BMI, Hersbruck, Germany), and eight breadths. All the breadths were measured using the large sliding calliper, except for the bi-epicondylar breadth which was measured using a Vernier callipers (PCE Italia s.r.l.). All anthropometric equipment was calibrated before the assessment period, with additional checks made against National Association of Testing Authorities certified calibration weights and rods. Corrected girths were calculated at the sites where the skinfold and girth measurements coincided (upper arm, thigh, and calf) using a formula originally proposed by Jelliffe and Jelliffe[28]. Skinfolds were taken using a calliper (Holtain Ltd, Crymych, UK) to the nearest 0.2 mm. The seven sites were chest, axilla, triceps, subscapula, abdomen, suprailium and front thigh. Skinfolds were taken three times and the me-

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dian was employed in further calculations. The sum of the seven skinfolds were also calculated. BD was estimated using the method of Jackson and Pollock.[24] BD was transformed to %BF by the Siri's equation.[25] The SDM, SAM, HWR and E:T were calculated using the method and equations of Carter and Heath.[21] Height-adjusted endomorphy values were used and the somatotypes were plotted on a two-dimensional grid system somatochart using the appropriate software (Somatotype 1.0 software).

TABLE I.—*Absolute size characteristics for top-class Kenyan marathon runners (mean ± s).*

Variable	Mean	s	Range
Age (yrs)	27.71	3.75	23-38
Body mass (kg)	57.71	4.02	51.2-67.2
Height (cm)	171.21	6.12	163-183
Sitting height (cm)	80.79	3.19	77.3-88.0
Personal best (h.min.s)	2.07.16	0.01.55	2.04.27-2.10.23
Skinfolds (mm)			
Chest	2.88	0.43	2.3-3.8
Axilla	3.28	2.02	0.5-7.0
Triceps	5.30	1.40	3.8-7.4
Subscapular	7.18	1.19	5.2-10.2
Abdomen	6.13	1.12	4.1-8.2
Suprailium	4.36	0.67	3.5-5.8
Front thigh	3.36	2.45	0.5-8.2
Sum of 7 skinfolds	32.48	6.02	24.05-49.6
Extremity:trunk ratio	0.38	0.13	0.2-0.7
Body density	1.13	0.02	1.11-1.16
Percentage of body fat (%)	8.87	0.07	8.8-8.9
Percentage of lean mass (%)	91.13	0.07	91.0-91.2
Lengths (cm)			
Arm Span	184.84	5.64	175.5-193
Arm	32.34	1.14	30.5-34.3
Forearm	28.12	1.12	25.5-29.75
Hand	21.26	1.12	18.5-22.5
Thigh	43.07	2.89	39-49.5
Lower leg	40.20	2.75	35.5-44
Foot	25.28	1.16	23.5-27.5
Breadths (cm)			
Biacromial	34.67	1.97	31-37
Transverse chest	30.69	1.64	28.25-34.5
Anterior-posterior chest	22.23	1.34	20.5-25
Humerus	5.32	1.11	4.35-9
Femur	7.54	1.21	6.6-11.5
Biilocristal	26.71	1.94	23.5-29.5
Girths (cm)			
Relaxed arm	24.93	1.26	23.1-27.3
Flexed arm	27.31	1.14	25.5-30
Forearm	25.15	1.01	23.5-27.5
Wrist	15.64	0.72	14.5-17
Chest	85.13	2.28	79.5-88.5
Waist	73.86	2.27	70-77.5
Hip	86.33	2.89	80.2-90
Upper thigh	50.98	1.98	48-54
Mid-thigh	46.74	2.44	42.5-51.2
Calf	33.91	1.90	31-36.5
Ankle	21.46	0.83	20.5-23.5
Corrected arm girth	2.44	0.10	2.25-2.68
Corrected thigh girth	0.42	0.21	0.15-0.78
Corrected calf girth	3.06	0.34	2.40-3.60

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Statistical analysis

Variables were tested for their skewness. All fitted to a normal distribution. Standard descriptive statistics (mean, *s* and range) were used to present the characteristics of the subjects for all directly measured and derived variables.

Results

The absolute size characteristics for top-class Kenyan marathon runners are presented in Table I. The mean somatotype, SDM, SAM HWR and E:T of top-class Kenyan marathon runners are presented in Table II and the somatopoints of each athlete in relation to the mean for the sample are displayed in the somatochart of Figure 1.

Discussion

The anthropometric profile of an athlete plays a role in determining his or her potential for success within a sport. This study is the first to investigate Kenyan marathon runners using a comprehensive range of directly measured and derived anthropometric variables. The data presented should be useful for future investigations on athlete selection, talent identification, and training programme development.

Skinfold thicknesses have a considerable face validity, providing a direct and relatively accurate measure of the amount of subcutaneous adipose tissue.[28] However, according to Norton *et al*.[29] in order to avoid the errors and assumptions which could be associated with the use of generalized predictive equations of fat percentage, the sum of skinfold values from the seven measured sites is recommended as the standard by several authors.[23, 30] Accordingly, in the present study we determined a low sum of seven skinfolds. Despite the fact that it is very risky to compare skinfold values from different studies, given the variability in technique, equipment and site location, the sum of skinfolds of our athletes was lower than that reported among groups of highly trained runners [14, 31, 32] and runners of lower ability.[33, 34] This is probably due to the fact that these runners undertake a higher training volume and that in this event fat metabolism prevails in training and competition.[35] Thus, it is likely that a lower sum of skinfolds facilitates running performance and thus minimal body fat is desirable because an excess of adipose tissue usually requires a greater muscular effort to accelerate the legs, and, consequently, the energetic expenditure at the same velocity would be higher.[36] Furthermore, fat patterning refers to the relative distribution of subcutaneous fat on the body as opposed to absolute amounts of fat.[37] To examine differences in fat patterning, most researchers compare skinfold thicknesses on the trunk and extremities.[38] In the present study, the mean E:T is low, indicating that Kenyan marathon runners seem to have a greater centralization of subcutaneous adipose tissue. This is not surprising as the body sizes of highly adapted endurance runners vary in accordance with performance requirements.[39] Thus, the loss of body fat is specific to muscular groups used during training and it is probable that lower extremity skinfolds of the Kenyan marathon runners facilitate running performance because a higher relative body mass distributed in the lower limbs would probably lead to a great muscular effort to accelerate the legs while running,[40] negative influencing the energy expenditure.

Many studies have detailed the somatotypes of athletes for various sports or positions within sports.[13, 41] Using the somatotype categories defined by Carter and Heath,[21] the top-class Kenyan marathon runners were best described as ectomor-

TABLE II.—*Somatotype variables for top-class Kenyan marathon runners (mean ± s).*

Variable	Mean	s	Range
Endomorphy	1.53	0.32	1.0-2.3
Mesomorphy	1.61	1.81	0.2-7.4
Ectomorphy	3.86	0.78	2.7-5.2
Somatotype dispersion mean	4.58	3.62	
Somatotype attitudinal mean	0.51	0.09	
Height to weight ratio	44.32	1.06	42.74-46.16
Skinfolds extremity to trunk ratio	0.36	0.11	0.19-0.51

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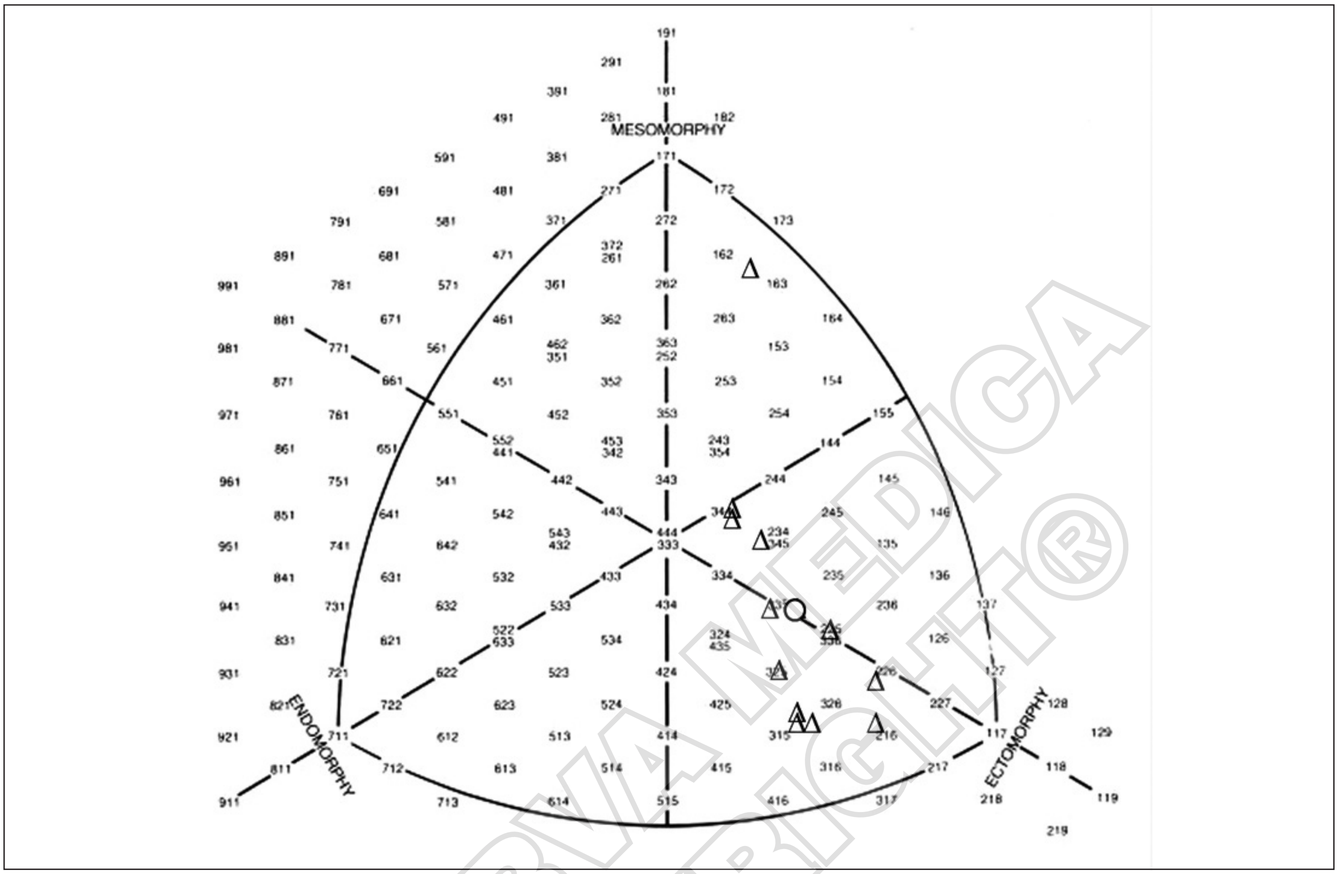

Figure 1.—Somatotype distribution of top-class Kenyan marathon runners. 0=mean somatotype (1.53-1.61-3.86).

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phy, with endomorphy and mesomorphy more than one-half unit lower. This condition has to be related to the relative linearity or slenderness of endurance runners' physique which may positively be related to the long-distance performances by having a lower body mass and, thus, requiring a smaller muscular effort while running [40] which positively influences the energetic expenditure.[33] Another possible explanation is that the variations in the aerobic capacity variables may lead to a significant interaction effect with somatotype over a long-lasting period of aerobic training and the magnitude of increase in these parameters varied according to somatotype group.[42] Thus, it could be possible that the nature of the training performed by Kenyan runners during their career have influenced their somatotype. Furthermore, the somatotype attitudinal distance is a measure of the average three-dimensional scatter of the individual somatopoints around the mean somatopoint and can be used to evaluate homogeneity in physique.[21] In the current study, Kenyan marathon runners were found to have greater homogeneity as indicated by a small SAM (*i.e.*, 0.51±0.09).

Conclusions

The present study has provided descriptive data and reference values of anthropometric characteristics, body composition and somatotype of top-class Kenyan marathon runners. These information provide a reference frame for coaches to control the training process in order to help improve athletes' performance, and to improve the specific talent detection and identification.

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