Coll. Antropol. 39 (2015) 4: 899–905
Original scientific paper

Anthropometric Characteristics of Chinese Professional Female Marathoners and Predicted Variables for Their Personal Bests

Xian-Gang Yang[1,2], Yang Wang[2], Da-Peng Bao[2], Yang Hu[2]

[1] Hebei Institute of Sport Science, Department of Research, Shijiazhuang, China
[2] Beijing Sport University, Sport Science Research Center, Beijing, China

A B S T R A C T

To investigate anthropometric characteristics of Chinese professional female marathoners and suitable predicted variables correlated with their personal bests (PB), 96 Chinese female long-distance runners were divided into international (<2 h 34 min), national (2 h 34min~2 h 45min) and average (2 h 45 min~3 h 19 min) levels according to their PB in marathon during the process of talent identification for London Olympic Games. Selected anthropometric variables, including height, body mass, percentages of body fat, girths, breadths, lengths and skin-folds were measured. Only iliac crest skin-fold of international athletes was significantly lower than it is in national group. Girth of forearm and lower limbs, length of lower limbs, and all skin-folds of national athletes were significantly lower than those from average level group. Percentages of body fat, girth of forearm and calf, length of lower limbs, and skin-folds at sites of subscapular, abdominal and iliac crest of athletes from average level group were significantly higher than those in international athletes. Positive correlation was found between forearm girth and PB, and between the subscapular, abdominal, iliac crest and triceps surae skin-folds and PB for total athletes. Negative correlation between biiliac breadth and PB in international athletes, and positive correlations between abdominal and triceps surae skin-folds and PB in national athletes were found. For average runners, high positive correlation was found between upper arm girth and PB, and between subscapular, abdominal, iliac crest and triceps surae skin-folds and PB. The findings suggested that compared to stride length, stride frequency and efficiency were more important factors influencing running performance, which were in accordance with running technique in Chinese female marathoners.

***Keyword: anthropometric** characteristics, Chinese professional female marathoners, personal best, talent identification*

Introduction

There was no doubt that anthropometric properties could be associated with exercise performance in humans. Anthropometric parameters such as body mass, body mass index (BMI), body fat, length of the upper leg, length of limbs, body height, girth of thigh, total skin-fold, and skin-folds of the lower limb had been showed association with running performance arrange from 100m to ultra-marathon previously[1-3].

High correlations in male top-class runners were found between the front thigh, the medial calf skin-folds and 1500 m and 10000 m run time, respectively. In female runners, the front thigh and medial calf skin-folds were highly correlated with 400 m run time.[4] Multiple regression and discriminant function analysis indicated that total skin-folds (triceps, biceps, subscapular, suprailiac and medial calf) was one of best predictors of running performance at the 10 km distance in male athletes.[5] Chest girth, upper leg length and thigh girth were correlated with running performances over 800, 1500 and 5000 m, while upper arm girth represented 10000 m performance in Japanese male middle- and long- distance runners[2]. Skin-folds in the lower limb are positively associated with running performances in marathon running[3]. Hetland et al. found long-distance runners had very low amounts of fat in the abdomen and legs.[6] Chest girth,

Received for publication July 10, 2013

TABLE 1
SAMPLE SIZE, PB, CV OF PB, AGE AND TRAINING DURATION OF THE ATHLETES

Groups	N	PB (min)	CV (%)	Age (years)	Training duration (years)
International	11	148.73±3.72	2.50	23.09±2.74	7.27±3.50
National	20	159.89±2.89	1.81	22.45±2.80	6.45±3.20
Average	65	175.08±12.09	6.91	19.09±2.83[a,b]	4.30±2.16[a,b]
Total	96	161.31±12.05	7.47	20.25±3.26	5.09±2.80

[a] significantly different from international runners, p<0.05
[b] significantly different from national runners, p<0.05

upper leg length, and triceps skin-fold all were assumed to be a quite powerful combination for the prediction of distance running performance for the 800, 1500 and 5000 m; and upper arm girth, arm length, and subscapular skin-fold all for the 10000 m[2]. In ultra-marathon event, Tokudome et al. found more favorable values for BMI and bone density in runners compared with sedentary controls[7]. Knechtle et al. found a positive significant association of both body mass and upper arm girth with the total running time in male Caucasian runners[8,9] and lower BMI were associated with faster running times in both male and female runners[10].

Those variables may be useful predictors of athletic performance[11] and improvements in performance were consistently associated with a decrease in the lower limb skin-fold.[12] Bale et al. also found that a slim physique high in ectomorphy was associated with improved performance in female long-distance runners[3]. These various anthropometric factors have different effects in different sports distances. Anthropometric variables for predicting personal best (PB) were also different for athletes specialized in running events differing in distance.

In recent years, female marathoners from China achieved remarkable performance in international competitions. Compared to European rivals, Chinese marathoners ran in shorter stride and faster frequency. Although such anthropometric variables mentioned which also maybe as predictors of marathon performance in Chinese female athletes, we postulated such running technique may be related to different anthropometric feature in Chinese athletes. The aims of this study were (i) to assess the anthropometric characteristics of Chinese elite female marathon athletes, (ii) to identify the best anthropometric parameters to predict their PB.

Materials and Methods

Participants

96 Chinese female long-distance runners participated in our study and all of them gave informed written consent. All athletes were officially registered in China Athletic Association, and competed in international or national competition. They were classified into three groups, international, national and average levels according to their PB in marathon. International athletes had PB faster than 2:34 (expressed in hours: minutes), national athletes had PB between 2:34 and 2:45, and average athletes had PB between 2:45 and 3:19. Participants' PB were searched in related datebases from International Athletic Association Federation (http://www.iaaf.org/athletes/biographies/index.html) and Chinese Athletic Association (http://www.athletics.org.cn/search/index.html).

Anthropometric variables

All measurements were executed during the process of talent identification for London Olympic in 2010. Height, body mass, percentages of body fat, lengths, breadths, girths and skin-folds from selected sites were measured.

Details for anthropometric parameters were presented as follows.

Girth: chest girth (horizontal girth of the chest at the level of nipples during normal breathing); upper arm girth (horizontal girth of the tensed biceps); forearm girth (maximum horizontal girth of the forearm); waist girth (minimum horizontal girth of the torso at the same level or a little above the umbilicus); hip girth (horizontal girth at the same level of most prominent place of gluteus maximus); thigh girth (horizontal girth of the middle part of the upper leg); calf girth (maximum horizontal girth of the calf); ankle girth (horizontal girth of the lowest part of the lower leg).

Length: leg length (vertical distance between the greater trochanter and the sole of the foot immediately below the lateral malleolus); upper leg length (arithmetic difference between leg length and lower leg length); lower leg length (distance from the proximal medial margin of the tibia to the floor); achilles tendon length (distance from the interior belly and inferior margin of triceps surae to pternion).

Breadth: biacromial breadth (distance between the acromial landmarks); biiliac breadth (distance between iliac crests); bitrochanterion breadth (distance between greater trochanters).

Skin-fold: triceps brachii skin-fold (back of the upper arm, halfway between the olecranon and the acromial process); subscapular skin-fold (inferior tip of the scapula, following the diagonal line of the left edge of the scapula); abdominal skin-fold (5 cm adjacent to the umbilicus, to the right side); iliac crest skin-fold (immediately above the iliac crest, on the most lateral side); triceps surae skin-fold (a point on the medial inside surface of the calf, at the level of the largest girth).

Body mass and percentages of body fat were measured by bioelectrical impedance technology using a commercial electronic body fat scale (BC-570, TANITA, JPN), to the nearest 0.1 kg and 0.1% respectively. Height, lengths, breadths and girths were measured to the nearest 0.1 cm using sliding caliper and steel tape measure. Skin-folds were measured to the nearest 0.2 mm using skin-fold caliper. Such morphological measuring equipment came from civil constitution monitoring instruments, which were provided by China Institute of Sport Science (CISS). Lengths, girths and skin-folds of the limbs were measured on the right side. All measurements of anthropometric variables were made by the same experienced investigator. Every measurement was taken three times in the morning following a 12 h fast at least, and the average value used for calculation. During this period, the athletes maintained their normal training schedule.

Statistical analysis

Athletes' PB were converted to minutes and data were expressed as mean±standard deviation (SD). The coefficient of variation (CV) of PB (CV=100%*SD/mean) was calculated. Analysis of variance was used to examine the difference between different levels of athletes. Pearson correlations were applied to study the interrelationships between the selected anthropometric variables and PB. All statistic analyses were performed with the Statistical Package for Social Sciences (SPSS, Version 13.0). The significance level was set to 0.05.

Results

The sample size, PB, CV of PB, age and training duration of the athletes in total and subgroups were summarized in Table 1. Age and training duration in both international and national groups were significantly higher than those in average groups, while there was no significant difference between international and national marathoners (Table 1).

As showed in Table 2, only iliac crest skin-fold of international athletes were significantly lower than its in national group (p=0.030), while there was no significant difference in remaining variables between international and national athletes (Table 2).

Girths of thigh, calf, ankle and forearm (p=0.010, p=0.010, p=0.013, p=0.000), lengths of leg, lower leg, upper leg and achilles tendon (p=0.000, p=0.000, p=0.018, p=0.031), and skin-folds at all sites (p=0.011, p=0.007, p=0.007, p=0.031, p=0.001) of athletes from national group were significantly lower than those from average group.

Percentages of body fat (p=0.030), girths of forearm and calf (p=0.046, p=0.007), lengths of leg, upper leg and lower leg (p=0.003, p=0.041, p=0.010), and skin-folds in subscapular, abdominal and iliac crest (p=0.000, p=0.000, p=0.000)of athletes from average group were significantly higher than those in international group.

As shown in Table 3, lower positive correlation between forearm girth and PB (r=0.364, p=0.018), and moderate positive correlations were found between the subscapular, abdominal, iliac crest, triceps surae skin-folds and PB (r=0.614, p=0.000; r=0.597, p=0.000; r=0.504, p=0.002; r=0.477, p=0.004) for total athletes.

In international group, only moderate negative correlation was found between biiliac breadth and PB (r=-0.692, p=0.018). For national runners, moderate positive correlations were found between abdominal and triceps surae skin-folds and PB (r=0.534, p=0.040; r=0.519, p=0.047). For average runners, high positive correlations were found between upper arm girth and PB (r=0.650, p=0.022), and between subscapular, abdominal, iliac crest and triceps surae skin-folds and PB (r=0.739, p=0.009; r=0.654, p=0.029; r=0.794, p=0.004; r=0.743, p=0.009). There was no significant correlation between length of limbs and PB in both entire sample and subgroups (Table 3).

Discussion

This was the first study which systematically and comprehensively explored the anthropometric properties of Chinese female marathoners and established a unique database, especially including almost all elite athletes in China at present. The participants were comprised of 96 highly trained athletes, whose main event was marathon, although most of athletes also competed in 5000 m and 10000 m, even competed in 1500m. Importantly, athletes in international and national groups had glorious PB and in highly homogeneous, with average PB 2 h 28 min and 2 h 39 min, and CV 2.50% and 1.81%, respectively.

Anthropometric variables in our study could be divided into two groups. The first group included height, length and breadth, which were measured between two osseous markers and constant after maturity. The latter group included weight, %fat, girth and skin-folds, which might be altered by diets and training. Stride length, frequency and efficient are the most important elements of marathon. Such as height, length of leg, upper leg and lower leg directly influenced the stride length. Rahmani found Senegalese sprinters had longer and lighter legs than Italian athletes[13], which contributed to more stride length and more efficiency during acceleration and deceleration. There was no study available to compare Chinese athletes with competitor from different countries. Our study investigated shorter height, length of lower extremity and also lighter body mass in international and national athletes compared to average ones. It was suggested that compared to stride length, stride frequency and efficiency would be more important factors in achieving better performance in Chinese female marathoners.

Several previous studies had highlighted the importance of the assessment of skin-folds in the lower limbs. Graves *et al.* reported only the medial calf skin-fold in elite

TABLE 2
THE DIFFERENCE OF ANTHROPOMETRY VARIABLES IN THREE SUBGROUPS

	International group	National group	Average group
Height (Cm)	161.05±5.40	161.10±4.14	164.72±5.08
Body Mass (Kg)	49.64±3.38	49.44±4.23	52.14±5.19
Percentage Of Body Fat (%)	15.85±4.03	17.06±4.35	18.88±4.15[c]
Girth (Cm)			
Chest	81.44±2.46	81.41±2.93	81.07±3.56
Waist	66.31±3.60	66.62±3.98	67.67±5.13
Hip	85.12±3.59	86.05±1.91	87.49±3.98
Thigh	49.61±2.16	49.17±2.05[b]	50.99±2.94
Calf	33.66±1.55	33.63±1.79[b]	34.82±1.79[c]
Ankle	19.97±0.84	19.76±0.81[b]	20.44±1.15
Upper Arm	23.83±1.11	22.90±2.09	23.49±1.64
Forearm	20.52±0.98	20.43±1.06[b]	21.63±1.32[c]
Breadth (Cm)			
Biacromial	35.14±1.26	35.12±0.80	35.07±1.96
Biiliac	24.02±2.29	23.70±1.84	23.92±2.20
Bitrochanterion	28.49±2.41	28.66±2.39	29.26±2.67
Length (Cm)			
Leg	80.73±3.01	80.69±2.77[b]	84.10±3.63[c]
Lower Leg	41.51±1.75	41.32±1.56[b]	43.24±2.18[c]
Upper Leg	39.22±2.18	39.37±2.32[b]	40.86±2.49[c]
Achilles Tendon	21.37±1.51	21.37±2.19[b]	22.81±2.81
Skin-Fold (Mm)			
Triceps Brachii	7.78±3.59	6.91±2.70[b]	9.06±2.89
Subscapular	4.94±1.83	6.41±2.10[b]	8.19±2.36[c]
Abdominal	5.17±2.19	7.84±4.87[b]	10.79±3.61[c]
Iliac Crest	3.44±1.86[a]	7.80±7.17[b]	10.76±4.16[c]
Triceps Surae	5.61±2.25	4.16±2.14[b]	7.20±3.38

a significantly different from national runners, $p<0.05$
b significantly different from average runners, $p<0.05$
c significantly different from international runners, $p<0.05$

female distance runners was statistically lower than its in good runners[14]. Bosch et al. compared black with white runners and found significant thinner skin-folds in triceps brachill, front thigh and medial in black runners compared to white runners[15]. Coetzer et al. also reported that 10000 m runners with average PB of 28min 33s (CV=2.0%) had a significantly lower sum of seven skin-folds compared to athletes with average best times of 29min 38s (CV=2.2%)[16]. Lower BMI[17] and the smaller body size were of importance for the better performance of the black runners[18]. To our knowledge, literature regarding the difference of anthropometric characteristics between different levels of female marathoners was rare, especially related to distance between osseous markers. There was no significant difference in height, bone width (humerus and femur) and girths (upper arm and calf) between elite, good and moderate female runners, with PB marathon time of <2 h 55 min, 2 h 55 min~3h 8 min, 3h 18 min~3h 30 min, respectively, whereas significant difference was found in triceps, subscapular, calf and total skin-folds, and calculated parameters such as percentage fat and body density[2]. Bale et al. observed the similar results using same variables in athletes majored in 10 km.[5] Our study observed not only significant difference in height and lengths of lower extremity, but also in girths of limbs and selected skin-folds between international and national, and average athletes. The results reflected that shorter and leaner the athletes were, the better PB they achieved.

How did the anthropometric properties influence running performance may be explained by both energetic expenditure and human kinetics. Higher skin-folds reflected more adipose tissue, and higher percentages of fat were also observed in average athletes in our study. An excess of adipose tissue usually required a greater muscular effort to accelerate the lower extremity, and the energetic expenditure at the same velocity would be higher. It was suggested that swing legs during a stride constitute a substantial part of the total metabolic cost of running. Based

TABLE 3
ASSOCIATION BETWEEN ANTHROPOMETRY VARIABLES AND PB IN TOTAL AND SUBGROUPS

	Total	International	National	Average
Height (Cm)	0.181	0.045	–0.029	0.317
Body Mass (Kg)	0.142	–0.116	0.086	0.482
Percentage of Body Fat (%)	0.162	–0.339	0.388	0.086
Girth (Cm)				
Chest	–0.053	–0.264	–0.054	0.163
Waist	–0.056	–0.196	–0.182	–0.147
Hip	0.172	–0.228	–0.217	0.248
Thigh	0.242	–0.594	–0.183	0.379
Calf	0.159	–0.355	–0.107	–0.269
Ankle	0.006	–0.076	0.192	–0.092
Upper Arm	0.098	–0.025	–0.057	0.650 p=0.022
Forearm	0.364 p=0.018	–0.348	–0.167	0.360
Breadth (Cm)				
Biacromial	–0.171	–0.248	0.009	–0.024
Biiliac	–0.223	–0.692 P=0.018	0.073	–0.489
Bitrochanterion	0.240	–0.522	0.071	0.441
Length (Cm)				
Leg	0.202	–0.236	0.018	0.324
Lower Leg	0.171	0.153	–0.099	0.176
Upper Leg	0.130	–0.448	0.076	0.267
Achilles Tendon	0.142	–0.384	–0.065	0.009
Skin-Fold (Mm)				
Triceps Brachii	0.314	0.062	0.298	0.561
Subscapular	0.614 p=0.000	–0.292	0.088	0.739 p=0.009
Abdominal	0.593 p=0.000	0.305	0.534 p=0.040	0.654 p=0.029
Iliac Crest	0.504 p=0.002	0.548	0.375	0.794 p=0.004
Triceps Surae	0.477 p=0.004	–0.533	0.519 p=0.047	0.743 p=0.009

Note: p-value is shown when <0.05.

on biomechanical considerations, morphology of lower extremity was regarded as a significant influence on the energetic cost of movement. For a given body mass, speed and gait, the smaller and more proximally distributed limb mass, the less kinetic energy required to accelerate and decelerate the legs, and thus, the lower the cost of movement[19]. Myers et al. had demonstrated a clear effect of limb mass and its distribution on cost of locomotion, the energy consumption of running at a given speed increased as the position of the same loads became more distal from waist to ankle[20]. Considering shorter height, there was no significant difference in the ratio of leg length to height, and the upper leg to leg length. Longer length of leg could bring longer stride length, at the other hand, brought more mass of lower extremity. Higher skin-folds in lower extremity also reflected higher relative body mass distributed in the lower limbs, which was not beneficial to swing legs during running, the energetic expenditure would be higher, ultimately decreased stride frequency and efficiency[15]. It was reasonable to postulate that mass of lower extremities, not the length itself, influenced the performance.

Most of studies focused on association between the body mass, percentages of fat and skin-folds (single, total and extremity/trunk ratio) and running performance, but were mainly studied based on heterogeneous samples. Hartung et al. found a significant correlation between percentage fat and marathon race time (average PB=3 h 26 min 54 s; CV=17.5%; r=0.38)[21]. Ready reported that body fat was significantly correlated with provincial ranking in 10 top-class middle-distance female runners (r=0.98)[22]. Tanaka et al. also reported a weak but statistically significant association between percentage fat and 10000 m race time in female runners (average PB=38 min 26.7s, CV=6.8%, r=0.33)[23]. Deason et al. observed a similar relationship in male 800m runners (average PB=2 min 12.6s; CV=5.5%; r=0.74)[24]. Brandon et al. reported correlations of r=0.67, 0.64 and 0.69 for percentage fat and 800m (average PB=2 min 21s, CV=8.5%), 1500m (average PB=4 min 51s, CV=10.3%) and 3000m (average PB=10 min 37s, CV=11.3%)race times, respectively[25]. The coefficients of the simple linear correlations with marathon performance time (between 2h 15min 21s and 4h 54 min 31s) were 0.67 for subscapular skin-fold and 0.61 for %fat.

Arrese *et al.* found iliac crest and abdominal skin-folds were correlated with race time in a homogeneous group of female marathoners (r=0.62, p=0.042; r=0.61, p=0.046), with average PB of 2 h 35 min 35 s and CV of 4.43%[4]. They also pointed out that the CVs in elite athletes were so small that high correlations between anthropometric parameter and running performance were not expected. Our investigation still got the similar results, which showed association between abdominal skin-fold and PB in national, average and total groups (r=0.534, p=0.040; r=0.654, p=0.029; r=0.593, p=0.000, respectively), and between iliac crest skin-fold and PB in average and total groups (r=0.504, p=0.002; r=0.794, p=0.004, respectively). In addition to these, we also found significant association between subscapular skin-fold and PB in both average and total groups, and between triceps surae skin-fold and PB in national, average and total groups. No association between triceps brachii skin-fold and PB was found suggested that skin-fold in both trunk and lower extremity were main sites influencing athletic performance. Arrese et al. attributed low correlation to heterogeneous samples with much higher CV in previous studies, which was supported by no significant association between sum of skin-folds, percentage fat and race time in 3000 m steeplechase, 5000 m[26] and 10 km[27] events (average PB: 8 min 38 s, 14 min 5 s and 32 min 6 s, respectively), with CV of 1.2%, 0.6%, 3.1%, respectively. There was also no association between any anthropometry parameters and PB found in international athletes (CV=2.50%), but in national groups (CV=1.81%). We postulated whether skin-folds could be suitable predictors of PB depending on subjects' performance. Besides possible genetic predisposition to leanness, intensive training and optimal nutrition supplementation made Chinese female international marathoners' skin-folds relatively lower and more stable compared to national and average athletes. Skin-folds were no longer determinants of performance in elite athletes. It was interesting that biiliac breadth was negatively correlated with performance in international group (r=-0.692, p=0.018). The boarder the biiliac breadth was, the better PB they achieved, but the reason was unclear.

The only limitation of our study was the time that elapsed between the measurements of anthropometric variables and achieving PB. It was noticed that athletes from international and national groups were older and had longer training duration than those in average group. We could not exclude the possibility that some average athletes would make great progress and become international competitors in the future. Their morphologic features would change greatly during this period, especially in first group of variables selected in our study. Although results revealed that there was no ideal anthropometric parameters for predicting PB in Chinese elite marathoners, but difference between three levels suggested that stride frequency and efficiency were more important determinants of performance in accordance with running technique in this cohorts.

Conclusion

Girth of limbs, length of lower extremity and skin-folds were main differences between athletes in different levels in Chinese female marathoners. International and national athletes presented lower girth in limbs, shorter height and lower extremity length, and thinner skin-folds. Anthropometric parameters predicting PB included skin-folds at trunk and lower extremity in national, average and total athletes, but not in international athletes. Stride frequency and efficiency were more important determinants of performance compared to stride length, which were in accordance with running technique in Chinese female marathoners.

Acknowledgements

This work was supported by Department of Science and Technology of the People's Republic of China (grant code: 2006BAK37B02).

REFERENCES

1. SHARWOOD K, COLLINS M, GOEDECKE J, WILSON G, NOAKES T, Clin J Sport Med, 12 (2002) 391. DOI: 10.1097/00042752-200211000-00012. — 2. TANAKA K, MATSUURA Y, Ann Hum Biol, 9 (1982) 473. DOI: 10.1080/03014468200006001. — 3. BALE P, ROWELL S, COLLEY E, J Sports Sci, 3 (1985) 115. DOI: 10.1080/02640418508729741. — 4. ARRESE AL, OSTARIZ E S, J Sports Sci, 24 (2006) 69. DOI: 10.1080/02640410500127751. — 5. BALE P, BRADBURY D, COLLEY E, Br J Sports Med, 20 (1986) 170. — 6. HETLAND ML, HAARBO J, CHRISTIANSEN C, Scand J Med Sci Sports, 8 (1998) 102. DOI: 10.1111/j.1600-0838.1998.tb00176.x. — 7. TOKUDOME S, KURIKI K, YAMADA N, ICHIKAWA H, MIYATA M, SHIBATA K, HOSHINO H, TSUGE S, TOKUDOME M, GOTO C, TOKUDOME Y, KOBAYASHI M, GOTO H, SUZUKI S, OKAMOTO Y, IKEDA M, SATO Y, J Epidemiol, 14 (2004) 161. DOI: 10.2188/jea.14.161. — 8. KNECHTLE B, KNECHTLE P, SCHULZE I, KOHLER G, Br J Sports Med, 42 (2008) 295. DOI: 10.1136/bjsm.2007.038570. — 9. KNECHTLE B, DUFF B, WELZEL U, KOHLER G, Res Q Exerc Sport, 80 (2009) 262. DOI: 10.1080/02701367.2009.10599561. — 10. HOFFMAN M D, Int J Sports Med, 29 (2008) 808. DOI: 10.1055/s-2008-1038434. — 11. BERG K, Sports Med, 33 (2003) 59. DOI: 10.2165/00007256-200333010-00005. — 12. LEGAZ A, ESTON R, Br J Sports Med, 39 (2005) 851. DOI: 10.1136/bjsm.2005.018960. — 13. RAHMANI A, LOCATELLI E, LACOUR J R, Eur J Appl Physiol, 91 (2004) 399. DOI: 10.1007/s00421-003-0989-x. — 14. GRAVES J E, POLLOCK M L, SPARLING P B, Int J Sports Med, 8 (1987) 96. DOI:

10.1055/s-2008-1025713. — 5. BOSCH AN, GOSLIN B R, NOAKES T D, DENNIS S C, Eur J Appl Physiol Occup Physiol, 61 (1990) 68. DOI: 10.1007/BF00236696. — 6. COETZER P, NOAKES T D, SANDERS B, LAMBERT MI, BOSCH A N, WIGGINS T, DENNIS S C, J Appl Physiol, 75 (1993) 1822. — 7. LARSEN H B, Comp Biochem Physiol A Mol Integr Physiol, 136 (2003) 161. DOI: 10.1016/S1095-6433(03)00227-7. — 8. MARINO F E, LAMBERT M I, NOAKES T D, J Appl Physiol, 96 (2004) 124. — DOI: 10.1152/japplphysiol.00582.2003. — 9. MORGAN W P, DANIELS T, Int J Sports Med, 15 (1994) 426. DOI: 10.1055/s-2007-1021082. — 20. MYERS M J, STEUDEL K, J Exp Biol, 116 (1985) 363. — 21. HARTUNG G H, SQUIRES W G, J Sports Med Physical Fitness, 22 (1982) 366. — 22. READY A E, Can J Appl Sport Sci, 9 (1984) 70. — 23. TANAKA K, MIMURA K, KIM HS, KAWABATA T, TAJIMA M, NAKADOMO F, MAEDA K, Ann Physiol Anthropol, 8 (1989) 79. DOI: 10.2114/ahs1983.8.79. — 24. DEASON J, POWERS S K, LAWLER J, AYERS D, STUART M K, J Sports Med Physical Fitness, 31 (1991) 499. — 25. BRANDON L J, BOILEAU R A, J Sports Med Physical Fitness, 32 (1992) 1. — 26. KENNEY W L, HODGSON JL, Br J Sports Med, 19 (1985) 207. DOI: 10.1136/bjsm.19.4.207. — 27. CONLEY DL, KRAHENBUHL GS, Med Sci Sports Exercise, 12 (1980) 357. DOI: 10.1249/00005768-198025000-00010.

Y. Hu

Hu Yang, Sport Science Research Center, Beijing Sport University, No. 48, Xinxi Road, Haidian District, Beijing, China; e-mail: hyyr1@163.com

ANTROPOMETRIJSKE KARAKTERISTIKE KINESKIH PROFESIONALNIH MARATONKI I PREDVIĐENE VARIJABLE ZA NJIHOVE NAJBOLJE OSOBNE REZULTATE

SAŽETAK

Kako bi istražili antropometrijska obilježja kineskih profesionalnih maratonki i prikladne predviđene varijable u korelaciji s njihovim najboljim osobnim rezultatima (PB), 96 kineskih trkačica na duge udaljenosti su podijeljene u međunarodne (<2 h 34 min), nacionalne (2h 34min ~ 2 h 45min) i prosječne (2 h 45 min ~ 3 h 19 min) razine prema njihovoj PB u maratonu tijekom procesa identifikacije talenata za Olimpijske igre u Londonu. Izmjerene su odabrane antropometrijske varijable, uključujući visinu, tjelesnu masu, postotak tjelesne masti, širinu, obujam, duljinu i nabore koža. Samo su ilijačni grbovi kože kod međunarodnih sportaša bili znatno manji nego što su u nacionalnoj skupini. Obujam podlaktice i donjih udova, dužine donjih udova i sve vrijednosti nabora koža nacionalnih sportaša bile su znatno niže od onih iz razine prosječne skupine. Postoci tjelesne masnoće, obujam podlaktice i potkoljenice, dužine donjih udova, a koža nabora na mjestima subscapular, abdomena i zdjelične kosti od sportaša iz razine prosječne skupine bili su znatno veći od onih u međunarodnim sportaša. Pozitivna korelacija je pronađena između obujma podlaktice i PB-a, i između nabora kože triceps surae subscapular, abdomena, zdjelične kosti i i PB za ukupne sportaša. Negativna korelacija između bilijačne širine i PB-a u međunarodnih sportaša i pozitivne korelacije između trbuha i nabora kože triceps surae i PB-a u je pronađen kod nacionalnih sportaša. Za prosječnog trkača, visoka pozitivna korelacija između opseg nadlaktice i PB-a, te između subscapulara, abdomena, zdjelične kosti i nabora kože triceps surae i PB-a. Ovi nalazi sugeriraju da su duljina koraka, učestalost koraka i učinkovitost bili važni čimbenici koji utječu na performanse trčanja, koji su bili u skladu s tehnikom trčanja kod kineskih maratonki.