

## **Anthropometric measurements and body composition of selected national athletes**

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### **ABSTRACT**

This study was conducted to determine the anthropometric measurements and body composition of selected national athletes. A total of 84 male athletes from 10 different types of sports and 24 female athletes from 5 types of sports were studied. The height and body weight of subjects were measured using the SEGA weighing balance with height attachment. Skinfold thickness measurements were taken using the Harpenden Calipers at 4 sites (biceps, triceps, subscapular and suprailiac). Percentage of body fat was calculated from the sum of 4 measurements of skinfold thickness. Based on body mass index (BMI), most of the male (68 subjects or 81%) and female (19 subjects or 79%) athletes were classified as normal. The percentage average body fat for both male and female athletes were  $13.8 \pm 4.5\%$  and  $24.7 \pm 5.3\%$ , respectively. The male and female athletes also had lower percentage of body fat when compared to non-athletes, however these athletes had slightly higher percentage of body fat when compared to those in selected countries.

### **INTRODUCTION**

Physical characteristics and body composition have been known to be fundamental to excellence in athletic performance (Mathur & Salokun, 1985). Specific athletic events require different body types and weights for maximal performance (American Dietetics Association, 1987). Some studies on the anthropometric measurements and body composition of obese students (Ismail & Chi, 1987), university students (Ismail & Zawiah, 1988), university staffs (Ismail & Zawiah, 1989) and Malaysian soldiers (Ismail, Isa & Janudin, 1991) have been carried out in Malaysia. However, there has been no information on anthropometric and body composition data of athletes although our government is very keen on sport excellence. The purpose of this study were to collect baseline data on anthropometric measurements and body composition of male and female national athletes and to compare with those in selected countries.

### **MATERIALS AND METHODS**

A total of 84 national male athletes from 10 different types of sports and 24 national female athletes from 5 types of sports were selected for this study. The selection of athletes and type of sports were based on priority determined by National Sports Council of Malaysia (NSC). The measurements were made at training camps during centralised training in preparation of the SEA

games.

The height and weight of subjects (barefooted and in light clothing) were measured to the nearest 0.5 cm and 0.1 kg, respectively, using the SECA weighing balance with height attachment. Skinfold thickness measurements were taken using Harpenden Calipers (British Indicators, UK) at 4 sites (biceps, triceps, subscapular and suprailiac) as recommended by Durnin and Rahaman (1967). Fat content as percentage of body weight was calculated from the sum of 4 measurements of skinfold thickness (Durnin & Womersley, 1974).

The body mass index ( $\text{kg/m}^2$ ) was also calculated for each subject. Body weight classification for subjects were determined as described by Bray (1979). Results were presented as a mean  $\pm$  SD and range. The anthropometric and body composition data of the athletes were compared with non-athletes (Ismail & Zawiah, 1988) and also with athletes of selected countries. Statistical differences in anthropometric and body composition data of the athletes and non-athletes were assessed by t-test.

Table 1. Mean physical characteristics of male athletes

Type of sports	n	Age (yr)	Weight (kg)	Height (m)	BMI ( $\text{kg/m}^2$ )	Body fat (%)
1. Sepaktakraw	17	23.9 $\pm$ 2.4	64.7 $\pm$ 4.9	1.73 $\pm$ 0.05	21.6 $\pm$ 1.6	15.2 $\pm$ 2.8
2. Badminton	7	16.4 $\pm$ 0.9	61.3 $\pm$ 4.9	1.67 $\pm$ 0.05	22.0 $\pm$ 1.8	14.6 $\pm$ 2.9
3. Swimming	6	18.0 $\pm$ 1.6	65.1 $\pm$ 5.8	1.74 $\pm$ 0.06	21.4 $\pm$ 1.3	8.8 $\pm$ 1.8
4. Basketball	11	24.4 $\pm$ 3.3	84.3 $\pm$ 5.2	1.88 $\pm$ 0.05	23.9 $\pm$ 1.4	14.1 $\pm$ 2.3
5. Silat	6	25.5 $\pm$ 1.4	67.3 $\pm$ 17.0	1.71 $\pm$ 0.09	22.6 $\pm$ 3.8	12.1 $\pm$ 5.2
6. Hockey	15	25.1 $\pm$ 2.8	67.4 $\pm$ 6.7	1.73 $\pm$ 0.07	22.5 $\pm$ 1.3	11.4 $\pm$ 2.5
7. Boxing	7	27.7 $\pm$ 3.2	56.9 $\pm$ 6.2	1.65 $\pm$ 0.05	20.9 $\pm$ 1.8	14.3 $\pm$ 2.0
8. Weight lifting (group 1)	5	27.8 $\pm$ 2.1	63.9 $\pm$ 8.7	1.60 $\pm$ 0.05	25.0 $\pm$ 2.3	18.0 $\pm$ 4.1
Weight lifting (group 2)	3	27.0 $\pm$ 5.7	110.1 $\pm$ 7.4	1.73 $\pm$ 0.00	36.9 $\pm$ 2.7	27.2 $\pm$ 1.3
9. Athletics	6	23.5 $\pm$ 3.7	63.3 $\pm$ 4.4	1.72 $\pm$ 0.06	21.3 $\pm$ 0.3	9.3 $\pm$ 1.6
10. Discus	1	25	85.5	1.73	28.6	17.1
Mean		23.9 $\pm$ 4.2	68.8 $\pm$ 13.2	1.73 $\pm$ 0.09	22.9 $\pm$ 3.5	13.8 $\pm$ 4.5

Table 2. Mean physical characteristics of female athletes

Type of sports	n	Age (yr)	Weight (kg)	Height (m)	BMI ( $\text{kg/m}^2$ )	Body fat (%)
1. Swimming	5	16.2 $\pm$ 2.1	53.1 $\pm$ 3.1	1.61 $\pm$ 0.04	20.6 $\pm$ 1.5	25.3 $\pm$ 1.7
2. Basketball	13	21.6 $\pm$ 1.9	61.4 $\pm$ 5.4	1.70 $\pm$ 0.07	21.2 $\pm$ 1.4	25.6 $\pm$ 4.7
3. Silat	2	25.5 $\pm$ 4.5	51.0 $\pm$ 11.0	1.54 $\pm$ 0.07	21.5 $\pm$ 3.0	24.5 $\pm$ 8.9
4. Athletics	3	22.0 $\pm$ 0.8	51.3 $\pm$ 1.2	1.66 $\pm$ 0.03	18.6 $\pm$ 1.0	17.4 $\pm$ 1.4
5. Shot-putt	1	27	71.8	1.69	25.1	32.3
Mean		21.1 $\pm$ 3.6	58.0 $\pm$ 7.6	1.66 $\pm$ 0.08	20.9 $\pm$ 2.0	24.7 $\pm$ 5.3

## RESULTS AND DISCUSSION

The mean physical characteristics of male and female athletes are shown in Table 1 and Table 2,

respectively. The mean age for male and female athletes were  $23.9 \pm 4.2$  and  $21.1 \pm 3.6$  year, respectively. Generally, all the athletes studied were classified as adult, except for athletes in badminton and swimming (for male athletes) and swimming (for female athletes) who were below 18 years old.

The mean body weight of male and female athletes were  $68.8 \pm 13.2$  kg and  $58.0 \pm 7.6$  kg, respectively. The mean body weight for the male athletes in most type of sports were in the range of 60 - 70 kg, except for boxing ( $56.9 \pm 6.2$  kg), basketball ( $84.3 \pm 5.2$  kg) and weight lifting (group 2) ( $110.1 \pm 7.4$ kg). The athletes from weight lifting (group 2) have the heaviest body weight because they were selected from the heavyweight, super heavyweight and super-super heavyweight's groups. For the female athletes, the mean body weight was in the range of 50 - 55 kg, except for athletes from basketball team ( $61.4 \pm 5.4$  kg) and shot-put (71.8 kg).

The mean height of male and female athletes were  $1.73 \pm 0.09$  m and  $1.66 \pm 0.08$  m, respectively. The athletes from basketball teams were the tallest group for male and female athletes, with a mean of  $1.88 \pm 0.05$  m and  $1.70 \pm 0.07$  m, respectively. This special physical characteristic of the athletes were consistent with the physical need for that kind of sports. These findings were similar to that reported by Mayhew, Piper and Holmes (1981) based on their study of 129 collegiate male athletes from 6 types of sports in United States of America. They reported that athletes from the basketball team were the tallest group with mean height of  $1.89 \pm 0.08$  m. Withers et al. (1987a) and Withers et al. (1987b) also reported that the male and female basketball players were heavier than most types of sports in South Australia.

The mean body mass index (BMI) and body fat of male athletes were  $22.9 \pm 3.5$  kg/m<sup>2</sup> and  $13.8 \pm 4.5\%$ , respectively, while for female athletes were  $20.9 \pm 2.0$  kg/m<sup>2</sup> and  $24.7 \pm 5.3\%$ , respectively. The male athletes from swimming and athletics were found to have the lowest body fat, while the weight lifters (group 1 and group 2) had the highest body fat compared to others. Relatively, the mean percentage body fat of male swimmers and athletics were  $8.8 \pm 1.8\%$  and  $9.3 \pm 1.6\%$ , respectively, while for weight lifters (group 2) was  $27.2 \pm 1.3\%$ . Similarly, the female athletes from the sport of athletics also have a lower body fat ( $17.4 \pm 1.4\%$ ), while the athletes from the sport of shot-put had a higher body fat ( $32.3\%$ ) compared to others.

The BMI classification of male athletes are shown in Table 3. Based on the classification by Bray (1979), most of the male athletes (68 subjects or 81%) were classified as normal (BMI 20.0 - 25.0), while 6 subjects (7%) were classified as underweight (BMI < 20.0), 7 subjects (8%) were classified as overweight (BMI 25.0 - 29.9), 2 subjects (3%) were classified as moderately obese (BMI 30.0 - 39.9) and 1 subject (1%) was classified as severely obese (BMI  $\geq$ 40.0). However it was clear that the athletes who had BMI above normal were not due to excessive body fat but due to muscle mass, thus they could not be classified as having body weight problem. The percentage of body fat data of athletes from various types of sports (Table 1) can support this statement, except for weight lifters (group 2), however, it was well known that the accuracy of skinfold thickness measurements on large body size subjects (eg. weight lifters) are quite difficult to achieve. Using a similar technique, the results obtained were within the range (5 - 38%) as reported by Durnin and Womersley (1974) in their study among 92 male subjects, aged from 20 - 29 year and body weight from 50 - 116 kg.

Table 4 presents the BMI classification of female athletes. Most of the female athletes (19 subjects or 79 %) were classified as normal (BMI 18.6 - 23.8), 3 subjects (13%) were classified as underweight (BMI < 18.6), only 2 subject (8%) were classified as overweight, while none were classified as obese. The two overweight subjects were from silat and shot-putt games, respectively. Their percentage of body fat were within the range as reported by Durnin and Womersley (1974) in their study among 100 female subjects whose age ranged from 20 – 29 years and body weight ranged from 47 - 114kg.

Table 3. BMI classification\* of male athletes

Type of sports	n	Under-weight (BMI <20.0)	Normal (BMI 20.0 -25.0)	Overweight (BMI25.1-29.9)	Moderately obese (BMI 30.0 - 39.9)	Severely obese (BMI ≥40.0)
1. Sepaktakraw	17	2	15	0	0	0
2. Badminton	7	1	6	0	0	0
3. Swimming	6	1	5	0	0	0
4. Basketball	11	0	9	2	0	0
5. Silat	6	1	5	0	0	0
6. Hockey	15	0	14	1	0	0
7. Boxing	7	1	6	0	0	0
8 Weight lifting (group 1)	5	0	2	3	0	0
Weight lifting (group 2)	3	0	0	0	2	1
9. Athletics	6	0	6	0	0	0
10. Discus	1	0	0	1	0	0
Total	84	6	68	7	2	1
Percent (%)	100	7	81	8	3	1

\* Bray (1979)

Table 4. BMI classification\* of female athletes

Type of sports	n	Under-weight (BMI <18.6)	Normal (BMI 18.6 - 23.8)	Overweight (BMI 23.9 - 28.7)	Moderately obese (BMI 28.8 - 39.9)	Severely obese (BMI ≥40.0)
1. Swimming	5	0	5	0	0	0
2. Basketball	13	0	13	0	0	0
3. Silat	2	1	0	1	0	0
4. Athletics	3	2	1	0	0	0
5. Shot-putt	1	0	0	1	0	0
Total	24	3	19	2	0	0
Percent (%)	100	13	79	8	0	0

\* Bray (1979)

Table 5 presents the mean anthropometric measurements and body composition of Malaysian athletes compared to those in selected countries. In general, based on weight and height, the Malaysian male and female athletes were comparable to others. However, their percentage body

fat were higher when compared to athletes in selected countries, especially the female athletes. Similar trends were observed among different types of sports as shown in Table 6 and Table 7, except for male swimmers in the USA, whose percentage body fat was the highest. Although the studies in those selected countries may be using different techniques, the results obtained may not differ significantly. Nowak, Knudsen and Schulz (1988) showed no significant difference between body fat values assessed by bioelectrical impedance and skinfolds among basketball players. Durnin and Womersley (1974) also reported that there was no significant difference of body fat calculated from the equation of Siri (1956) and Brozek *et al.* (1963).

Table 5. Comparison of mean physical characteristics of male and female athletes in selected countries.

Countries	n	Age (yr)	Weight (kg)	Height (m)	BMI (kg/m <sup>2</sup> )	Body fat (%)
<b>Male athletes:</b>						
*South Australia <sup>1</sup>	207	24.2	74.7	1.80	23.1	10.1
*China <sup>2</sup>	23	22.0	83.1	1.74	27.4	NA
*Israel <sup>3</sup>	29	NA	70.7	1.76	22.8	9.3
*U.S.A. <sup>4</sup>	129	20.1	79.3	1.79	24.7	11.0
**Malaysia	84	23.9	68.8	1.73	22.9	13.8
<b>Female athletes:</b>						
*South Australia <sup>5</sup>	182	22.5	59.2	1.67	21.2	18.5
*China <sup>2</sup>	14	20.0	66.0	1.66	24.0	NA
*Israel <sup>3</sup>	20	NA	58.8	1.66	21.3	13.5
*Nigeria <sup>6</sup>	69	20.4	58.5	1.63	22.0	15.8
*Germany <sup>7</sup>	20	20.6	57.0	1.63	22.0	15.2
**Malaysia	24	21.1	58.0	1.66	20.9	24.7

\*University athletes, <sup>1</sup>Withers *et al.* (1987a), <sup>2</sup>Chen *et al.* (1989), <sup>3</sup>Hanne *et al.* (1986), <sup>4</sup>Mayhew *et al.* (1981), <sup>5</sup>Withers *et al.* (1987b), <sup>6</sup>Mathur & Salokun (1985), <sup>7</sup>Novak *et al.* (1977), \*\*Present study, NA - not available.

Physical characteristics and body composition have been known to be fundamental to excellence in athletes performance (Mathur & Salokun, 1985). It has been found that the athletes with lower body fat percentage had higher maximum oxygen uptake (VO<sub>2</sub>max). In other words, the athletes with lower body fat percentage seemed to utilize oxygen most efficiently (Heck, 1980), while the excess of body fat was reported to be a deterrent to physical performance (Leelarthae-pin, Chesworth & Boleyn, 1983). Minimum level of fatness are particularly advantageous for gymnasts, figure skaters, wrestlers, distance runners and other endurance athletes (Smith, 1984).

Table 8 presents the comparison of anthropometric measurements and body composition of national athletes with non-athlete university students (Ismail & Zawiah, 1988) using a similar technique. Although the athletes had higher body weight and BMI but their body fat was significantly lower when compared to non-athletes. Similar results were reported by Leelarthae-pin *et al.* (1983) and Nowak *et al.* (1988).

## CONCLUSIONS

Generally, there was not much of a difference in the body weight, height and percentage of body fat of national athletes from different types of sports except for basketball players, weight lifters (group 2) and discus (for male athletes) and shot-putt (for female athletes), consistent with the physical need for that particular kind of sport. The national male and female athletes had significantly lower body fat when compared to non-athletes. Physical characteristics data showed that the mean height and weight of the Malaysian male and female athletes were classified as normal, however the mean body mass index and percentage of body fat were slightly higher when compared to values for athletes in selected countries. This investigation indicate the need for further research on the effect of diets and training regime on body composition since it is associated with athletes performance. In addition, it would be interesting to compare the nutritional status and physical activity during training season and out of training season to get the baseline data to enable some adjustments to be made on current dietary intakes and activity levels of the athletes.

Table 8. Comparison of physical characteristics of national athletes with non-athletes (mean  $\pm$  SD)

Parameters	National athletes	Non-athletes <sup>1</sup>
<b>Male:</b>		
Age (yr)	23.9 $\pm$ 4.2	22.8 $\pm$ 1.2*
Weight (kg)	68.8 $\pm$ 13.2	54.8 $\pm$ 6.0*
Height (m)	1.73 $\pm$ 0.09	1.66 $\pm$ 0.05*
BMI (kg/m <sup>2</sup> )	22.9 $\pm$ 3.5	19.9 $\pm$ 1.7*
Body fat (%)	13.8 $\pm$ 4.5	16.5 $\pm$ 3.4*
<b>Female:</b>		
Age (yr)	21.1	21.9 $\pm$ 1.2
Weight (kg)	58.0 $\pm$ 7.6	47.1 $\pm$ 4.8*
Height (m)	1.66 $\pm$ 0.08	1.55 $\pm$ 0.06*
BMI (kg/m <sup>2</sup> )	20.9 $\pm$ 2.0	19.6 $\pm$ 1.8*
Body fat (%)	24.7 $\pm$ 5.3	27.4 $\pm$ 3.6*

<sup>1</sup> Ismail & Zawiah (1988)

\* P < 0.05

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