Research Article

# Body composition parameter changes among young male and female competitive swimmers and nonswimmers

Pallavi Dave, Rohit Subhedar, Priyanka Mishra, Dirgha Sharma

Multispecialty Department of Physiotherapy, Bombay Hospital, Indore, Madhya Pradesh, India.
Correspondence to: Pallavi Dave, E-mail: pallavidave13@gmail.com

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**Abstract**

**Background:** Researches showed that estimation of body composition parameters in competitive swimmers were affected by swimming when compared with their respective age-matched nonswimmers. These results encouraged us to reestimate the body composition parameters in our athletes with competitive swimming as their main sport.

**Objective:** To evaluate the body composition parameters among young male and female competitive swimmers and nonswimmers.

**Materials and Methods:** An observational randomized experimental study was conducted at Multispecialty Department of Physiotherapy, Bombay Hospital, Indore, India. Twenty young male and female swimmers and 20 young male and female nonswimmers were subjected toward their individualized body composition analysis with the help of Tanita BC-418 body composition analyzer, based on the principle of bioelectrical impedance, for interpreting and analyzing the body composition parameter variations.

**Result:** The obtained probability value for *t* test indicated significant levels ($p < 0.02$ and $p < 0.05$; two tailed) for basal metabolic rate (BMR) and body fat percentage, respectively, while less significant difference ($p > 0.05$; two tailed) was observed for height, weight, and fat-free mass. They showed higher percentage of body fat and BMR than nonswimmers and other athletes. Moreover, female swimmers showed higher percentage of body fat than male swimmers, and the fat mass was more in lower extremities than in male swimmers as they had more fat mass on trunk. In addition, swimmers revealed more fat mass on lower extremities than their upper extremities.

**Conclusion:** The statistical analysis and results helped us to conclude that young competitive male and female swimmers showed significant parameter differences in various body composition parameters than nonswimmers and other athletes.

**KEY WORDS:** Competitive swimmers, bioelectrical impedance, body composition parameters, segmental analysis

## Introduction

During recent years, assessing body physique has established an enormous amount of interest in the field of sports science.[1] Early age participation in a competitive sport has been shown to be related with specific body composition and body proportions.[2] The physique of leading and world-class athletes differs from that of the nonathletic counterparts.[3] The body size, structure, and composition must be studied, which can be used to analyze an individual's fitness to participate in sports, personifying the profile of athlete in various sports and estimating the optimal body for optimal performance and health.[4,5] Competitive swimming is a specific activity accomplished with a goal to covering the target distance as quick as possible.[6] Swimming performance depends on optimizing propulsion and minimizing the opposing factor—the drag.[7,8] Body composition and anthropometric characteristics are

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related to minimizing the drag force and, thereby, improving the competitive sports performance.[9]

## Body Composition and Athletes

It is said that "body fat, not weight" is the best measure of health and fitness; thus, body composition assessment should be an integral part of each athletes' physical fitness profile regardless of body weight.[10] Earlier, body mass index (BMI) was found to be the best measure for body fat (BF) percentage (BF%) among ratios of weight and height to quantify an individual's obesity level.[11,12] However, BMI values specify the relative body weight and not the composition of the body; because thin mass weighs far more than fat, many athletes are misclassified as obese based on BMI. Therefore, body composition analysis provides more accurate body assessment than BMI in athletes.[13,14] Body composition is considered as an ideal parameter for fitness analysis and is acquiring much more significance in estimating the fitness levels among individuals in sports and those eager to sustain exceptional physical fitness.[15]

In athletes, body composition measures are widely used to prescribe desirable body weight, to optimize competitive performance, and to evaluate the effectiveness of various training regimens.[16] Optimal body composition may vary among individuals in different sports, as specific athletic events require different body type and weight for maximal performance.[17,18] Variations in body composition can be used as data pertaining to athlete's adaptation to various kinds of training.[19]

There are lot of body composition components in sports such as height, weight, fat mass (FM), fat-free mass (FFM), muscle mass, total body water, and so on, but the most important component in all the sports is BF because every feature such as strength, agility, speed, flexibility, and so on, owes a big relation to BF.[20] Generally, high ratios of FFM to FM are favorable for athletes but very less BF may end up in the weakening of health and performance.[21]

Body composition analysis is used to guarantee that athletes are not compromising thin tissue, health, or performance in an attempt to reach at a weight-established arbitrarily by the coach or by a particular sport; this signifies that body composition analysis plays a vital role in competitive athletic participation.[22]

Thus, our study deals with the evaluation of body composition parameters among young male and female competitive swimmers and nonswimmers, mainly aiming toward interpretation and estimation of basic body composition parameter differences, which persist among young male and female competitive swimmers and nonswimmers.

## Literature Review

Georgiou and coworkers studied the estimation of body composition parameters in competitive swimmers, and the result of their study showed that lower BF and increased lean body mass (LBM) in the region of upper extremities when compared with their lower extremities and that, on comparing between sexes, male subjects revealed greater central distribution of fat, when compared with females in whom BF was more in the region of legs.[31]

Christopher Patrick Borgard assessed the body composition among male collegiate runners and swimmers using dual-energy X-ray absorptiometry (DXA), and the results showed that swimmers showed considerably greater total BF% ($p = 0.004$) and legs BF% ($p = 0.004$), despite having a greater lean torso-to-legs ratio than the runners ($p = 0.000$). However, although the swimmers showed the higher average body weight of the two groups, the runners really revealed more measured lean tissue mass (in kg) situated in the legs than the swimmers.[33]

Zuniga et al. compares the body composition, body build, and anthropometric characteristics of boy and girl sprint swimmers and the results of the independent t tests showed that the lone mean differences between the boy and girl sprint swimmers were for fat% (boys = 9.40% ± 5.35% fat; girls = 12.73% ± 6.19% fat) and endomorphic rating (boys = 2.87 ± 0.96; girls = 4.29 ± 1.22). For the current age group of sprint swimmers, body fatness measurements were the lone gender difference, and no variances were found for body build measures related to musculoskeletal size, muscularity, skeletal size, total body mass, or body breadth dimensions.[32]

Ertas Dolek Burcu et al. determine the body composition of elite Turkish swimmers, and at the end of the study, there was no significant difference between BMI, BF%, mesomorphy values, and swimming styles. They found significant differences in terms of values of endomorphy ($p < 0.01$) and ectomorphy ($p < 0.01$).[34]

Oates et al. measured the body composition of collegiate swimmers, runners, and baseball players with iDXA and found that all athletes revealed similar lean mass, but runners showed significantly less FM than swimmers. Significantly higher percentages of fat in the waist (android cut) and hip (gynoid cut) areas in baseball players were noted than those in both swimmers and runners, and between them, swimmers showed significantly greater values than runners. The non–weight-bearing swim training did not benefit with any bone mass benefits, whereas runners and baseball players revealed greater bone mass values. They also concluded that variations in body composition between swimmers, runners, and baseball players may reveal the variations in physical qualities required to outclass in a sport and may also reveal variations in training intensity and design between various college athletic programs.[24]

Schneider et al. investigated the differences and relationships between body fat and plasma lipoproteins in male and female swimming and track athletes using the noninvasive and authenticated measurements of FFM by total body electrical conductivity and found that swimmers showed more total body fat (15.5 ± 3.4 kg vs. 12.3 ± 0.4 kg) and BF% (23.3% ± 6.1% vs. 19.7% ± 2.9%) than those in the track athletes. Considerable higher BF% (29.3% ± 2.4% vs. 22.5% ± 3.9%) was seen in female swimmers than that in the female track athletes. When compared with male athletes, considerable higher levels of plasma high-density lipoprotein-cholesterol were observed in the female swimming athletes (61.5 ± 10.6 mg/dL vs. 50.2 ± 9.3 mg/dL) and the female track athletes (56.0 ± 9.4 mg/dL vs. 48.3 ± 7.9 mg/dL).[35]

Oppliger et al. evaluated strength, flexibility, and body composition differences between age-group swimmers and nonswimmers and concluded that swimmers were considerably taller, heavier, and showed greater LBM than nonswimmers, with variances emphasized in the better ability of swimmers, and that vertical jump power was significantly greater for swimmers. Swimmers showed greater shoulder abduction flexibility than nonswimmers, with female subjects exhibiting greater ankle and trunk flexibility than male subjects; thus, age-group swimmers possess superior strength, body composition, and flexibility characteristics when compared with nonswimmers.[26]

Moffat et al. compared the body composition of synchronized swimmers and nonswimmers; BF and lean body weight were calculated from body density measurements. Swimmers were ranked rendering to skill level and capacity in an attempt to forecast success in synchronized swimming from BF% or lean body weight. They found no statistically significant differences between groups for height, weight, BF%, or lean body weight.[27]

Fleck determined the body composition of elite American athletes and found that swimmers (male subjects, 12.4% ± 3.7%; female subjects 19.5% ± 2.8%) showed greater fat values than other athletes such as boxing (male subjects, 6.9% ± 1.6%) and wrestling (male subjects, Junior World Freestyle, 7.9% ± 2.7%). Events such as the 100, 200, and 400 m in athletes (male subjects: 100 and 200 m, 6.5% ± 1.2%; female subjects: 100, 200, and 400 m, 13.7% ± 3.6%), which are very anaerobic in nature, and enormously aerobic events such as the marathon (male subjects, 6.4% ± 1.3%) showed lower BF% values.[25]

Sjödin et al. investigated the influence of physical activity on BMR in athletes and found that the athletes showed a significantly higher BMR than was expected from calculations based on body mass (16%, $p < 0.05$) or body composition (12%, $p < 0.05$). The nonathletic control group showed no equivalent variations. The athletes showed a 13% higher ($p < 0.001$) BMR than controls if related to FFM and 16% ($p = 0.001$) if related to both FFM and FM.[30]

### Objectives

1. To determine the various body composition parameters among young male and female competitive swimmers and nonswimmers and changes in their physical characteristics such as height and weight.
2. To analyze and interpret the basic differences between the BF%, FFM, and basal metabolic rate (BMR) of young competitive swimmers and nonswimmers.
3. To determine the segmental distribution of body composition parameters in young male and female competitive swimmers.

## Materials and Methods

### Study Design, Setup, and Duration

An observational randomized experimental study was conducted in Multispecialty Department of Physiotherapy, Bombay Hospital, Indore, Madhya Pradesh, India, for a duration of 6 months, with sample data collection of competitive young competitive swimmers and nonswimmers of Shishukunj School, Indore.

### Materials

Tanita BC 418 Body Composition Analyzer (principle: bioelectric impedance analysis), BMI chart, weight chart, digital weighing machine, and height chart were used for the purpose of this study.

### Sampling Population, Size, and Design

Totally, 40 subjects, aged between 9 and 11 years, who were competitive young male and female swimmers and young male and female nonswimmers, were taken for study and divided into four groups, with each group comprising 10 subjects or samples.

- Group A: Competitive young male swimmers
- Group B: Competitive young female swimmers
  Both these group formed the experimental groups.

- Group C: Young male nonswimmers
- Group D: Young female nonswimmers
  Both these group formed the control groups.

### Inclusion Criteria

- Age group, 9–11 years.
- Young competitive swimmers and nonswimmers randomly selected from Shishukunj School, Indore.
- For body composition analysis, Tanita BC-418 was used.
- 40 subjects were included: 20 competitive young swimmers, 10 boys/10 girls.
- 20 young nonswimmers, 10 boys/10 girls.

### Exclusion Criteria

- Subjects older than 11 years and younger than 9 years of age.
- Athletes other than swimmers were excluded.
- Subjects with any illness or disease.

### Procedure

The body composition parameters of young competitive swimmers and nonswimmers were measured using segmental multifrequency bioelectrical impedance analysis by "Tanita BC-418" machine.

The subjects were asked be with empty bladder and normally hydrated, that is, proper time gap should be there between measurement/analysis and meal or competition/practice.

**Outcome Measures**

Height, weight, BF%, FM, FFM/LBM, BMR, right and left leg fat masses, right and left arm fat mass, and trunk fat mass (TFM) were the outcome measures calculated

**Variables**

1. Independent variables
   - Body composition analysis
   - Competitive swimming
2. Dependent variables
   - Weight
   - Height
   - BF%
   - FFM
   - BMR
   - Segmental fat mass

**Statistical Analysis**

The descriptive statistics such as mean and standard deviation of selected parameters such as age, height, weight, BMI, BMR, BF%, body fat mass, FFM, right leg fat mass (RLFM), right leg FFM, left leg fat mass (LLFM), left leg FFM, right arm fat mass (RAFM), right arm FFM, left arm fat mass (LAFM), left arm FFM, TFM and trunk FFM were identified. Prevalence of an outcome variable along with 95% confidence interval was calculated. Student's unpaired *t* test was used to compare the mean values of different groups obtained for selected parameters. The probability value $p < 0.05$ and $p < 0.02$ was considered as significant while $p < 0.007$ and $p < 0.001$ was considered as highly significant.

## Result

1 reveals the comparison of BF% between male and female swimmers and nonswimmers. When BF% was considered, the probability values of unpaired *t* test of young swimmers and nonswimmers when equal variances assumed were 2.42 and 3.05, respectively, for 18 degrees of freedom. The obtained probability value indicated a significant value ($p < 0.03$ and $p < 0.007$, two tailed), which clearly reported that there was a significant difference between male and female swimmers and nonswimmers.

When the mean value of the body composition parameters such as height, weight, BMR, BF%, and FFM of young male swimmers and nonswimmers were compared, as shown in Table 2, it was found that the probability values of unpaired *t* test when equal variances assumed were 0.44, 1.69, 2.52, 2.02, and 1.23, respectively, for 18 degrees of freedom. The obtained probability value for *t* test indicated significant levels ($p < 0.02$ and $p < 0.05$; two tailed) for BMR and BF%, respectively, while less significant difference ($p > 0.05$; two tailed) was observed for height, weight, and FFM.

Table 2 also shows the comparison of the body composition parameters such as height, weight, BMR, BF%, and FFM of young female swimmers and nonswimmers. When the mean value of all these parameters were compared, the probability values of unpaired *t* test when equal variances assumed were 1.82, 1.82, 2.32, 0.95, and 1.88, respectively, for 18 degrees of freedom. The obtained probability value for *t* test indicated significant levels ($p < 0.08$, $p < 0.09$, and $p < 0.03$; two tailed) for height, weight, BMR, and FFM, respectively.

Table 3 shows the comparisons between male swimmers and nonswimmers regarding measurement of fat distribution in lower and upper extremities. When the mean values of the body composition parameters such as RLFM, LLFM, RAFM, LAFM, total leg fat mass, and total arm fat mass of young male swimmers and nonswimmers were compared, it was observed that the probability values of unpaired *t* test when equal variances assumed were 6.23, 5.87, and 6.07, respectively, for 18 degrees of freedom.

The obtained probability values for student's unpaired *t* test indicated highly significant levels ($p < 0.001$; two tailed) for RLFM and RAFM; LLFM and LAFM; and total leg and total arm fat masses, respectively, which influenced clearly that there is no doubt in confirmation that there is a highly significant difference between male swimmers and nonswimmers for fat distribution in the lower and upper extremities.

Table 3 also shows the information on comparisons between female swimmers and nonswimmers in order to measure the fat distribution in the lower and upper extremities. The mean values of the body composition parameters such as RLFM, LLFM, RAFM, LAFM, total leg fat mass, and total arm fat mass of young female swimmers and nonswimmers were compared. When equal variances were assumed, the probability values of unpaired *t* test for the lower and upper extremities body composition parameters were found to be 7.21, 6.57, and 6.90, respectively, for 18 degrees of freedom.

The comparison between male swimmers and female swimmers regarding fat distribution in lower extremities and TFM is shown in Table 4. The mean value of the body composition parameters such as total TFM and total leg fat mass of young male swimmers and female swimmers were compared, and the obtained probability values of unpaired *t* test when equal variances assumed were 2.71 for 18 degrees of freedom, showing significant difference between male and female swimmers regarding BF distribution.

## Discussion

According to the results of statistical analysis, Table 1 reveals the comparison between BF% of male and female swimmers. The obtained probability value ($p < 0.03$, $t = 2.42$, two tailed) indicated a significant difference between BF% of male and female swimmers and results showed that female swimmers possessed higher percentage of body fat than male swimmers. Oates et al and Evan et al also showed similar result in their studies.[23-24] BF% of young female and male nonswimmers considered in this study showed that the female nonswimmers revealed more BF% than male subjects. The probability value obtained ($p < 0.007$, $t = 3.05$, two tailed) [Table 1] indicated highly significant difference; thus, according to results, it was proved that female subjects

**Table 1:** Comparison of BF% between groups A and B (swimmers) and between groups C and D (nonswimmers)

| BF% | Mean difference | Std. error of difference | ¡ „ | å value | Á (LOS) |
|---|---|---|---|---|---|
| Groups A and B | –3.760 | 1.554 | 18 | 2.42 | <0.03* |
| Groups C and D | –5.04 | 1.653 | 18 | 3.05 | <0.007** |

*Mean difference is significant at the 0.03 level
**Mean difference is highly Significant at the 0.007 level

**Table 2:** Comparison of body composition parameters between groups A and C (male swimmers and nonswimmers) and between groups B and D (female swimmers and nonswimmers)

| Body composition parameters | Mean difference | Std. error of difference | ¡ „ | å value | Á (LOS) |
|---|---|---|---|---|---|
| Groups A with C | | | | | |
| Height | 1.10 | 2.480 | 18 | 0.44 | >0.05* |
| Weight | 2.89 | 1.711 | 18 | 1.69 | >0.05 |
| BMR | 57.00 | 22.614 | 18 | 2.52 | <0.02*** |
| BF% | 3.00 | 1.363 | 18 | 2.02 | <0.05** |
| FFM | 1.40 | 1.138 | 18 | 1.23 | >0.05* |
| Groups B with D | | | | | |
| Height | 6.30 | 3.471 | 18 | 1.82 | <0.09** |
| Weight | 6.47 | 3.559 | 18 | 1.82 | <0.09** |
| BMR | 136.30 | 58.773 | 18 | 2.32 | <0.03**** |
| BF% | 1.72 | 1.814 | 18 | 0.95 | >0.05* |
| FFM | 4.43 | 2.361 | 18 | 1.88 | <0.08*** |

*Mean difference is very less significant at the 0.05 level
**Mean difference is significant at the 0.05 and 0.09 level
***Mean difference is significant at the 0.02 and 0.08 level
****Mean difference is significant at the 0.03 level

**Table 3:** Comparison of fat distribution in lower and upper extremities between groups A and C (male swimmers and nonswimmers) and between groups B and D (female swimmers and nonswimmers)

| Fat distribution in lower and upper extremities | Mean difference | Std. error of difference | ¡ „ | å value | Á (LOS) |
|---|---|---|---|---|---|
| Groups A with C | | | | | |
| RLFM and RAFM | 0.86 | 0.138 | 18 | 6.23 | <0.001** |
| LLFM and LAFM | 0.83 | 0.141 | 18 | 5.87 | <0.001** |
| Total leg and total arm fat masses | 1.69 | 0.278 | 18 | 6.07 | <0.001** |
| Groups B with D | | | | | |
| RLFM and RAFM | 1.54 | 0.214 | 18 | 7.21 | <0.001** |
| LLFM and LAFM | 1.44 | 0.220 | 18 | 6.57 | <0.001** |
| Total leg and total arm fat masses | 2.98 | 0.432 | 18 | 6.90 | <0.001** |

RLFM, right leg fat mass; RAFM, right arm fat mass; LLFM, left leg fat mass; LAFM, left arm fat mass.
**Mean difference is highly significant at the 0.001 level

**Table 4:** Comparison of total masses in groups A and B between male and female swimmers

| Groups A with B | Mean difference | Std. error of difference | ¡ „ | å value | Á (LOS) |
|---|---|---|---|---|---|
| Trunk FM and total leg mass | –1.36 | 0.502 | 18 | 2.71 | <0.02** |

**Mean difference is significant at the 0.02 level in general have higher percentage of body fat than male population, which was also supported by different studies. When the swimmers were compared with nonswimmers for BF% [Table 2], the obtained probability values ($p < 0.05$, $t = 2.02$, two tailed) for BF% of male swimmers was significantly higher than male nonswimmers; however, in female swimmers, no significant difference ($p > 0.05$, $t = 0.95$, two tailed) was found than female nonswimmers. The results of our study showed that swimmers possess more percentage of body fat than nonswimmers and female subjects show higher fat percentage. There was less difference found in female swimmers and nonswimmers owing to small sample size. However, we can say that swimmers, in general, possess more fat percentage than nonswimmers, and it was found in different studies conducted by Oates et al and Fleck that swimmers generally possess more fat than other athletes and nonswimmers.[24–25]

Another hypothesis of our study was that swimmers would be taller and heavier than nonswimmers and possess more FFM than nonswimmers. Results for height, weight, and FFM were analyzed and found that female swimmers showed significantly more height ($p < 0.09$, $t = 1.82$; two tailed), weight ($p < 0.09$, $t = 1.82$; two tailed); and FFM ($p < 0.08$, $t = 1.88$; two tailed) than by female nonswimmers. However, there was a less-significant difference between the height ($p > 0.05$, $t = 0.45$; two tailed), weight ($p > 0.05$, $t = 1.69$; two tailed), and FFM ($p > 0.05$, $t = 1.23$; two tailed) of male swimmers and nonswimmers [Table 2]. Research done by Oppliger et al.[26] also showed that swimmers were taller and heavier, with more FFM than nonswimmers of the same age group. However, the study by Moffat et al.[27] concluded in their results that there was no significant difference in height, weight, and FFM between swimmers and nonswimmers. Thus, our hypothesis that swimmers possess more height, weight, and FFM than nonswimmers was justified by both the above-mentioned studies. The energy expenditure of swimmers or athletes is always more compared with nonswimmer or nonathletic group because of high level of activity, and they must consume high-energy intake to meet the energy demands.[28] Therefore, we made another hypothesis that swimmers would show higher BMR than nonswimmers. When BMR was statistically analyzed, the obtained probability value in Table 2 for BMR indicated significant levels ($p < 0.02$; $t = 2.52$; two tailed), which clearly revealed that there is a significant difference between male swimmers and nonswimmers for BMR. In addition, the probability value ($p < 0.03$, $t = 2.32$; two tailed) showed significant difference in female swimmers and nonswimmers for BMR. Thus, our results showed higher BMR in swimmers than nonswimmers, which correlates with the results of the study done by Sjodin et al., showing higher BMR in athletes compared with nonathletes.[28–30] Fat distribution in swimmers was analyzed in our study, and the results for fat distribution shown in Table 3. The obtained probability values indicated highly significant levels ($p < 0.001$; two tailed) for RLFM and RAFM; LLFM and LAFM; and total leg and total arm fat masses, respectively which influenced clearly that there is a highly significant difference between male and female swimmers and nonswimmers for fat distribution in the lower and upper extremities. Therefore, it was determined that swimmers show more fat distribution in lower extremities than upper extremities. When male and female swimmers were compared for fat distribution [Table 4], the obtained probability values indicated significant level ($p < 0.02$; $t = 2.71$; two tailed) for total TFM and total leg fat mass, which influenced clearly that there was a significant difference between male swimmers and female swimmers regarding body fat distribution in the lower extremities. These results showed that female swimmers possess more fat on lower extremities than male swimmers who have centralized fat distribution, i.e., more on trunk. Same results were obtained by the Georgiou and coworkers in their study on estimation of body composition parameters in competitive swimmers and results showed that lower BF and increased LBM in the region of upper extremities when compared with the lower extremities and that, on comparing between sexes, male subjects revealed greater central distribution of fat, when compared with females in whom BF was more in the region of legs.[31] Thus, this discussion in detail helps us to correlate the influence of body composition parameters on swimming as a competitive sport.

### Delimitation

1. Four groups of male and female young competitive swimmers and nonswimmers from Shishukunj School, Indore (Madhya Pradesh) of identical sample size ($n = 40$, age group: 9–11 years) were test subjects in the study.
2. Body composition analysis was performed by BIA apparatus BC-418-Tanita.

### Limitation

1. Age group was limited to 9–11 years.
2. Study was limited to subjects of Shishukunj School, Indore (Madhya Pradesh), India.
3. Competitive swimmers and nonswimmers of same class were the test subjects.

## Conclusion

It is concluded that there is a significant difference in body composition parameters among young male and female competitive swimmers and nonswimmers. BF% and BMR in swimmers were significantly higher than those in nonswimmers. Other parameters such as height, weight, and FFM showed less-significant difference. In addition, there is a significant difference among male and female swimmers in terms of BF%. Young female swimmers showed significantly higher percentage of body fat than young male swimmers. Among the young nonswimmers group too, female subjects showed higher percentage of body fat than male subjects. It is also estimated that young competitive swimmers showed more fat mass in lower extremities than in upper extremities and male subjects possessed more fat distribution over trunk, i.e., fat is centralized when compared with female subjects who revealed more fat in lower limbs.

Thus, it is concluded that differences persist among competitive swimmers and nonswimmers in the young age group. Our study strongly states that male and female swimmers are affected by body composition parameters and their importance hold a greater significance in improving competitive swimming performance. We recommend further research on a large group of subjects involved in competitive swimming performance. We also recommend advanced research on individualized body composition analysis of both male and female young and adult swimmers with differences in swimming techniques.

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