
A Comparative Morphometric Analysis of Trained Young Male and Female Swimmers and Table Tennis Players

Priya Nandy, Pritha Chatterjee, Anupam Bandyopadhyay

Department of Physiology, Serampore College, University of Calcutta, Serampore, West Bengal, India

Email address:

bando_anupam@yahoo.co.in (A. Bandyopadhyay)

To cite this article:

Priya Nandy, Pritha Chatterjee, Anupam Bandyopadhyay. A Comparative Morphometric Analysis of Trained Young Male and Female Swimmers and Table Tennis Players. *American Journal of Sports Science*. Special Issue: Kinanthropometry. Vol. 4, No. 1-1, 2016, pp. 37-43. doi: 10.11648/j.ajss.s.2016040101.17

Abstract: The study was designed to evaluate and compare the somatotype characteristics of male junior Swimmers, female junior Swimmers, and Table Tennis players. Twenty-six Swimmers and twenty-nine Table Tennis players were evaluated for their anthropometric and somatotype characteristics. Endomorphy, Mesomorphy and Ectomorphy components were evaluated for the entire groups. Mesomorphy components of male and female Swimmers were higher than the Table Tennis players. Total fat content was significantly higher in both male and female Table Tennis players when compared to the Swimmers. The male and female Swimmers and Table Tennis players were more endomorphic in average. Moreover, desired sports specific body type were not found when evaluated individually. The mesomorphy components were found to be higher in male Swimmers (30%) compared to 0% in female Table Tennis players.

Keywords: Swimming, Table Tennis, Somatotype, Endomorphy, Mesomorphy, Ectomorphy, Fat %

1. Introduction

Athlete's performance mainly depends on the body composition which is related to the athlete's ability to sustain both aerobic and anaerobic power to overcome the resistance. In sports like Swimming and Table Tennis, body composition is the central theme of training. Different workers had attempted to establish the relationship between somatotype characteristics and competitive success in performance level in different sports [1, 2, 3, 4, 5]. It is already established that physique plays an important role in athletic performances. Somatotyping express the physique which is the configuration of the entire body [6]. Morphometric analysis can be best understood by somatotyping. Somatotype is the contribution of composition of three components: endomorphy (relative fatness), mesomorphy (relative musculoskeletal robustness) and ectomorphy (relative linearity) [7, 8]. Table Tennis is an asymmetric and acyclic sport and swimming is a water sports in which work and rest time periods are continuously altered. It is already established that proper training session affects the proper build up of the needed skills to perform specific sports activity [9]. According to the World Health Organization (WHO) Bulletin (Print version ISSN 0042-

9686 of 2007), executive training program may be quite valuable as an additional focus of study of professional students in schools of public health, global health sciences or other health professional schools. The interest in anthropometric characteristics, body composition and somatotype from different competitive sports has increased over the last decades. It has been well described that there are specific physical characteristics in many sports, such as anthropometric profile, that indicate whether the player would be suitable to compete at highest level in a specific sport. The quantification of morphological characteristics of athletes can be a key point in relating body structure to sports performance. Most of the scientific literature has focused on physiological and biomechanical variables, physical performance, and prevention and treatment of injuries. There are few studies on physical characteristics of young and adult players till date. Moreover, very few research work has been carried out in morphometric analysis of trained male and female junior swimmers and table tennis players [10]. Thus the aims of the study was to evaluate and compare the anthropometric characteristics, body composition and somatotype characteristics of male and female Swimmers and Table tennis players along with a focus on morphometric development.

2. Method

2.1. Subjects

Twenty six swimmers (20 males and 6 females) and twenty nine table tennis players (14 males and 15 females) participated as subjects. Individual NFHS (National Standard of Living Index) and SCAT (Sports Competition Anxiety Test) were carried out in each subject. They were free from cardiovascular, metabolic or immunologic disorders and orthopaedic abnormality, and did not use any medications that might affect muscle function. All participants involved in the sports activities had participated in competitions at regional and district level. All subjects and their parents were informed about the purpose and procedures of this study. Permission was obtained from institutional ethical committee.

2.2. Anthropometric Measurements

Anthropometric measurements of all players were done on the same day to avoid technical error. Measurements were done by the Level 1 Anthropometrists accredited by International society for advancement of Kinanthropometry (ISAK) [11] with the help of ISAK manual [12]. Stature was measured with the help of stadiometer (ISAK) [11]. Body mass (kg) was measured with an electronic weighing machine. Skinfold thickness for determining the fat% and total fat content were measured with a Slim guide skinfold calliper (CESCORF). Anthropometric tape and sliding calliper (CESCORF) were used to measure girth (arm and calf), breadth (bicipondylar humerus and femur), circumferences (chest, waist, hip, mid thigh, upper thigh) respectively.

2.3. Somatotype

Heath-Carter [13] method was followed for somatotype rating. The following equations were used for calculating somatotype.

Endomorphy = $-0.7182 + 0.1454 \times \sum SF - 0.00068 \times \sum SF^2 + 0.000014 \times \sum SF^3$ where $\sum SF = (\text{triceps} + \text{biceps} + \text{subscapular} + \text{supraspinale skinfold}) \times (170.18/\text{height in cm.})$.

Mesomorphy = $0.858 \times \text{humerus breadth} + 0.601 \times \text{femur breadth} + 0.188 \times \text{corrected arm girth} + 0.161 \times \text{corrected calf girth} - \text{height} \times 0.131 + 4.5$.

Three different equations are used to calculate Ectomorphy according to the height-weight ratio (HWR):

If HWR is greater than or equal to 40.75 then,
Ectomorphy = $0.732 \times \text{HWR} - 28.58$.

If HWR is less than 40.75 and greater than 38.25 then,
Ectomorphy = $0.463 \times \text{HWR} - 17.63$.

If HWR is equal to or less than 38.25 then,
Ectomorphy = 0.1

2.4. Body Fat % and Total Fat Content

Body Density (kg/mm^3) was measured using the Durnin & Womersley's [14] generalized equation and Total Body Fat

Percentage (%) was calculated using the equation derived by Brozek *et al* [15] Siri [16]. The Total Fat Mass (kg) was evaluated by using the values of Total Body Fat Percentage (%) and Body Mass i.e. Weight (kg)

2.5. Statistical Analysis

Statistical analysis was done with SPSS package. Mean Values and Standard Deviations of each mentioned parameters of both players (male and female) were recorded. The unpaired two tail T test was done to compare each of the parameters of both players (between male swimmers and male table tennis players and between female swimmers and female table tennis players). Probability of error due to random sampling was rejected at the level of $p < 0.05$. The correlation (r) was done between parameters by Pearson's Correlation Coefficient (r).

3. Result

Table 1 showed the anthropometric characteristics and body composition of the male Swimmers and Table Tennis players. Table 2 represented the anthropometric characteristics and body composition of their female counterparts.

Table 1. Anthropometric characteristics of young Indian male Swimmers and Table Tennis players ($n =$ sample size, $p =$ probability of error due to random sampling, NS = not significant).

Parameters	Swimmer (Male, n=20)	Table Tennis (Male, n=14)	Level of Significance
Stature (cm)	153.87±13.37	155.82±14.24	NS
Body Mass (kg)	45.6±10.59	47.64±10.30	NS
Body Fat (%)	14.15±5.81	16.40±4.93	NS
Total Fat (kg)	4.53±1.86	6.20±2.54	P<0.05
Arm Girth (cm)	23.93±3.76	24.39±2.4	NS
Calf Girth (cm)	29.99±3.47	31.76±2.40	NS
Bicipondylar Humerus Breadth (cm)	5.78±0.59	5.81±0.62	NS
Bicipondylar Femur Breadth (cm)	8.45±0.69	8.97±0.75	P<0.05
Chest Circumference (cm)	79.91±8.89	79.36±7.79	NS
Waist Circumference (cm)	70.13±8.04	67.27±18.67	NS
Hip Circumference (cm)	78.91±7.71	81.68±6.80	NS
Mid Thigh Circumference (cm)	44.79±4.68	47.36±4.32	NS
Upper Thigh Circumference (cm)	47.98±5.89	50.04±4.71	NS

No statistical significant differences were observed when stature, weight, fat percentage, arm girth, calf girth, bicipondylar humerus breadth, chest circumference, waist circumference, hip circumference, mid thigh circumference, upper thigh circumference for male Swimmers and table Tennis players, which were shown in Table 1. No statistically significant differences were also observed when their female counterparts were considered (Table 2). Total Fat Content

was significantly higher ($p < 0.05$) in case of both male and female Table Tennis players, which was shown in Fig 1. Biepicondylar femur Breadth was slightly higher in case of male Table Tennis players than male swimmers with a significant level which was shown in Fig 2

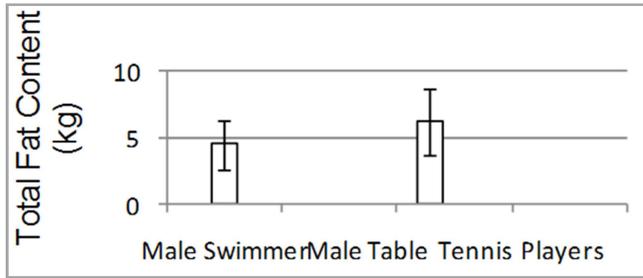


Fig. 1. Mean \pm SD values of Total Fat content (kg) of trained Male Swimmers and Table Tennis Players.

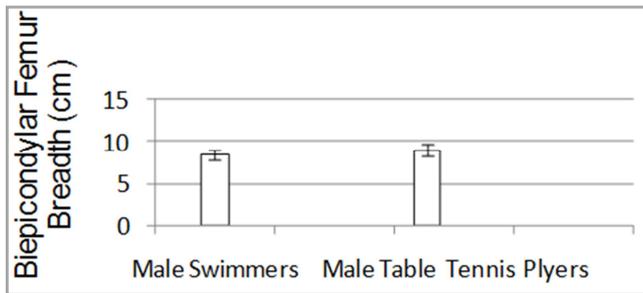


Fig. 2. Mean \pm SD values Biepicondylar Femur Breadth (cm) of trained Male Swimmers and Table tennis players.

Table 2. Anthropometric variables of trained young Indian female Swimmers and Table Tennis players (n= sample size, p = probability of error due to random sampling, NS = not significant).

Parameters	Swimmer (Female, n=6)	Table Tennis (Female, n=15)	Level of significance
Stature (cm)	153.87 \pm 13.37	155.82 \pm 14.24	NS
Body Mass (kg)	45.6 \pm 10.59	47.64 \pm 10.30	NS
Body Fat (%)	14.15 \pm 5.81	16.40 \pm 4.93	NS
Total Fat (kg)	4.53 \pm 1.86	6.20 \pm 2.54	P<0.05
Arm Girth (cm)	22.75 \pm 1.44	23.06 \pm 5.05	NS
Calf Girth (cm)	30.47 \pm 1.37	31.57 \pm 5.55	NS
Biepicondylar Humerus Breadth (cm)	5.48 \pm 0.26	5.40 \pm 0.35	NS
Biepicondylar Femur Breadth (cm)	8.08 \pm 0.45	8.21 \pm 0.86	NS
Chest Circumference (cm)	79.5 \pm 3.42	79.99 \pm 16.39	NS
Waist Circumference (cm)	68.5 \pm 2.93	69.08 \pm 15.29	NS
Hip Circumference (cm)	83.33 \pm 3.68	86.53 \pm 15.02	NS
Mid Thigh Circumference (cm)	43.47 \pm 4.37	44.67 \pm 8.01	NS
Upper Thigh Circumference (cm)	50.42 \pm 5.07	50.70 \pm 10.46	NS

Table 3 showed the correlation coefficients among the measured variables for the male Swimmers and Table Tennis players. The correlation of one variable with another was done to understand whether alteration of one variable can influence the other. The correlation of stature and calf girth, biepicondylar humerus breadth, hip circumference, mid thigh circumference) were statistically significant ($p < 0.05$) in both male Swimmers and Table Tennis players which were shown in Table 3. Stature and biepicondylar femur breadth were statistically significant ($p < 0.05$) only in case of male Table Tennis players.

Table 4 showed the relationship between different parameters when the female Swimmers and Table Tennis players were considered. The correlations between stature and calf girth, biepicondylar humerus Breadth, biepicondylar femur breadth, hip circumference, mid thigh circumference were statistically significant ($p < 0.05$) in case of female Table Tennis players (Table 4). The correlation between body mass and arm girth, calf girth, chest circumference, hip circumference, upper thigh circumference were statistically significant ($p < 0.05$) in case of both female Swimmers and Table Tennis players but in case of female Table Tennis players body mass and biepicondylar humerus breadth, biepicondylar femur breadth, waist circumference, mid thigh circumference were also statistically significant ($p < 0.05$). Arm Girth and calf girth, upper thigh circumference showed positive significant ($p < 0.05$) correlation in case of both female players. Calf girth and biepicondylar humerus breadth, biepicondylar femur breadth, mid thigh circumference, upper thigh circumference, biepicondylar femur breadth and mid thigh circumference, upper thigh circumference were statistically significant ($p < 0.05$) in female Table Tennis players.(Table 4).

Table 5 showed the body types of experimental male subjects of both activities. Similar body types were found in case of swimmers but half of the table tennis population was endomorphic.

Table 6 showed the body types of female subjects of both activities. 83.33% swimmers were endomorph but 67% table tennis population were endomorphic. Mesomorphy (17%) was present only in swimmers whereas Ectomorphy was present in table tennis population (33%).

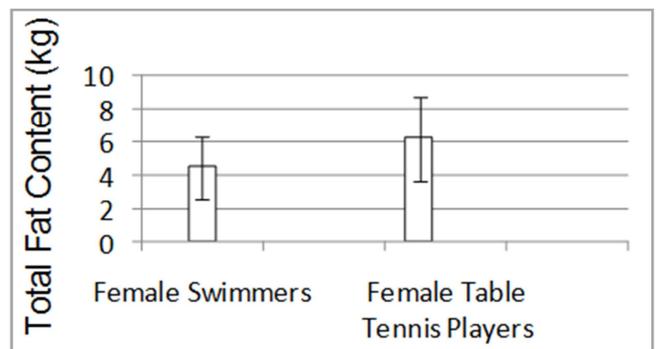


Fig. 3. Mean \pm SD values of Total Fat Content (kg) of trained Female Swimmers and Table Tennis Palayers.

Table 3. The Correlation values of different variables of male Swimmers and Table Tennis players ((n= sample size, p=probability of error due to random sampling, NS = not significant).

Correlated parameters	Swimmers (male, n=20)	Table Tennis (male, n=14)
In between Stature and Calf girth	0.509, p<0.05	0.691, p<0.05
In between Stature and Biepicondylar Humerus Breadth	0.563, p<0.05	0.731, p<0.05
In between Stature and Biepicondylar Femur Breadth	0.200, NS	0.881, p<0.05
In between Stature and Hip Circumference	0.511, p<0.05	0.725, p<0.05
In between Stature and Mid Thigh Circumference	0.505, p<0.05	0.622, p<0.05
In between Body Mass and Arm Girth	0.829, p<0.05	0.813, p<0.05
In between Body Mass and Calf Girth	0.896, p<0.05	0.916, p<0.05
In between Body Mass and Biepicondylar Humerus Breadth	0.596, p<0.05	0.730, p<0.05
In between Body Mass and Biepicondylar Femur Breadth	0.682, p<0.05	0.933, p<0.05
In between Body Mass and Chest Circumference	0.920, p<0.05	0.852, p<0.05
In between Body Mass and Waist Circumference	0.834, p<0.05	0.624, p<0.05
In between Body Mass and Hip Circumference	0.879, p<0.05	0.958, p<0.05
In between Body Mass and Mid Thigh Circumference	0.868, p<0.05	0.877, p<0.05
In between Body Mass and Upper Thigh Circumference	0.852, p<0.05	0.862, p<0.05
In between Arm Girth and Calf Girth	0.867, p<0.05	0.763, p<0.05
In between Arm Girth and Biepicondylar Humerus Breadth	0.494, p<0.05	0.381, NS
In between Arm Girth and Upper Thigh Circumference	0.898, p<0.05	0.887, p<0.05
In between Calf Girth and Biepicondylar Humerus Breadth	0.545, p<0.05	0.802, p<0.05
In between Calf Girth and Biepicondylar Femur Breadth	0.668, p<0.05	0.838, p<0.05
In between Calf Girth and Mid Thigh Circumference	0.831, p<0.05	0.845, p<0.05
In between Calf Girth and Upper Thigh Circumference	0.842, p<0.05	0.810, p<0.05
In between Biepicondylar Femur Breadth and Mid Thigh Circumference	0.407, NS	0.776, p<0.05
In between Biepicondylar Femur Breadth and Upper Thigh Circumference	0.508, p<0.05	0.741, p<0.05

Table 4. The Correlation Values of different parameters of female swimmers and table tennis players ((n= sample size, p=probability of error due to random sampling, NS = not significant).

Correlated parameters	Swimmer (Female, n=6)	Table Tennis (Female, n=15)
In between Stature and Calf girth	0.711, NS	0.816, p<0.05
In between Stature and Biepicondylar Humerus Breadth	0.207, NS	0.386, p<0.05
In between Stature and Biepicondylar Femur Breadth	0.657, NS	0.550, p<0.05
In between Stature and Hip Circumference	0.383, NS	0.802, p<0.05
In between Stature and Mid Thigh Circumference	0.384, NS	0.827, p<0.05
In between Body Mass and Arm Girth	0.921, p<0.05	0.959, p<0.05
In between In between Body Mass and Calf Girth	0.769, NS	0.972, p<0.05
In between Body Mass and Biepicondylar Humerus Breadth	0.359, NS	0.590, p<0.05
In between Body Mass and Biepicondylar Femur Breadth	0.537, NS	0.852, p<0.05
In between Body Mass and Chest Circumference	0.875, p<0.05	0.985, p<0.05
In between Body Mass and Waist Circumference	0.626, NS	0.986, p<0.05
In between Body Mass and Hip Circumference	0.811, p<0.05	0.981, p<0.05
In between Body Mass and Mid Thigh Circumference	0.758, NS	0.969, p<0.05
In between Body Mass and Upper Thigh Circumference	0.889, p<0.05	0.979, p<0.05
In between Arm Girth and Calf Girth	0.860, p<0.05	0.932, p<0.05
In between Arm Girth and Biepicondylar Humerus Breadth	0.501, NS	0.530, NS
In between Arm Girth and Upper Thigh Circumference	0.906, p<0.05	0.964, p<0.05
In between Calf Girth and Biepicondylar Humerus Breadth	0.038, NS	0.492, p<0.05
In between Calf Girth and Biepicondylar Femur Breadth	0.452, NS	0.783, p<0.05
In between Calf Girth and Mid Thigh Circumference	0.617, NS	0.959, p<0.05
In between Calf Girth and Upper Thigh Circumference	0.745, NS	0.972, p<0.05
In between Biepicondylar Femur Breadth and Mid Thigh Circumference	0.562, NS	0.801, p<0.05
In between Biepicondylar Femur Breadth and Upper Thigh Circumference	0.412, NS	0.784, p<0.05

Table 5. Somatotype categories of trained young male Swimmers and TableTennis players.

Swimmers (Male, n=20)		Table Tennis Players (male, n=14)	
Endo-Meso-Ecto	Category	Endo-Meso-Ecto	Category
2.0-2.7-3.5	Mesomorphic Ectomorph	7.1-4.9-0.9	Mesomorphic Endomorph
1.8-1.7-5.2	Endomorphic Ectomorph	5.5-4.7-1.6	Mesomorphic Endomorph
2.9-3.3-3.3	Mesomorphic Ectomorph	4.6-4.0-3.2	Mesomorphic Endomorph
4.4-3.5-2.2	Mesomorphic Endomorph	3.8-3.4-3.9	Endomorphic Ectomorph
2.5-4-2.9	Ectomorphic Mesomorph	4.6-3.5-3.6	Ectomorphic Endomorph
4.8-6.8-1.1	Endomorphic Mesomorph	2.1-2.2-4.2	Mesomorphic Ectomorph
1.9-4.2-3.3	Ectomorphic Mesomorph	4.3-2.8-3.9	Ectomorphic Endomorph
0.7-1.4-3.7	Mesomorphic Ectomorph	2.8-3.9-3.1	Ectomorphic Mesomorph
5.0-3.8-0.9	Mesomorphic Endomorph	1.3-1.8-6.3	Mesomorphic Ectomorph
2.7-0.9-5.9	Endomorphic ectomorph	6.1-5.5-0.8	Mesomorphic Endomorph
3.3-3.7-2.6	Endomorphic Mesomorph	1.8-4.4-4.0	Ectomorphic Mesomorph
2.5-4.6-2.2	Endomorphic Mesomorph	5.3-3.6-3.0	Mesomorphic Endomorph
1.6-3.9-3.0	Ectomorphic Mesomorph	2.2-3.6-3.8	Mesomorphic Ectomorph
8.1-5.5-1.0	Mesomorphic Endomorph	4.6-4.9-1.6	Endomorphic Mesomorph
7.1-4.6-1.0	Mesomorphic Endomorph		
4.5-3.0-2.8	Mesomorphic Endomorph		
4.7-4.2-2.1	Mesomorphic Endomorph		
1.7-2.2-5.3	Mesomorphic Ectomorph		
2.2-3.2-4.1	Mesomorphic Ectomorph		
5.2-4.7-1.8	Mesomorphic Endomorph		
Endomorphy=35%, Mesomorphy=30%, Ectomorphy=35%		Endomorphy = 50%, Mesomorphy = 21%, Ectomorphy = 29%	

Table 6. Somatotype categories of female Swimmers and Female Table Tennis players.

Swimmers (Female, n=6)		Table Tennis Players (female, n=15)	
Endo-Meso-Ecto	Category	Endo-Meso-Ecto	Category
3.5-3.7-1.8	Endomorphic Mesomorph	3.1-2.5-4.1	Endomorphic Ectomorph
2.9-2.5-2.8	Ectomorphic Endomorph	3.2-2.7-4.2	Endomorphic Ectomorph
3.5-3.4-2.2	Mesomorphic Endomorph	1.6-2.5-4.7	Mesomorphic Ectomorph
5.6-3.7-1.3	Mesomorphic Endomorph	1.2-2.1-5.8	Mesomorphic Ectomorph
4.1-3.7-3.1	Mesomorphic Endomorph	5.6-3.6-1.8	Mesomorphic Endomorph
5.8-3.6-1.4	Mesomorphic Endomorph	0.7-2.7-5.3	Mesomorphic Ectomorph
		5.1-3.6-0.7	Mesomorphic Endomorph
		7.6-4.8-0.1	Mesomorphic endomorph
		9.4-8.4-0.1	Mesomorphic Endomorph
		5.5-3.4-1.5	Mesomorphic Endomorph
		3.9-3.2-3.1	Mesomorphic Endomorph
		4.3-3.0-1.5	Mesomorphic Endomorph
		3.8-2.2-3.4	Ectomorphic Endomorph
		5.7-2.4-3.0	Ectomorphic Endomorph
		6.7-3.8-1.3	Mesomorphic Endomorph
Endomorphy=83%, Mesomorphy =17%, Ectomorphy =0%		Endomorphy = 67%, Mesomorphy = 0%, Ectomorphy = 33%	

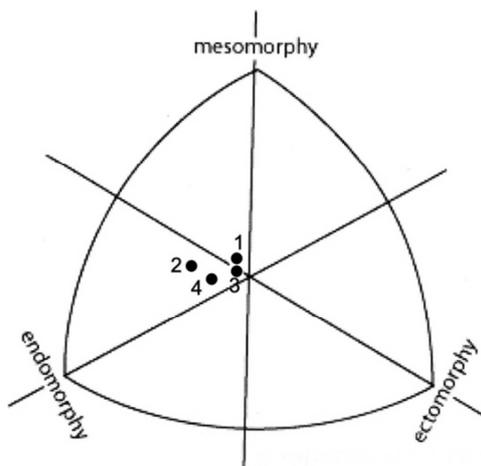


Fig 4. Somatochart of the male and female Swimmers and Table Tennis players.(1= male Swimmers, 2=female Swimmers, 3= male Table Tennis players, 4= female Table Tennis players).

4. Discussion

The objectives of this study was to find out the trends of the individual somatotype characteristics between water surface and normal surface sports. It is assumed that different functional requirements in different sports would produce differences in the anthropometric variable between these sports group. It is well known that somatotyping methods are especially helpful in sports which the body could directly influence the biomechanics of movements and thus resulting performance [17]. These are also the suggestion of various athletes involved in these sports altering their body constitution characteristics; and the appearance of optimal level of human physique. The growth and development differences among the participants of this age group (10-20 years) were very significant to compare them directly through anthropometric measurements, but when determining the somatotype using the Heath and Carter

method [19], the only relevant interrelation was between anthropometric parameters and chronological age. Human somatotype may be treated as very important health-related anthropometric indicators. In the present study, 50% male Table Tennis players possessed more endomorphy components but that of swimmers were only 35%. On the other hand 83% female swimmers were endomorph whereas 67 % Table Tennis players were endomorph. The percentage of endomorphy was higher in both male and female subjects but a high emphasized mesomorphic component was characterized by high levels of subcutaneous fat tissue. In case of male swimmers endo-meso-ecto components were present equally but in case of female swimmers majority of them possessed endomorph characteristics who had an accentuated mesomorphic component (mesomorphic endomorph). In both male and female Table Tennis players, ectomorphic components were present in greater amount than mesomorphy component.

The mesomorphy component reflects the skeletal muscle mass in the human body. In the present study, 21% of the male population and none of the female population of Table Tennis group possessed more mesomorphy components. It was possible to further divide the group into those dominated by endomorphic component of the mesomorphic somatotype (endomorph mesomorph) which was present in larger amount than the ectomorphic mesomorph category. 29% male Table Tennis players and 33% female Table Tennis players belong to the group of ectomorphic somatotype component. The values of other two components (endomorph and mesomorphy) were much less emphasized and subdivided into two ectomorphic subtypes (mesomorphic balanced ectomorph). It seemed to be obvious that a mesomorph can play an important role in any sports like Swimming and Table Tennis [18, 19]. Competitive success is primarily a result of quality and degree of technical and tactical knowledge in structurally complex games like Table tennis and Swimming. Accordingly, the differences in the competitive success of the young players are mostly the result of differing levels of technical as well as tactical skills. Those differences are much more salient at this competitive level than among top senior players where a high level of technical/tactical knowledge can be assumed. From the primary level i.e. from the first day of training of a person to become a player, basic anthropometric and body constitution factors are important to required in proper percentage. Total fat content (kg) were significantly ($p < 0.05$) higher in case of both male and female in table tennis players because they possessed high quantity of subcutaneous fat. Bicipicondylar femur breadth (cm) was also found significantly ($p < 0.05$) higher in case of male table tennis players. The parameters which were positively and significantly ($p < 0.05$) correlated with one another proved that alteration of the one influences the others.

5. Conclusion

In the present study the trained male and female junior

Table tennis players and Swimmers were analysed on the basis of their morphometry. Most of the selected variables significantly correlated in trained junior male and female Swimmers, male Table Tennis players and female Table Tennis players. In trained junior female Swimmers, only few variables significantly correlated. Only 35% male Swimmers, 17% of female Swimmers and 21% of male Table Tennis players were mesomorphic. But mesomorphy along with ectomorphy was essential for the improvement of performance of players in Swimming and Table Tennis.

Findings suggest that there is a high probability for the developmental change in different aspects of morphometric phenotypes of selected sports athletes. These phenomena may be explained by the effects of continuous intensive training and achievement of highly-sports defined shapes. It can be concluded that the training to build their musculoskeletal growth which is the main important part of these types of water games (Swimming) and surface games (Table tennis), may not be specific to the events demand. Musculoskeletal development of the players especially in the female Table Tennis players is not specific for this event. Endomorphy was present in high percentage in the players of both events whereas the requirement was mesomorphy. These results could serve as a basis for more accurate and purposely focused management of the training process. Morphometric parameters of the body and the athlete's core values of the partial somatotype indices could be a useful marker of the correctness of the chosen coaching techniques.

References

- [1] Gualdi-Russo, E., Zaccagni, L., Somatotype, role and performance in elite volleyball players. *The Journal of Sports Medicine and Physical Fitness*, 33 (2), 179-18, 2001.
- [2] Siders, W., Relationships among swimming performance, body composition and somatotype in competitive collegiate swimmers. *Journal of Sports Medicine and Physical Fitness*, 33 (2), 166-171, 1993.
- [3] Sullivan, J., Anthropometric characteristics and performance related predictors of success in adolescent pol. *Journal of Sports Medicine*, 34 (2), 179-184, 1994.
- [4] Sanchez-Munoz, C., Sanz, D., Zabala, M., Anthropometric characteristics, body composition and somatotype of elite junior tennis players. *British Journal of Sports Medicine*, 41(11), 793-799, 2007.
- [5] De Hojo, M., Sanudo, B., & Paris, F., Analysis of the somatotype, body composition and anthropometry in badminton players between 12 and 16 years. In: A. Less, D. Cabello, G. 2009.
- [6] TorresLuque (Eds.), Science and racket sports IV (pp. 112-117). London, New York: Routledge.
- [7] Maud, P. J. and Foster, C. (1995) Physiological Assessment of Human Fitness. Champaign, Illinois: Human Kinetics.
- [8] Mac Dougali, J. D.; Wenger, H. A. and Green, H. J., Physiological Testing of the High Performance Athlete. Champaign, Illinois: 1991, Human Kinetics.

- [9] Gordon, M. J., A review of the validity and accuracy of self-assessments in health professions training. *Academic Medicine*. 66(12): 711-780, 1991.
- [10] Cristóbal Sánchez-Munoz, David Sanz, Mikel Zabala, Anthropometric characteristics, body composition and somatotype of elite junior tennis players. *Br J Sports Med* 2007; 41: 793-799.2007.
- [11] International Society for the Advancement of Kinanthropometry (ISAK), available at www.isakonline.com.
- [12] ISAK, International Standards for Anthropometric assessment, ISAK manual, *International Society for the Advancement of Kinanthropometry (ISAK)*, Lower Hutt, New Zealand, 2011.
- [13] Heath, B. H., and Carter, J. E. L., A modified somatotype method, *American journal of Physical Anthropology*, 27: 57-54, 1967.
- [14] Durmin, J. V. G. A. and Womersley, J., Body fat assessed from the total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. *British Journal of Nutrition*, 32, 77-97, 1974.
- [15] Brozek J., Grande, F., Anderson, J. T., Densitometric analysis of body composition: Revision of some quantitative assumptions. *Annals New York Academy Sciences* 110: 113-140, 1963.
- [16] Siri, W. E., The gross composition of the body. In C. A. Tobias & J. H. Lawrence (Eds.), *Advances in biological and medical physics* (vol. 4, pp. 239-280). New York: Academic. 1956.
- [17] Massida, M., Toselli, S., Brasili, P., Calo, C. M., Somatotype of elite Indian gymnasts. *Coll Antropol*, 37(3): 853-7, 2013.
- [18] De Rose, E., H., Guimaraes, A. C., "A model for optimization of somatotype in young athletes". In: Ostin M, Buenen G, Simons J: *Kinanthropometry II*, University Park Press, Baltimore, 1980.
- [19] Prades, F., Carrasco, L., Martinez, E., Herrero, R., "Anthropometric profile, somatotype, and body composition of young table tennis players", *Revista Internacional de Ciencias del Deporte*, Vol. 3, No. 7, pp. 11-23, 2007.