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Physique and motor abilities of junior gymnasts from West Bengal, India

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Abstract
The purpose of this study is assess the physical and motor abilities of young adolescent gymnasts, assess the relationship between body composition parameters with the motor abilities and to establish the pattern of body type of young male and female gymnasts. The study was composed of 24 male and 28 female gymnasts who were aged between 5-17 years. Anthropometric, body composition parameters, motor fitness & strength parameters, lung function parameters and somatotyping were studied. The weight of male and female gymnasts of present study was higher in male but lower in female than sedentary children and it was also significantly lower than international values. The handgrip strength was also significantly higher in male and lower in female than sedentary children. The anaerobic power was significantly higher in male and female than sedentary children. The somatotying of present study was ectomorphic mesomorph. The height, flexibility, vertical jump, aerobic power were also significantly lower than international value. Significantly lower values of present study found in balance stork test, upper length, lower length extremity, shoulder width, elbow and knee diameter, vertical jump, flexibility & higher values found in wrist and ankle diameter than Iranian Junior gymnasts. The PEFR value of present study was also significantly lower than different sports. This study revealed that the physique and body composition pattern of junior gymnasts are different from there sedentary counterpart. Thus for the purpose of identification of talent and of developing a successful gymnasts, a suitable database for physique and physiological profile has to be established. Further improvement in motor abilities needs to be emphasized by adequate training and appropriate conditioning.

Keywords: anthropometry, reaction time, balance test, anaerobic power, somatotype, gymnasts

1. Introduction
Gymnastics is a discipline of serial complex exercise activities that have some factors that differentiate from others sports. These are the force, postural control on movement, extreme range of motion and of the body expression. The physiologic requirements of gymnastics reflect a muscular load and exercise comparable to other sports. Gymnastics is a type of strength power sport demanding high levels of both anaerobic power and flexibility capacities for successful performance. Gymnastics performances usually last under 90 seconds. The level of the activities is too high for long term performance. It requires explosive sprinting, jumping, pushing, and pulling skills, together with balance [1].

Elevated anaerobic capacity, muscle resistance and strength, explosive power, flexibility and agility are the most important factors needed to achieve success in gymnastics competition [2].

As physiological and anthropometric profiles have been developed to describe the qualities and characteristics of elite athletes in their respective sports. Cagnoa *et al.* [3] stated that many factors including anthropometric factors might influence the gymnast's performance. Besides, Benardot [4] observed that gymnasts had generally a small body size in comparison to other categories of athlete.

The physiological and anthropometric profile as well as body composition profile of gymnastics can be used in evaluating for talent identification and these traits can be important for coaches at all levels [5].

Physical and physiological parameters vary from region to region of a country which mainly depends on genetic factors, environmental and economic factor. As there is dearth of physical and physiological parameters of young gymnasts of eastern region of India, we planned to undertake this study.

The purpose of the present study is to assess the physical and motor abilities of young adolescent gymnasts and its relationship with body composition parameters.

2. Methods
Subjects
This cross sectional study was carried out on 24 male and 28 female gymnasts who were aged between 5-17 years of different gymnastic club of Hooghly district of West Bengal.

The test items & questionnaire administered & the methods used are given below:

Study Design
This cross sectional comparative study include the use of questionnaire, history of athletic activities, strength and speed. This was done among male and female gymnasts of age range (5-17 years) from different gymnastic club of Hooghly district of West Bengal.

Study Area

There are many gymnastic club and training institute in Hooghly district of West Bengal. We take gymnastic clubs from Serampore area and Uttarpara area. From selected gymnastic club, gymnasts were selected at random from willing gymnasts.

The research study was conducted qualitatively and quantitatively. Collection of data was done through questionnaire, interviews and experimental work.

Study questionnaire

- Duration of training.
- Average practice hour per day.
- Level of play.

Ethical consideration

The ethical approval was obtained from human ethical committee of Serampore College. Besides, written consent was taken from club authority and guardian of gymnasts before the beginning of study.

Parameters studied

- **Age (years) -** Age of subject was determined from their date of birth recorded in the club register and it was rounded off to the nearest whole number.
- **Anthropometric measurements and somatotyping**
  1. **Body weight (kg):** It was measured by standard weighing machine with lightly clothed and bare footed.
  2. **Body height (cm):** It was taken by anthropometric rod without shoe. We also take the upper length extremity and lower length extremity of the subjects.
  3. **BMI:** It was calculated from height and weight by using the equation of [6].

     BMI (kg/m^2) = (Body weight in kg)/(Body height in meter)^2.

  4. **Arm span (cm):** With back against wall, arms were extended horizontally. Distance taken from out stretched finger tips of one hand to the other.
  5. **Hand span (cm):** It was the maximum distance between the tip of the thumb and the tip of the little finger in expanded position of the hand.
  6. **Waist circumference (cm):** Horizontal circumference at level of the greater lateral indentation of trunk.
  7. **Hip circumference (cm):** Horizontal circumference at level of near most protrusion of the buttocks.
  8. **Waist/hip ratio:** It was calculated from waist circumference divided by hip circumference.
  9. **Skin fold measurement (mm):** Skin fold thickness was measured by Slim Guide Caliper. Biceps, triceps, sub scapular, supraspinale and medial calf skin folds were measured on the right side of the body.
  10. **Somatotyping:** All players were measured on the same day to avoid technical error by the Level 1 Anthropometrics accredited by International Society for Advancement of Kinanthropometry (ISAK). Body mass (kg) was measured with an electronic weighing machine. Skin fold thickness (biceps, triceps, sub scapular, and supraspinale) for determining the fat% and total fat content were measured with a skin fold caliper which requires a constant closing compression of $10g.mm^{-2}$ through-out the range of measurements.

      The following circumferences & girth were measured for this purpose-

      a) Arm girth.
      b) Calf girth.
      c) Chest circumference.
      d) Waist circumference.
      e) Hip circumference.
      f) Mid thigh circumference.
      g) Upper thigh circumference.

      Somatotype Heath-Carter [7] method was followed for somatotype rating. The following equations were used for calculating somatotype.

      Endomorphy = $-0.7182+0.1454 \times \sum SF - 0.00068 \times \sum SF^2 + 0.0000014 \times \sum SF^3$

      Where $\sum SF$ = (triceps + biceps +sub scapular + supraspinale skin fold) x (170.18/height in cm.).

      Mesomorphy = 0.858 x humerus breadth + 0.601 x femur breadth + 0.188 x corrected arm girth + 0.161 x corrected calf girth – height x 0.131 + 4.5.

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

      If HWR was greater than or equal to 40.75 then, Ectomorphy = 0.732 x HWR – 28.58.

      If HWR was less than 40.75 and greater than 38.25 then, Ectomorphy = 0.463 x HWR – 17.63.

      If HWR was equal to or less than 38.25 then, Ectomorphy = 0.1.
  11. **Percentage of body fat:** It was calculated by using the formula of Jackson and Pollock [8].

      The following formula was utilized for calculation of percentage of body fat of both boys and girls at 9-21 years.

      Percentage of body fat = [(4.95/D)-4.50]x100 [9]

      Where D is the body density

      Now, the body density (D) is,

      $D = 1.112502-0.0013125x(x_1) + 0.0000055x(x_1)^2-0.0002440x(x_2)$

      Where x_1= Sum of biceps, triceps, sub scapular and supraspinale skin folds.

      And x_2= Age in years.

      The total body fat mass can be calculated by this formula---

      Total fat mass= (% of body fat/ 100) x body weight in kg

      Lean body mass or fat free weight is the qualitative expressions of body tissues, such as, bones, muscles nerve fibers etc. which can be determined by:

      Fat free mass= Body weight in kg – total fat mass in kg

Motor fitness and strength parameters

1. Resting heart rate (bpm) & blood pressure (mmHg) by Auscultatory method [10].
2. Measurement of maximum oxygen consumption by Queen's college step test [11] (L/min): This test was used for assessing cardio respiratory fitness by using following equations –

   Men- VO_2 max = 111.33-[o.42 x step test pulse rate (b/min)]
   Women- VO_2 max = 65.81-[0.1847 x step test pulse rate (b/min)]
3. Sargent vertical jump test [12] (cm).
4. Measurement of hand strength by hand grip dynamometer (kg) [13]: The measurement was taken with the best of two trials with 30 seconds rest between trials. The dynamometer scale was read in kg.
5. Flexibility by sit & reach test (cm) [14]: The best three trails measure to the nearest half cm were the test score.
6. Balance stork test [15]: The score is the greatest number of seconds counted between the time of the heel is raised and the balance is lost on three trials with the preferred foot. Only the highest score is recorded.
7. Bridge up test for hyperextension of spine [15]: The best score of three trials is recorded and then subtract from his/her standing height.
8. Trunk and neck extension test [15]: Subtract his/her base of three lifts from his/her trunk and neck length score.
9. Speed by 50 yard dash [15].
10. Shuttle run for agility [15].
11. Reaction time by ruler drop test [15]: When the subject catches the stick, the score is read just above the edge of the thumb.
12. Margaria anaerobic power test [16-17]: The unit of this score was expressed in kgm/sec.

Lung function parameters

1. Peak expiratory flow rate (PEFR) (lit/min): It is the maximum flow which can be sustained for a period of 10 seconds during a forced expiration starting from a total lung capacity.
   It was measured by Weight's peak flow meter.

Statistical analysis

Mean, standard deviation, correlation between parameters were analyzed. Student's t-test was performed to compare the mean between two groups. Regression equation was made based on the basis of year of exposure, BMI and body fat mass.

3. Results and discussion

Table 1 represents mean, SD and 't'- test values of physical and physiological parameters of male and female young gymnasts. The average age of male gymnasts is 9 years and in case of female it is 10 years. Significant differences has been found only in case of waist hip ratio and % of body fat (male > female) and also the endomorphic component (female > male). As body type and composition is an important factor for gymnastic ability, when male and female junior gymnasts are compared with sedentary boys and girls of West Bengal [18-19], no significant difference has been observed in body weight, body height and BMI between young female gymnast and sedentary girls of West Bengal but sedentary boys have lower body height and weight values than junior gymnast boys of present study. % of body fat is significantly lower in junior gymnasts boys and girls than their sedentary counterpart [20-21]. Biacromiale diameter (shoulder width) of gymnast boys and girls is greater than sedentary boys and girls of same age group [22-23] indicating that gymnast boys and girls have wider shoulder. This high diameter of upper limb can be effective for sustaining weight and avoiding injury [24].

Male and female gymnasts when divided in groups according to their year of training- 1-3 years group and > 3 years group (Table 2), it is found that body weight, body height, upper and lower body extremity length increase significantly ($P< 0.001$) with increase in training period, probably due to the effect of training. Besides, speed, anaerobic power, vertical jump test score, balance increase with increase in year of training; but grip strength, PEFR, body type do not change with the year of training, probably the gymnasts of present study are in preadolescent stage where the effects of hormone on growth is minimum (Fig: 2-3).

Table 3 and 4 represent the correlation values between physique, years of training and motor abilities among male and female gymnasts of present study. All the correlation values are significant ($P< 0.001$) and positive except agility, speed, reaction time and aerobic power where relationship are negative. All the motor abilities show significant correlation with year of training except agility, flexibility, reaction time and aerobic power. Aerobic power was measured for 8 adolescent gymnasts (mean age 14 years). So on the basis of year of training, BMI and body fat mass simple regression equations are constructed on the basis of which motor abilities can be predicted (Table 5).

The Heath- Carter anthropometric somatotype of gymnasts of 9-10 years age was estimated and it was ectomorphic mesomorph which corroborate the study of Claessens [25] for Belgian girls gymnasts of 13-20 years and Mexican precompetitive gymnasts [26] (Fig: 1).

No significant difference in motor abilities of male and female junior gymnast has been found in our study. Male and female gymnast of present study when compare with the sedentary school going boys and girls of West Bengal [18-19], it is found that anaerobic power, grip strength and agility values of male and only anaerobic power value of female gymnasts are significantly higher than their sedentary counterpart. No significant difference in speed in case of male and handgrip strength in case of female gymnasts and sedentary boys and girls of same age group has been found. PEFR value of male and female gymnast is also significantly lower ($P< 0.001$) than sedentary boys and girls of similar age group [27-28]. PEFR value of female gymnast is significantly lower than athletes-long distance runner, sprinter, javelin thrower, jumper, basketball player, badminton player and swimmer of West Bengal [29]. This differences in motor abilities might be due to less number of subjects in our study, genetic factor and the secular trend (Fig: 9).

Comparison of physique and motor fitness parameters of junior gymnasts with Mexican precompetitive female gymnasts [26], male and female elite Greek gymnasts [30] and young gymnasts [31] of 5-8 years revealed that female

gymnasts [31] of 5-8 years had lower body weight, biacromial diameter and leg length than junior gymnasts of present study, probably due to higher age range of our study population (9-10 years). Mexican precompetitive female gymnasts [26] have significantly higher body weight than junior gymnasts of present study but insignificant differences have been found in case of body height and BMI. Besides, male and female elite Greek gymnasts [30] have significantly higher body fat, flexibility, body weight, height, aerobic power and vertical jump ability than junior gymnasts (male and female) of present study except vertical jump ability of female gymnasts where the difference was not significant (Fig: 4-6). These differences might be due to genetic factor, socio-economic factor and methods used.

Again male gymnasts of present study when compared with Iranian junior elite gymnasts [24], it is found that Iranian gymnasts are older, heavier and taller than male gymnasts of present study. Upper extremity and lower extremity length, biacromial diameter are significantly higher in Iranian gymnasts than junior gymnasts of West Bengal. Besides flexibility, vertical jump test score and balance stork test score is significantly lower in junior gymnasts of present study in comparison of Iranian gymnasts. The reason might be due to the age that is male Iranian gymnasts are adolescent (mean age 15 year) and they have 5 years training experience in comparison to junior gymnasts (mean age 9 years and training experience less than 3 years). Besides, genetic, nutritional factors and environmental factor might be the reason for these differences (Fig: 7-8).

4. Tables & Figures

Table 1: Mean, standard deviation and 't'-test values of physical, body composition and physiological parameters of male and female gymnasts

Parameters	Mean+SD		't'-Test (P value)
	Male (n=24)	Female (n=28)	
Age (years)	8.83+2.81	9.96+2.82	0.31
Body height (cm)	129.98+13.66	132.13+11.82	0.55
Body weight (kg)	28.68+9.92	29.86+8.69	0.65
Upper length (cm)	54.84+4.84	53.05+5.36	0.21
Lower length (cm)	75.13+9.68	79.07+7.64	0.11
Arm span (cm)	131.12+16.43	131.46+14.32	0.94
Hand span (cm)	17.14+2.32	16.24+2.02	0.14
Shoulder width (cm)	25.46+4.04	25.57+3.01	0.91
Wrist diameter (cm)	12.83+1.57	12.71+0.97	0.75
Ankle diameter (cm)	7.72+1.25	7.52+1.04	0.54
Hip circumference (cm)	67.68+10.55	63.68+6.99	0.11
BMI (kg/m^2)	16.50+2.19	16.7+2.30	0.74
W/H ratio	0.87+0.04	0.80+0.07	8.4919E- 05****
% of body fat	4+2	6+4	0.02**
Body fat mass	1.11+1.10	2.00+1.83	0.04
Lean body mass	27.56+9.11	27.86+7.23	0.90
Endomorph	1.53+0.73	2.1+0.96	0.02**
Mesomorph	3.98+0.98	3.52+0.79	0.07
Ectomorph	2.86+1.21	3.04+1.09	0.57
Handgrip strength (kg) (R)	19.67+12.26	17.14+12.25	0.46
Handgrip strength (kg) (L)	13.08+10.39	12.07+8.40	0.70
Blood pressure (SBP) (mmHg)	99.25+10.31	98.57+9.64	0.81
Blood pressure (DBP) (mmHg)	65.75+10.37	63.96+8.55	0.51
PEFR (lit/min)	187.08+52.62	175+48.80	0.40
Speed (sec)	8.80+1.49	8.67+2.15	0.79
Agility (sec)	12.42+1.61	12.59+1.29	0.69
Anaerobic power (kgm/sec)	34.29+19.89	33.30+15.60	0.85
Aerobic power (ml/kg/min) (n=8)	45.81+6.72	34.05+3.18	0.30
Flexibility test (cm)	17.17+3.29	18.68+3.88	0.13
Vertical jump test (cm)	22.60+5.61	21.10+6.83	0.40
Balance stork test (sec)	7.40+6.96	8.31+8.34	0.67
Reaction time (sec)	0.22+0.04	0.24+0.05	0.13
Bridge up test (Hyperextension of spine) (cm)	72.81+7.78	74.30+6.97	0.47
Trunk neck extension test (cm)	6.29+4.74	6.59+6.32	0.85

*P<0.05, **P<0.02, ***P<0.01, ****P<0.001

Table 2: Mean, standard deviation and 't'-test values of physical, body composition and physiological parameters of gymnasts according to year of training

Parameters	Mean+SD		't'-Test (P value)
	1-3 years (n=29)	>3 years (n=23)	
Year of training	2+0.89	7.04+3.17	9.94303E-08****
Age (years)	8.03+1.64	10.83+3.23	0.001****
Body height (cm)	126.44+8.93	137.02+14.27	0.003
Body weight (kg)	25.47+4.37	34.15+11.31	0.001****
Upper length (cm)	52.19+2.92	56.02+6.50	0.01***
Lower length (cm)	74.28+7.95	80.99+8.48	0.01***
Arm span (cm)	126.85+10.81	137.37+17.88	0.02**
Hand span (cm)	16.05+1.73	17.42+2.49	0.03
Shoulder width (cm)	23.88+2.11	27.48+3.85	0.0003****
Wrist diameter (cm)	12.45+0.89	13.22+1.56	0.04
Ankle diameter (cm)	7.13+0.74	8.10+1.36	0.004
Hip circumference (cm)	62.21+4.55	70.41+11.27	0.003
BMI (kg/m^2)	15.78+1.38	17.65+2.66	0.004
W/H ratio	0.86+0.05	0.8+0.08	0.01***
% of body fat	4+3	6+4	0.04
Body fat mass	1.03+0.79	2.29+2.03	0.01***
Lean body mass	24.50+3.94	31.86+10	0.002
Endomorph	1.67+0.70	2.05+1.08	0.15
Mesomorph	3.76+0.83	3.83+0.90	0.75
Ectomorph	3.02+1.06	2.88+1.25	0.67
Handgrip strength (kg) (R)	15.34+8.57	22.04+15.01	0.07
Handgrip strength (kg) (L)	10.03+5.84	15.70+11.74	0.04
Blood pressure (SBP) (mmHg)	94+6.82	105.04+9.76	4.5166E-05****
Blood pressure (DBP) (mmHg)	61.69+8.83	68.70+8.73	0.01***
PEFR (lit/min)	167.93+35.19	198.26+59.75	0.04
Speed (sec)	9.25+2.10	8.06+1.19	0.01***
Agility (sec)	16.92+22.57	12.09+1.32	0.26
Anaerobic power (kgm/sec)	27.31+10.12	42.28+21.57	0.01***
Aerobic power (ml/min) (n=8)		39.93+7.95	
Flexibility test (cm)	17.29+3.57	18.83+3.65	0.14
Vertical jump test (cm)	19.86+3.94	24.23+7.78	0.02**
Balance stork test (sec)	5.80+5.24	10.64+9.44	0.04
Reaction time (sec)	0.23+0.05	0.22+0.05	0.56
Bridge up test (cm) (Hyperextension of spine)	70.4+4.29	77.14+8.42	0.001****
Trunk neck extension test (cm)	6.17+5.97	6.81+5.19	0.68

*P<0.05, **P<0.02, ***P<0.01, ****P<0.001

Table 3: Correlation between different body parameters, year of training, motor ability and athletic ability parameters of male and female gymnasts

Parameters	Height		Weight		BMI		Body fat mass		Lean body mass	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Age	0.94****	0.88****	0.89****	0.91****	0.55****	0.76****	0.51****	0.66****	0.91****	0.92****
Agility	-0.74****	-0.57****	-0.60****	-0.47****	-0.26	-0.30*	-0.26	-0.12	-0.62****	-0.52****
Strength (R)	0.95****	0.80****	0.86****	0.79****	0.53****	0.62****	0.50****	0.58****	0.87****	0.80****
Strength (L)	0.88****	0.82****	0.91****	0.78****	0.69****	0.59****	0.62****	0.66****	0.92****	0.77****
Speed	-0.69****	-0.62****	-0.63****	-0.50****	-0.38***	-0.35**	-0.42***	-0.24	-0.63****	-0.54****
Anaerobic power	0.92****	0.82****	0.93****	0.85****	0.69****	0.71****	0.57****	0.65****	0.95****	0.86****
Flexibility	0.10	0.19	0.14	0.24	0.18	0.20	-0.01	0.08	0.15	0.26
Aerobic power	-0.77****	0.56****	-0.89****	-0.13	0.51****	-0.99****	0.57****	0.65****	-0.85****	-0.74****
Reaction time	-0.55****	-0.24	-0.37***	-0.30*	-0.003	-0.29*	-0.10	-0.15	-0.38***	-0.32*
Bridge up test (Hyperextension of spine)	0.92****	0.91****	0.90****	0.89****	0.61****	0.71****	0.56****	0.77****	0.91****	0.88****
Trunk & neck extension test	0.22	0.14	0.34**	0.08	0.38***	-0.02	0.18	0.22	0.35**	0.04
Balance stork test	0.70****	0.58****	0.59****	0.60****	0.31*	0.45****	0.17	0.46****	0.63****	0.60****

*P<0.05, **P<0.02, ***P<0.01, ****P<0.001

Table 4: Correlation between different measuring parameters & Year of training of gymnasts

Parameters	Year of training (n=52)
Age	0.83****
Height	0.73****
Weight	0.81****
BMI	0.69****
Body fat	0.61****
Lean body mass	0.80****
Agility	-0.08
Strength (R)	0.67****
Strength (L)	0.68****
Speed	-0.45****
Anaerobic power	-0.05
Flexibility	0.17
Aerobic power	0.19
Reaction time	0.07
Bridge up test (Hyperextension of spine)	0.45****
Trunk & neck extension test	0.09
Balance stork test	0.65****

*P<0.05, **P<0.02, ***P<0.01, ****P<0.001

Table 5: Regression equation for prediction of Handgrip strength, speed, anaerobic power, aerobic power, hyperextension test, balance stork test & trunk neck extension test on the basis of Year of exposure, BMI, Body fat mass among gymnasts

Parameters	Regression equation	R^2
Right handgrip strength (kg)	RHS= 2.458year of exposure+7.907	0.453****
	RHS= 3.125BMI-33.58	0.325****
	RHS= 3.721body fat mass+12.39	0.233****
Left handgrip strength (kg)	LHS= 1.877year of exposure+4.596	0.456****
	LHS= 2.641BMI-31.32	0.401****
	LHS= 3.319body fat mass+7.265	0.321****
Speed (sec)	Speed= -0.254year of exposure+9.781	0.211****
	Speed= -0.304BMI+13.75	0.134***
	Speed= -0.371body fat mass+9.293	0.101*
Anaerobic power (kgm/sec)	AnP= -1.290BMI+55.33	0.027
	AnP= -1.652body fat mass+36.53	0.022
Aerobic power (ml/kg/min)	AP= 0.172BMI+35.17	0.005
	AP= -0.021body fat mass+38.06	4E-05****
Hyperextension test (cm)	HT= 0.975year of exposure+69.25	0.203****
	HT= 0.625BMI+62.99	0.037
	HT= 1.361body fat mass+71.22	0.089*
Balance stork test (sec)	BST= 1.447year of exposure+1.802	0.406****
	BST= 1.351BMI-14.50	0.157***
	BST= 1.635body fat mass+5.328	0.116**
Trunk neck extension test (cm)	TNET= 0.288BMI+1.662	0.013

*P<0.05, **P<0.02, ***P<0.01, ****P<0.001

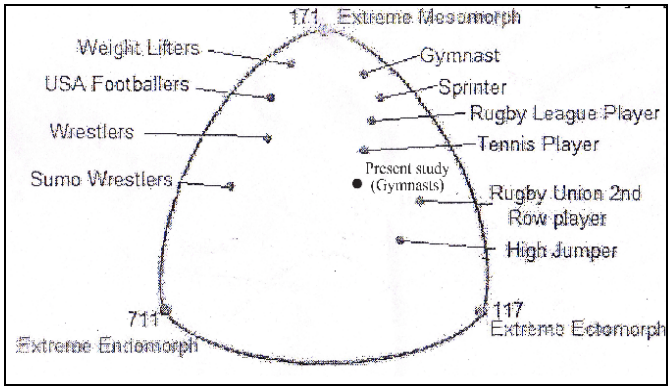

Fig 1: Somatochart of gymnasts of present study with different athletic events [32-33]

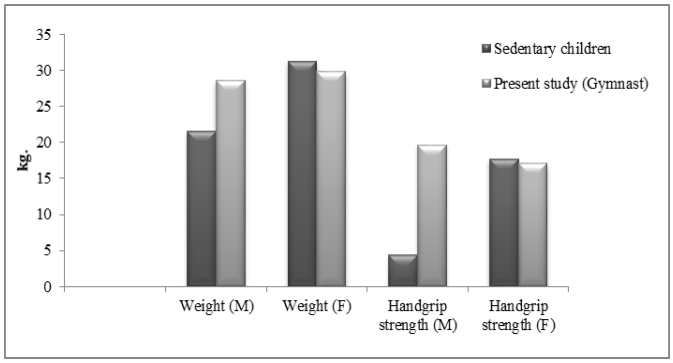

Fig 2: Comparison of weight & handgrip strength of male & female gymnasts of present study with sedentary male (Chatterjee *et al*, 1993) & female (Mandal, 2006)

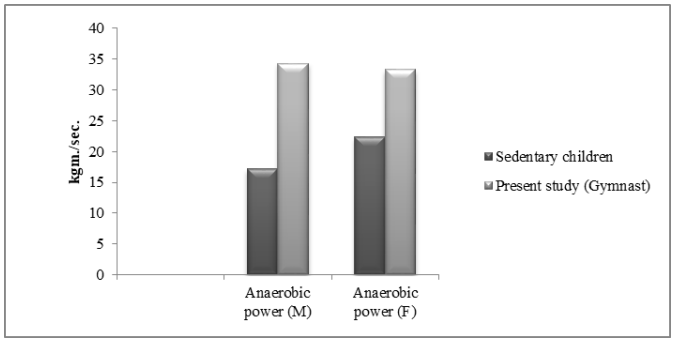

Fig 3: Comparison of anaerobic power of male & female gymnasts of present study with sedentary male (Chatterjee *et al*, 1993) & female (Mandal, 2006)

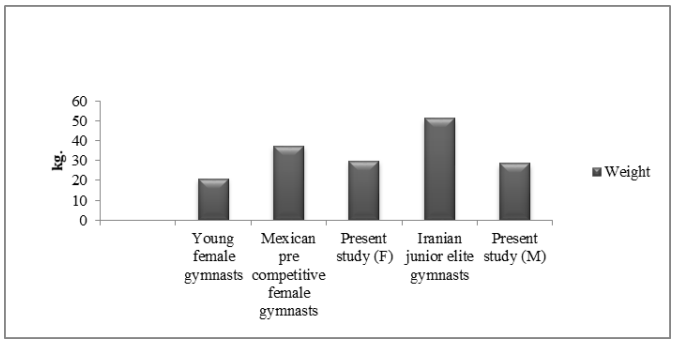

Fig 4: Comparison of weight of male & female gymnasts of present study with young female gymnasts (Thomas *et al*, 2013), Mexican pre competitive female gymnasts (Alcala *et al*, 2014) & Iranian junior elite gymnasts (Arazi *et al*, 2013)

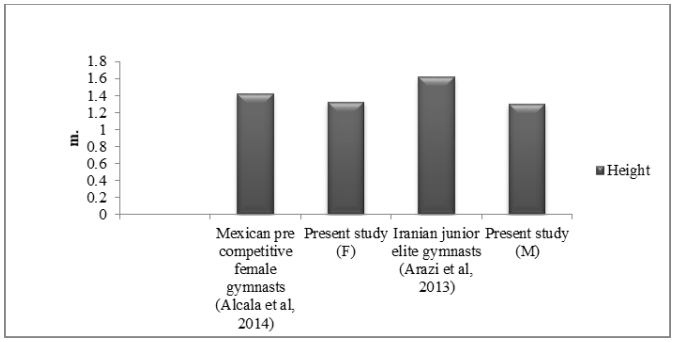

Fig 5: Comparison of height of male & female gymnasts of present study with Mexican pre competitive female gymnasts & Iranian junior elite gymnasts

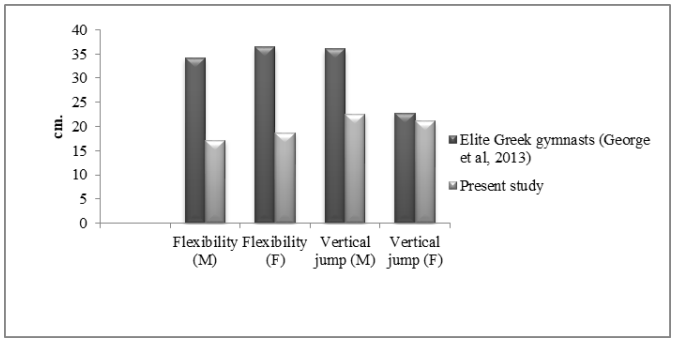

Fig 6: Comparison of flexibility & vertical jump of male & female gymnasts of present study with elite Greek gymnasts

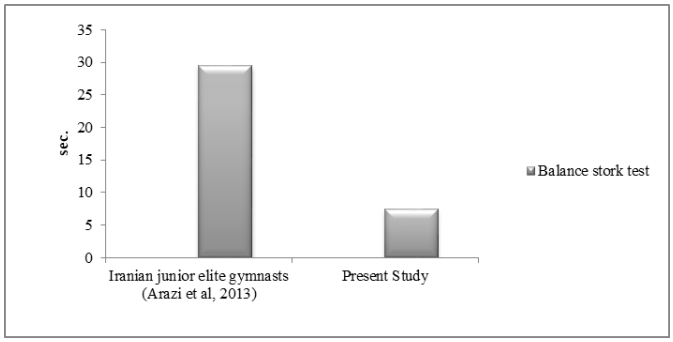

Fig 7: Comparison of balance stork test of male gymnasts of present study with Iranian junior elite gymnasts

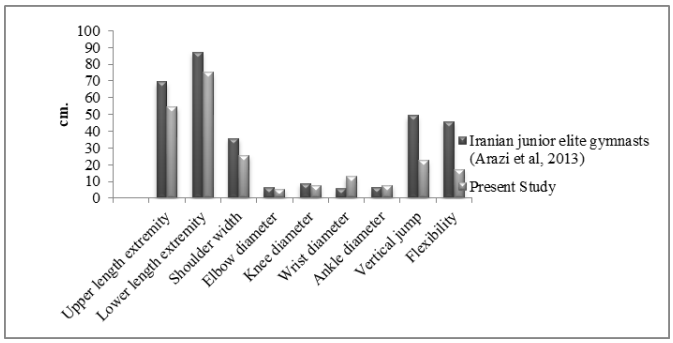

Fig 8: Comparison of different anthropometic & motor ability parameters male gymnasts of present study with Iranian junior elite gymnasts

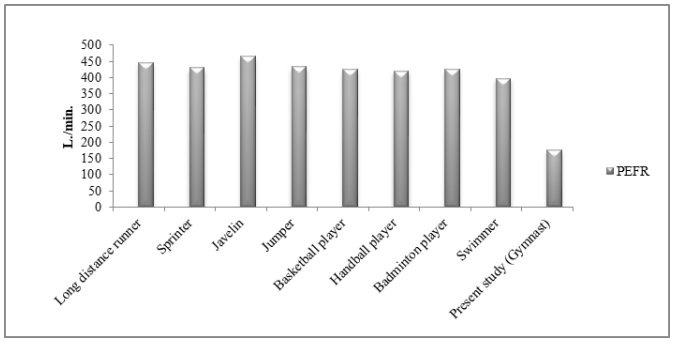

Fig 9: Comparison of PEFR of female gymnasts of present study with different sports (Chatterjee *et al*, 2002)

5. Conclusion

Thus this study revealed that the physique and body composition pattern of junior gymnasts are different from their sedentary counterpart- % of body fat is lower and biacromiale diameter is higher. The gymnasts are ectomorphic mesomorph. The anaerobic power is higher in gymnasts than non athlete boys and girls of West Bengal. The differences might be due to genetic factor and level of training.

Thus for the purpose of identification of talent and of developing a successful gymnasts, a suitable database for physique and physiological profile has to be established and this database will allow for comparison of the performance of this trainee gymnasts with national and international standard. Further improvement in motor abilities needs to be emphasized by adequate training and appropriate physical conditioning.

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