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Comparative study on morphological differences of Indian male jumpers, runners and throwers

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Abstract
The purpose of the study was to find out the differences of Somatotypes among different athletes of Jummping, running and throwing events. Total 72 subjects (top three players of selected events) were selected from All India Athletic Intervarsity championship 2015 held at P.U. Patiala. For assessing the somatotype anthropometric technique developed used by Heath and Carter 1984. Analysis of variance was used to analyzing the mean differences. Results of the study reveled that Throwers were significantly greater in endomorphy and Mesomorphy whereas the Jumpers were significantly greater in Ecomorphy than other two groups.

Keywords: Morphological differences, Indian male jumpers, runners, throwers

Introduction
The human physique differs in a thousand ways. It can be analyzed by studying the size, shape and form of an individual. For this purpose, sets of selected anthropometric measurements are taken on an individual. The Inter group comparisons are made to understand the physical peculiarities of a population. From such body measurements, it is also possible to estimate the distribution of fat and development of bone and muscle in one's body. This is known to be more important in the case of athletes and sportsmen where the physical fitness plays a vital role in the competitive performance.

The competitive sports demand event specific physique and body composition to achieve the success. De Garay *et al*. 1974 [5] concluded that top-level performance in a particular event demands a specific type of size and shape, if other aspects are being similar. They showed high correlation between the body profile of an athlete and specific task (event) in which he/she excelled. Various other studies also suggest that different body size, shapes and proportions are beneficial in different physical activities. Hirata 1996 suggested that a nation with people whose general physique is limited to the characteristics of champions in certain events must concentrate their sports training on those specific events. He also concluded that Japanese with small body-builds are best for gymnastics, long distance running, boxing and weight lifting etc. whereas the Americans who are large and lean are best for basketball, Volleyball, Swimming, long jump, short and middle distance running.

Sports sciences have a long history of studying physique. Sheldon et at. Used photoscopic and anthroposcopic methods to describe individual physique as three different somatotype viz.; (i) Endomorphy (fatty: predominance of digestive organs, softness and roundness of contour throughout the body), (ii) Mesomorphy (muscular: predominance of muscles, bones and connective tissues) and (iii) Ectomorphy (predominance of surface area over body mass linearity). This method has basic shortcoming i.e., it does not quantify the various body dimensions, indices and ratios. The body profile technique of Mc Ardle *et al*. Describes physique in terms of muscular and non muscular components. The diversity in overall body dimensions can be compared among individuals or groups from that of reference man and reference woman.

The rules of 20th-century competition are quite different from those of ancient times, the spirit of the sport remains true to its early Greek roots. The modern Olympic motto *Citius*, *Altus*, *Fortius* (faster, higher, stronger) best captures track & field competition. Each event determines who can run the fastest, who can jump the highest or the longest, or who can throw the farthest.

Track & Field consists of running, hurdling, jumping, and throwing events, held between individuals and teams at indoor and outdoor meets. The running and hurdling competitions make up the track events, while the jumping and throwing contests comprise the field events. In many countries the sport as a whole is called *athletics.*

The throws (shot put, discus, javelin, and hammer) are field events in athletics. They are measure for explosive strength (power) in a human being from ancient time to modern time. The throwers of shot put, Discus, Javelin and hammer differed greatly in physique from the other athletes.

The jumps are the fundamental activities of human beings which had catered the food gathering and safety need of man kind right from the ancient times. Competitive jumps had come a long way in the development of technique and style. They are included in the modern Olympic Games right from their very start in Athens (1896).

Running is a method of terrestrial locomotion allowing humans and other animals to move rapidly on foot. Running is a type of gait characterized by an aerial phase in which all feet are above the ground (though there are exceptions [(rspb)]. This is in contrast to walking, where one foot is always in contact with the ground, the legs are kept mostly straight and the center of gravity vaults over the stance leg or legs in an inverted pendulum fashion (Biewener, 2003) [2]. A characteristic feature of a running body from the viewpoint of spring-mass mechanics is that changes in kinetic and potential energy within a stride occur simultaneously, with energy storage accomplished by springy tendons and passive muscle elasticity (*Cavagna, Saibene, Margaria, 1964)* [4]. The term running can refer to any of a variety of speeds ranging from jogging to sprinting.

Sprints are short running events in athletics and track and field. Races over short distances are among the oldest running competitions. The first 13 editions of the Ancient Olympic Games featured only one event – the stadion race, which was a race from one end of the stadium to the other (Instone, 2010) [8]. There are three sprinting events which are currently held at the Olympics and outdoor World Championships: the 100 metres, 200 metres, and 400 metres.

Middle distance running events are track races longer than sprints up to 3000 metres. The standard middle distances are the 800 metres, 1500 metres and mile run, although the 3000 metres may also be classified as a middle distance event. The 880 yard run, or half mile, was the forebear to the 800 m distance and it has its roots in competitions in the United Kingdom in the 1830s. The 1500 m came about as a result of running three laps of a 500 m track, which was commonplace in continental Europe in the 1900s.

Long-distance running, or **endurance running**, is a form of continuous running over distances of at least three kilometres (1.86 miles). Physiologically, it is largely aerobic in nature and requires stamina as well as mental strength (Grine, Frederick E. et. al., 2006) [6].

In modern human society, long-distance running has multiple purposes: people may engage in it for physical exercise, for recreation, as a means of travel, for economic reasons, or for cultural reasons. Long distance running can also be used as a means to improve cardiovascular health. Running improves aerobic fitness by increasing the activity of enzymes and hormones that stimulate the muscles and the heart to work more efficiently. Endurance running is often a component of physical military training and has been so historically. Professional running is most commonly found in the field of sports, although in pre-industrial times foot messengers would run to deliver information to distant locations. Long-distance running as a form of tradition or ceremony is known among the Hopi and Tarahumara people, among others (Lonergan, 2013) [9].

In the sport of athletics, long-distance events are defined as races covering three kilometres (1.86 miles) and above. The three most common types are track running, road running and cross country running, all of which are defined by their terrain– all-weather tracks, roads and natural terrain, respectively. Typical long-distance track races range from 3000 metres to 10,000 metres (6.2 miles), cross country races usually cover 5 to 12 km (3 to 7½ miles), while road races can be significantly longer, reaching 100 kilometres (60 miles) and beyond. In collegiate cross country races in the United States, men race 8000 or 10000 meters, depending on their division, whereas women race 6000 meters. The Summer Olympics features three long-distance running events: the 5000 metres, 10,000 metres and marathon (42.195 kilometres, or 26 miles and 385 yards). Since the late 1980s, Kenyans and Ethiopians have dominated in the long-distance competitions of international multi-sport events. (Roth, Stephen 2011) [10].

Somatotype

The term Somatotype is a Greek word, which means "forms of body". Sheldon first used this word Somatotype in 1940, the greater propagation of interest regarding a particular type of physique that provides an athlete with greater performance for a particular games, come up around the middle of twentieth century. Heath Carter explained Somatotype as a description of the present morphological confirmation. It is expressed in a three numeral rating, consisting of three sequential numerals, always recorded in the same manner. Each numeral represents the evaluation of three primary components of physique, which describe individual variations in human morphology and composition.

He gave Somatotyping methods in 1967, Heath Carter method of Somatotyping is one such attempt, which fulfils to major extent these requirements and is widely in use through out the world during last three decades.

It is based on anthropometric measurements, which are easy to take on the subjects. Heath Carter took ten anthropometric measurement for determine Somatotyping viz. height, weight, skin fold of triceps, sub scapular, supraspinal and calf, biepicondylar diameters of humerus and femur, girths of biceps and calf.

Somatotyping looks at how fat, muscular and linear the body is, in that order. Somatotype can describe everyone's body shape. There are three extremes:

Extreme Endomorph

Wide hips and narrow shoulders (pear-shaped), A lot of fat on the body, upper arms and thighs and Quite slim wrists and ankles.

Extreme Mesomorph

Broad shoulders and relatively narrow hips (wedge-shaped), Muscular body, Strong forearms and thighs and Very little body fat

Extreme Ectomorph

Narrow shoulders, hips and chest, Thin face, high forehead, Thin legs and arms, Very little muscle or fat.

Everyone is a mixture of all three basic body types, with ratings such as 3 4 4 or 352.

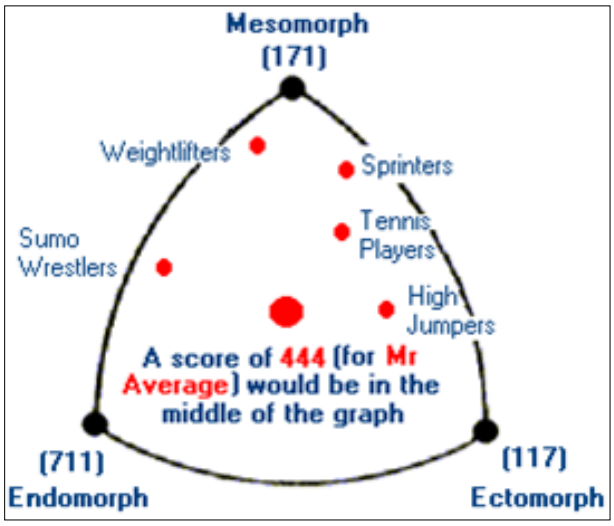

Fig 1

Procedure Sample

For the purpose of the study total 72 subjects (24 each of running, jumping and throwing) were selected on the basis of top three performers from All India athletic Intervarsity Athletic Meet 2015 held at P.U. Patiala. Subjects selected from different events i.e. 100 meter run, 200 meter run, 400 meter run, 800 meter run, 1500 meter run, 5000 meter run, 10000 meter run, Half Marathon, Shot put, Discus throw, Javelin throw, Hammer throw, Long Jump, High Jump, Triple Jump and Pole vault. Age of the subjects was 18 to 25 years that is according AIU rules.

Selection of Variables

Morphological differences were assessed on basis somatotypes. Heath Carter explained Somatotype as a description of the present morphological confirmation. It is expressed in a three numeral rating, consisting of three sequential numerals, always recorded in the same manner. Each numeral represents the evaluation of three primary components of physique, which describe individual variations in human morphology and composition. He gave Somatotyping methods in 1967, Heath Carter method of Somatotyping is one such attempt, which fulfils to major extent these requirements and is widely in use through out the world during last three decades.

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Collection of data

The data in the form of criterion measure of study described above were collected through the following methods-

1. **Body Weight:** The subjects were examined in clothing of known weight in Kg in order to record nude weight with the help of weighing machine. The position of the subject was anatomical position, the palm face outward eye looking ahead neck and back was straight.
2. **Stature:** Stature in cm. was taken as the maximum distance from the point vertex on the head to the ground. Subject was made to stand erect with heels together and arms hanging naturally by the side and head in the frank fort horizontal plane along a wall on which a measuring tape was fixed. The subject is instructed to "look straight ahead" and "take a deep breath." And the recorder had noted the height up to nearest mm. with the help of measuring tape.
3. **Arm Muscle Girth:** The subject was made to raise his right arm to horizontal position in the sagittal plan with the fully supinated forearms flexed at the elbow to an angle of 45º. The subject was asked to tense his biceps, the measurement was taken with the help of measuring tape wrapped at right angle to the long axis of the upper arm where the maximum girth was possible.
4. **Lower Leg Muscle Girth:** The subject was made to stand erect with body weight equally supported on both legs. The measuring tape was wrapped around the right lower leg and measurement was taken at right angle to the axis of lower leg, where it was maximum.
5. **Humerus Biepicondyler Diameter:** The subject's right arm was raised forward to the horizontal and the forearm flexed to right angle at elbow. The distance between medial and lateral epicondylar of the humerus was measured with the help of Vernier caliper and the value was recorded.
6. **Femur Biepicondyler Diameter:** The subject was made to sit and the right leg was flexed at the knee to from a right angle with thigh. The distance between medial and lateral epicondylar of the femur was measured with the help of vernier caliper and the value was recorded.
7. **Triceps Skin Fold:** The mid acromiale-radiale line on the posterior surface of the right arm was marked and the skin fold about one centimeter above marked level was picked up and jaws of the calipers were applied to the fold and after waiting for 2-3 seconds the reading was taken. One more reading was taken in the same way and average of the two was the final score.
8. **Sub Scapular Skin Fold:** A point below the right scapula was marked. The skin fold about one centimeter below marked level was picked up and jaws of the caliper were applied to the fold and after waiting for 2 - 3 seconds the reading was taken. One more reading was taken by the same procedure and average of the two was the final score.
9. **Suprailiac Skin Fold:** A point above the anterior superior iliac spine on the line to the anterior auxiliary's boarder of right side was marked. The skin fold about 2 to 5 centimeter above marked level was picked up, the caliper was applied to the fold and after waiting for 2 - 3 seconds the reading was taken. One more reading was taken by the same procedure and average of the two was considered.
10. **Calf Skin Fold:** The subject was made to sit on a chair with knees bent at right angles. Medial side of the right calf, slightly above the level of the maximum girth was marked. The skin fold above the marked level was picked up and jaws of the caliper were applied to the fold. After waiting for 2 to 3 seconds the reading was taken. One more reading was taken by the same procedure and average of the two was considered.

Toots and methods

Somatotype

The following Heath and Carter (1984) [3] method was applied to determine Somatotype of subjects;

Endomorphy

$-0.7182 + 0.1451 \times *\sum SF - 0.00068 \times *\sum SF^2 + 0.0000014 \times *\sum SF^3$

[Where SF = sum of triceps, sub scapular and supraillic skin fold multiplied by 170.18/height in centimeter].

Mesomorphy

0.858 × humerus breadth + 0.601 × Femur breadth + 0.188 × *Corrected arm girth + 0.161 × *Corrected calf girth – height × 0.131 + 4.5

(* Subtract the triceps skin fold and calfskin fold from the arm girth and calf girth, respectively).

Ectomorphy: - The ectomorphy was determined by comparing the calculated height, weight ratio (HWR) of the subject with the underline values given below.

$$HWR = \frac{Height\ in\ cm.}{\sqrt[3]{Weight\ in\ kg.}}$$

If HWR is greater than or equal to 40.75 than

$$Ectomorphy = 0.732 \times HWR - 28.58$$

- If HWR is less than 40.75 and greater than 38.25 then $Ectomorphy = 0.463 \times HWR - 17.68$
- If HWR is equal to or less than 38.25 than ectomorphy = 0.1

Statistical Procedure

According to purpose of the study the Analysis of variance (ANOVA) was applied to assessing the mean somatotype of different group. Where the f value was found significant further pair wise mean difference was analyzed through Least significant difference test. (LSD Test). Level of significance was set at 0.05 level.

Analysis of data

Table 1: Endomorphy

source of variation	D.F.	SS	MSS	F-value
Treatment	r-1=2	19.8	9.9	8.002
Error	N-r=69	85.36	1.2371	

Significance 0.05 level

Tab F (2, 69) =

Since calculated F value is greater than tabulated F value, the hypothesis is accepted and we conclude that significant difference is existing in the mean endomorphy of Jumpers, throwers and Runners. To further find out which group is having greater endomorphy, pair wise mean analysis is done through LSD test.

Table 2: Treatment means arranged in order of magnitude

Athletic Events groups			Mean difference	CD at 5%
Throwers	Runners	Jumper		
4.49	2.46		2.03	0.106
4.49		2.39	2.1	
	2.46	2.39	0.07	

*Significant at 5% level

Comparing the pair wise mean difference with critical difference we are able to conclude that mean endomorphy of throwers is significantly greater than mean endomorphy of jumpers, and Runners. Further mean endomorphy of Runners is insignificantly greater than mean endomorphy of runners and mean endomorphy of runners is the least from all the two groups.

Endomorphy

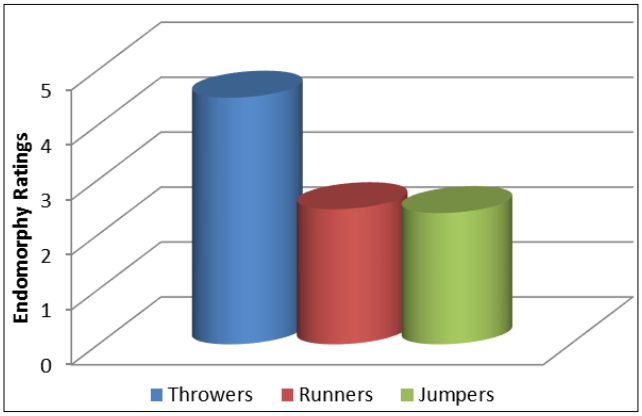

Fig 2: The mean Endomorphy rating of Throwers Runners and jumpers.

Table 3: Mesomorphy

Source of variation	D.F.	SS	MSS	F-value
Treatment	r-1=2	61.2	30.6	11.33
Error	N-r=69	186.49	2.70	

Significance 0.05 level

Tab F (2, 69) =

Since calculated F value is greater than tabulated F value, the hypothesis is accepted and we conclude that significant difference is existing in the mean mesomorphy of Throwers, Runners and jumpers. To further find out which group is having greater mean mesomorphy, pair wise means analysis is done through LSD test.

Table 4: Treatment means arranged in order of magnitude.

Athletic Event groups			Mean difference	CD at 5%
Throwers	Jumpers	Runners		
2.42	2.032		0.388	0.1561
2.42		1.61	0.81	
	2.032	1.61	0.422	

*Significant at 5% level

Comparing the pair wise mean difference with critical difference we are able to conclude that mean mesomorphy of throwers is significantly greater than mean mesomorphy of Runners and Jumpers. Further mean mesomorphy of jumpers is also significantly greater than mean mesomorphy of runners and mean mesomorphy of runners is significantly the least from all the two groups.

Mesomorphy

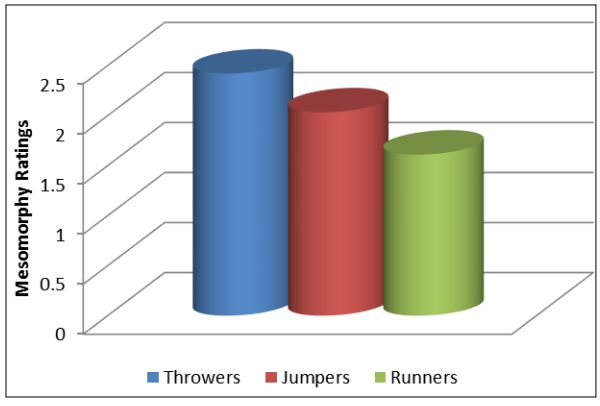

Fig 3: The mean Mesomorphy rating of Throwers, Jumpers and Runners.

Table 5: Ectomorphy

source of variation	D.F.	S.S.	M.S.S	f-value
Treatment	r-1=2	98.28	49.14	46.733
Error	N-r=69	72.56	1.0515	

Significance 0.05 level
Tab F (2, 69) =

Since calculated F value is greater than tabulated F value, the hypothesis is accepted and we conclude that significant difference is existing in the mean ectomorphy of throwers, Jumpers and runners. To further find out which group is having greater mean ectomorphy, pair wise means analysis is done through LSD test.

Table 6: Treatment means arranged in order of magnitude.

Athletics Events Groups			Mean difference	CD at 5% level
Jumpers	Runners	Throwers		
3.44	3.25		0.19*	0.165
3.44		1.91	1.53*	
	3.25	1.91	1.34*	

*Significant at 5% level

Comparing the pair wise mean difference with critical difference we are able to conclude that mean ectomorphy of Jumpers is significantly greater than mean ectomorphy of runners and throwers. Further mean Ectomorphy of runners is also significantly greater than mean ectomorphy of throwers and mean ectomorphy of throwers is significantly the least from all the two groups.

Ectomorphy

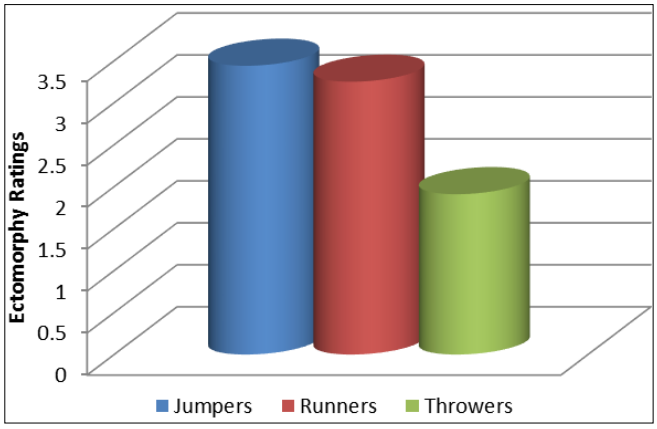

Fig 4: The mean Ectomorphy rating of Jumpers, Runners and Throwers.

Conclusion

On basis of statistical analysis following conclusion were made.

1. Mean Endomorph of thrower was greatest followed by Runners and Jumpers.
2. Mean Mesomorph of Thwores was greater followed by Jumpers and Runners.
3. Mean Ectomorphy of Jumpers was greatest followed by Runners and Throwers.

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