Chapter- II

REVIEW OF RELATED LITERATURE

A review of the related literature to the present study available in the library of Lakshmibai National Institute of Physical Education, Gwalior and library of Department of Physical Education, University of Rajasthan, Jaipur has been abstracted in this chapter to provide the background material to evaluate its significance and as well as to interpret its findings. The review of literature is divided into two sections. Studies pertaining to the relationship of somatotype variables to different motor fitness components like strength, speed, endurance, flexibility, balance, etc. are included in the section-A. Section-B covers those studies pertaining to the relationship of somatotype components to different games and sports like, Track and Field, Gymnastics, Swimming, Basketball, Football, Weight Lifting, Wrestling and Hockey. The findings of the study pertaining to the relationship of somatotype variables to a different motor fitness components and different games and sports are summarized at the end of the chapter. Some of the most related review of literatures is presented below.
Section-A

Somatotype and Different Motor Fitness Components

Strength

Sills and Everett\(^1\) studied the relationship of somatotypes to performance in motor and strength tests. Four hundred boys in the age group of 14 to 29 years as subjects were selected. They found that mesomorphs were stronger than endomorphs, endomorphs were stronger than ectomorphs, ectomorphs were superior to the endomorphs in speed, agility and endurance, mesomorphs were superior to both endomorphs and ectomorphs in agility, speed and endurance, excess body weight is a handicap to endomorphs in the performance of physical test, considerations should be given to body types in formulating standard for achievements in strength test and motor test.

Radcliff\(^2\) in fourteen years old boys found the highest correlation between somatotype components and strength. The motor ability variables were negatively related with endomorphy. These correlations were -0.48 for physical fitness index; -0.43 for standing broad jump and -0.43 for total reaction time (negative connection).

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Hawthorne\textsuperscript{3} studied the relationship of the structural and functional aspects of college men by correlating the ratings in the three components of somatotype with score in Roger's physical fitness index, vertical jump and Brace test of motor ability. It was observed that a real relationship did exists between mesomorphy and Roger's physical fitness index, endomorphy and Vertical jump and ectomorphy and motor ability as measured by the Brace test.

Parnell\textsuperscript{4} reported in the study that Oxford students who undertook strenuous exercise were generally well equipped to do so. They fell primarily in the mesomorphic classification, but it was reported central linear types were commonly athletic too. Where the musculature components are related less than three, participation in sports activities becomes less common and participation in contact sports becomes rate. Peripheral ectomorphs, because of their lack of musculature, are likely to embarrass instructors of physical education: they may swim, provided the water is very warm. The other half of the non-athletic world is populated by the peripheral endomorph with too little musculature proportionately for

\textsuperscript{3} Jesse J. Hawthorne, "Somatotype and Its Relationship to Selected Motor Performance of College Men" (Unpublished a Doctoral Dissertation, University of Texas), Cited by H. Harrison Clarke, Robert N. Irving and Barbara H. Heath, "Relation of Maturity, Structural and Strength Measures to the Somatotype of Boys 9 through 15 years of Age" Research Quarterly, 32, (1961): 449.

much activity. They are characterized by relatively small bones and preponderance of soft tissue. Type 623 has much to carry but proportionately little to carry it within mechanical language, a power/weight ratio that is inadequate for quick acceleration or movement they were very antithesis of type 263.

Borms\(^5\) compared the somatotype component rating of high and low strength groups of boys at 10, 13 and 16 years of age. Grouping for strength was based on a composite score comprising of Roger's strength index and physical fitness index and a mean of 11–cable tension strength test. It was found that the higher gross strength groups at each age level were more mesomorphic than the lower strength groups and that the lower strength group was more ectomorphic than the other groups.

Morton\(^6\) with adolescent boys as subjects concluded that the motor ability variables were not significantly related to somatotype assessment. The three motor ability variable showed a consistently significant relationship with the ectomorphy, the variable were standing broad jump, bar push-ups and physical fitness index.

\(^{5}\) J.W. Borms, "Relationship Between Selected Maturity, Physique, Body Size Motor Factor and of Ten, Thirteen and Sixteen Years Old Boys" *Completed Research in Health, Physical Education and Recreation*, 8 (1966): 76.

\(^{6}\) Alan R. Morton, "Comparison of Sheldon's Trunk Index and Anthroposcopic Methods of Somatotyping and Their Relationship to the Maturity, Structure and Motor Ability of the Boys 9 to 16 years of Age" *Dissertation Abstracts International*, 25 (1967): 16.
A number of studies have been conducted in foreign countries involving somatotypes and anthropometric measures. Heath, Hopkins and Miller\(^7\) worked with a Japanese sample and reported, it is evident that the fat and balanced somatotype are much rare and the 'muscular' somatotype much more frequent in the Japanese men than in the American men.

Hindmarch\(^8\) conducted a study entitled significance of physique maturational body size, body strength motor ability and reaction characteristics of 8-year-old boys. He found significant difference in the mean score of standing broad jump between mesomorphs and endomorphs. The mesomorphs were found to be superior in all the motor ability variables than the endomorphs.

Watson and O'Donovan\(^9\) studied the relationship of somatotype components to strength among 53 post-pubertal boys in the age group of 16 to 18 years. It was found that the strength index was related positively to the Sheldon somatotype rating for endomorphy and mesomorphy, and

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negatively to ectomorphy. The strength index was also found to be related positively to mesomorphy rating according to the Heath Carter method. The endomorphy and ectomorphy rating by this method, however did not exhibit to any relationship strength.

Endurance

Laubach, Hollering and Goulding\textsuperscript{10} studied the relationship of cardio-vascular endurance to somatotype components among 30 university men students. Two tests were used to measure cardio-vascular endurance, viz, the Harvard Step Test. Somototype rating were given according to the Heath Carter Anthropometric method. Cardiovascular endurance as measured by the Harvard Step Test was found to be significantly related to endomorphy and positive with ectomorphy. Contrarily endurance as measured by the Ohio Step Test was found to be unrelated to any of the somatotype components.

Miller\textsuperscript{11} after studying the relationship of 300 yard run time scores to pondrial index among 486 undergraduate students concluded that


ponderosity of the body is a significant factor in the performance of the 300-yard run.

Spain, Nathan and Gells\textsuperscript{12} relationship of somatotype to coronary atherosclerotic heart disease and reached the conclusion that endomorphic mesomorphs have a higher prevalence of heart disease as compared to other categories of somatotype.

**Speed**

Munroe\textsuperscript{13} reported that physique type did not seem to appear to be an important factor in motor ability elements of power, speed agility or recreation time in twelve years old boys. No somatotype components were highly related to factor relating to physical ability, although endomorph appeared to be a handicap in high physical accomplishment.

Tahamont\textsuperscript{14} Somatotype rating was given according to Heath Carter anthropometric method and anaerobic power was measured by the Margaria test. Statically significant relationships were found between each


of the somatotype components and anaerobic power. The multiple correlations between anaerobic power and the interactions of the somatotype component were not sufficiently high to be practical value.

Herbelinck and Postma\textsuperscript{15} conducted a study of physical education majors in South Africa. The physical education major tends to be athletic types as described by Kretschmer. The relationship between body measurement and motor fitness was found to be insignificant except in between biceps girth and shot put ability. Mesomorph was the most distinctive feature of a subject's somatotype. Mesomorph was also superior in all motor fitness tests except in the sixty yards and the ectomesomorphs in all tests except in the shot put event.

Schreiber\textsuperscript{16} compared the anaerobic capacity of university athletes as it was influenced by their somatotype. It was found that mesomorphs and endomorphs have higher anaerobic capacities than other somatotype categories.


Flexibility

Sills and Everett\(^{17}\) compared the endomorphs, mesomorphs and ectomorphs in a male university student on test of flexibility, endurance, speed, strength and agility. Each subject was selected as a member of one somatotype group on the basis of a high rating (5 to 7) for one component and low ratings (below 3) for the other two components. It was concluded that mesomorphs are superior to both, endomorphs and ectomorphs are superior to endomorphs in endurance, speed and agility. The inferiority of endomorphs and ectomorphs was identified with excess weight and inadequate strength respectively.

Dewskin\(^{18}\) compared the somatotype component scores of women enrolled in a flexibility programme with those of a reference group. Significant differences were found for all the three components.

Clarke and Peterson\(^{19}\) compared the somatotypes of boys aged 10 to 15 years and classified into four categories of athletic ability as indicated by coaches ratings. The categories were Exceptional-III, Good-


II, Regular participant-I and Non-participant-NP. Comparisons were made at two levels, viz., elementary school and junior high school. At elementary school level, 35.7 per cent of the boys in category III were mid-types, and 28.5 per cent each were mesomorphs and ectomorphs. No endomorphs and very few endo-mesomorphs were found in this category. Somatotypes of boys in category II were also distributed in a similar manner.

Balance

Van Galder\textsuperscript{20} Compared the cardio-vascular endurance, power, agility, balance, reaction-time and movement time scores of 100 men classified into five somatotype categories, viz., endomorphs, mesomorphs, ectomorphs, endo-mesomorphs and mid types. ANOVA followed by Scheffe’s post hoc test revealed that endomorphs were inferior to the other group in cardio-vascular endurance, power, agility and movement time, and consequently it was concluded that success in tests assessing these qualities less likely for endomorphs than for other body types.

Pere and Others\textsuperscript{21} conducted a study to investigate relationship between performance and physique of Finnish athletes. They reported


that the followers to different branches of athletics do not differ appreciably as to their body constitution except extreme group. He also reported that definite ideal type for a certain athletic event could be as certain and that athlete differs slightly in body build from other Finnish men of the same group.

Section - B

Somatotype Components Related to Different Games and Sports

In evaluating physique and body composition of champions, one must distinguish between two sets of factors. On the one hand we have factors of genetic origin i.e. height, bone width, which we can not change with training, and on the other hand those factors which correspond to qualities i.e., percent body fat, weight, strength etc. that can be influenced by training as a result of adaptive processes.

Track and field

De Gray et al\(^{22}\) conducted a comprehensive study on the Mexico Olympians. All their track groups had similar somatotype distributions and were concentrated mainly in the ecto-mesomorphic category. Sixty one

percent of their thrower was endo-mesomorphs, the remainders being
dominant mesomorphs. On the other hand, the jumpers, vaulters and
decathlon athletes had no dominant endo-mesomorphs.

Carter et. al\textsuperscript{23} has presented a review on the somatotypes of 1039
male and male and female athletes. Their finding supported the
hypothesis that physique is selective in champion performance; but
somatotype patterns were found narrower in the higher level of
competition.

Cureton\textsuperscript{24} tested 55 middle aged athletic champions and compared
them with 400 middle-aged men and with normal young men. The former
champions were more mesomorphic (3-5-4), more linear in skeletal build,
less fat with wider shoulders, smaller hips and smaller gluteus and
abdominal girths. They also had stronger dynamometric strengths and
better cardiovascular tests.

The outstanding study to date on track and field competitors is
Tanner's\textsuperscript{25}, in which 137 competitors of Olympic and British Empire and

\textsuperscript{23} Ibid, p. 72.
\textsuperscript{24} T.K. Cureton, "Comparison of 55 Middle Aged Former Athletic Champions with
Some 400 Middle Aged Men and with Normal Young Men (Proceedings of the 23 Annual
meeting of the American Association of Physical Anthropologists) \textit{American Journal of
Physical Anthropology}, 12 (1954); 294.
\textsuperscript{25} J.M. Tanner, \textit{The Physique of the Olympic Athlete}. Cited by H.S. Sodhi and L.S.
Commonwealth Games were studied. This sample represented a little over a third of all those at Rome, who had achieved the Olympic standard. He found that only half the Somatotypes in the general population were present in the Olympic sample, which ranged from endo-mesomorphs through ecto-mesomorphs to meso-ectomorphs. There were marked differences in somatotype distribution between competitors in different events. The discus, javelin and hammer throw and shot putters mostly had somatotype around 3-6-2 or 3.5-6-2. The track athletes and jumpers on the other hand had somatotype mostly ranging between 2-5-3 and 2-3-5. Among the runners there was a clear difference between sprinters and others. The average somatotype of the sprinters was 2.5-5.5-3, of the 400-m runners 2.5-4.5-4 and 1500-m, 5000-m and marathon 2.5-4.4.

Westlake in a study of the somatotypes of female track and field athletes, found that the whole group had either or both mesomorphy and ectomorphy as the dominant components. Comparisons of event groups revealed that the throwers were more endomorphic, more mesomorphic and less ectomorphic than the sprinters, distance runners and jumpers.

Westlake divided 61 female track and field athletes of San Diego County into four groups on the basis their best event and somatotyped

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27 Ibid, p. 94.
them using the Heath-Carter (1967) anthropometric method. The mean
somatotypes for each group were: sprinters 3-3.5-4; jumpers 3-3-4.5;
distance runners 3-4-3.5 and throwers 5-4.5-2. Throwers differed from the
other groups in being heavier, more endomorphic, more mesomorphic and
less ectomorphic. Distance runners were shortest and they were less
linear than sprinters and jumpers. High endomorphy and mesomorphy
seemed to be assets to throwers, as with male throwers the body mass
was important.

Carter28 (1970) in his review of somatotype of athletes found the
San Diego State and high school runner higher on endomorphy, lower on
mesomorphy and slightly higher on ectomorphy than Olympic runner's
Olympic runner were 26 year old, but were smaller and lighter than the
San Diego runners. The high school runners were shortest and lightest.
Apparently, somatotype is a selective factor in distance running at the high
school level. Because fat is obviously a handicap in running, the range on
that more people of suitable height and weight can achieve success at
one of the distance runs.

p. 466.
Gymnastics

To determine whether women gymnast differ significantly from non-athletes in relation to somatotype and whether place winner differ from non-place winners. Falls and Humphery29 somatotyped 71 gymnast participating in a regional, university gymnastics competition and 54 non-athletes from a university population.

In a 1974 study of Olympic Gymnast, Carter, Street and Martin30 said that men gymnast was the most mesomorphic of the male athletes. While the lowest groups are the reference male, basketball players and long distance runners. He stated that gymnasts were significantly more mesomorphic than at of the groups except divers and Canoeists. The Canoeists were significant more mesomorphic than the remaining groups.

Between 1965 and 1970, Mass31 studied 23 top selected male gymnast. The gymnast distinguishes themselves clearly from the other groups. They were small and had a broad upper part of the body with great circumferences. The width measurements below the waist are not small for their stature. An important difference with the Judoka as a group

is the small circumference of the legs both in the absolute and relative numbers but they also differ from each other in relative's trunk length. Gymnasts have short upper legs and upper arms in cm. as well as in percentage.

The data on 79 Indian gymnasts of which 43 belonged to the man group and 36 to the boys were also reported, (Sodhi\textsuperscript{32} el. al.) It could be possible to examine 59% of the men gymnasts and 55% of boys' gymnast during the national competition. To study the relationship on physical characteristics with the competitive performance, the data of men gymnasts were divided into 4 subgroups on the basis of competitive performance. The best men gymnasts showed a tendency of relative young age. They had a typical V-shaped structure of their trunk. The Indian gymnasts when compared with their American and Japanese counterparts were smaller in lateral growth than gymnasts of other groups in these regards. They were better in strength and flexibility than the latter. The men gymnasts were found to be better in all the above-mentioned actors than the boy's gymnasts. The tests of strength and flexibility used in the study seemed to be valid for predicting the performance of gymnast.

Football

Heath\textsuperscript{33} somatotyped 66 university football players, using her modification of Sheldon's method. When compared with the means for college student rated by Sheldon's and others (1940), these football players were approximately one-half unit higher on the first component, one and three quarters units higher on the second component, and one and one quarter units lower on the third component.

Sidhu\textsuperscript{34} and Wadhvan worked on footballers that were found to be of average height, with larger trunk and smaller lower extremities than the controls. They also had more of lean tissue in the extremities than the latter.

In a study of junior high school athletes, Shelley\textsuperscript{35} found that those athletes who were outstanding in football were largely mesomorphic or mid types and that they were taller and heavier than other athletes.

Sheldon et al.\textsuperscript{36} has made many interesting observations regarding the somatotype of college football players in America. They have brought out the problem nature of the somatotypes, which are successful in the case of players playing at various field positions.

**Basketball**

Lewis\textsuperscript{37} studied the Somatotypes of "A Grade" university representatives, and national representative basketball players in New Zealand and found that the heights and weights of players at different levels of selection did not differ, nor did the somatotype rating, except for a decrease in endomorphy by half a unit at the higher levels of selection.

Carter\textsuperscript{38} reported data on the University of Iowa, San Diego team and the USSR outstanding basketball players who become taller and heavier respectively in accordance with superiority of the team. The somatotypes of the two United States University teams were somewhat similar, whereas the Russian team fell between these two and had a smaller range. In the United States samples all the endomorphs were guards and they were shortest men in the team. In general, as the height


decreased, mesomorphy increased, whereas the level of endomorphy remained moderately low and relatively constant.

Hirata\textsuperscript{39} studied 186 Tokyo Olympic basketball players who averaged 189.4 cm. in height and 84.3 kg in weight. Except the shot putters they were found to be tallest in his sample of different games, the tallest of the players being 218 cm. Hirata stated that it was an obviously favorable condition for shooters to be tall, and the lean type was particularly suitable for prompt action, so they had the most suitable.

Carter\textsuperscript{40} reported a sample of ten USSR female basketball players somatotyped by Heath. They were found to be fairy tall (173.0 cm.) and heavy (71.2 kg) for women, with a mean somatotype of 4.3-4.5-3. The close balance between endomorphy and mesomorphy and the lack of physiques dominant in ectomorphy characterized this sample.

Sodhi\textsuperscript{41} studied the top ranking Indian national basketballers found that the increasing standard of the participants average stature was greater. The top class teams in the world have a greater average height than the teams of lower standard. A significant correlation was seen

between the stature and performance in the competition. The value of correlation was very high with the field-basket scores.

**Volleyball**

In the study by Sodhi\(^2\) et al. data of 97 Indian Volleyball players were divided into four groups – National men (N = 12), State (N = 21), National University (N = 27) and District (N = 25) groups. The volleyballers in each group were compared with control group (N = 25), as well as the champions reported elsewhere. Each subject was examined with 12 anthropometric and 10 tests of performance. The results of the study revealed the three groups of volleyball players and the controls, with a persistent decreasing gradient in most of the variables, in the order as mentioned above. In somatotyping the volleyballers on the whole possessed less rating of ectomorphic component than the controls. Among volleyballers only district level players had shown significantly higher value of endomorphic component than that of the state. In the mesomorphic component the control the control sample showed rather higher rating than the volleyballers of each group. In the ectomorphic component volleyball players were observed to be more lean and thin than the controls. Contrarily among the different groups of vellyballers the

ectomorphic component showed non-significant result with the sole exception of national volleyballers who scored more on ectomorphic scale than the state. However, on average the volleyballers in each group were meso-ectomorphic in their somatotype.

Sodhi and Sidhu⁴³ found that players in the Indian national team dominated other groups in all anthropometric measurements. They were lighter in proportion to stature with proportionately shorter trunks, longer lower extremities, smaller chests and narrower hips. The rating of endomorphic and mesomorphic components was lower, but that of ectomorphic component was higher in their case. They had greater musculo-skeletal tissue in the thigh relative to the upper arm and possessed wider knees relative to the elbows than players of lower standards. However, the amount of body fat was less in them.

Sodhi⁴⁴ reported data of different levels of volleyballers and found that with increase in standard of the game the average stature of the players was greater. This means tall players have a natural advantage in performance. However, the volleyballers are not as tall as basketballers one the whole.

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⁴³ H.S. Sodhi and L.S. Sidhu, Physique and selection of sportsman, p. 60.
Hockey

Sidhu and Wadhvan\textsuperscript{45} Somatotype 101 university sportsmen specializing in four sports, namely, hockey, football, basketball and throwing. A reference group of non-participants from the same population was also somatotyped. It was found that the subjects in hockey, throwing, and the references group had the highest mean endomorphic rating (3.5) while subjects in the football, and basketball group had the least mean rating in endomorphy (3).

Sodhi\textsuperscript{46} and his associates worked on 57 college hockey players and found results similar to those obtained by Malhotra and his colleagues, except for goalkeepers who were tallest and heaviest in this sample. The substitute height also depicted the same pattern. However, the gradual decline in substitute length/setting height suggested that in relation to the lower extremities, the trunk height increased from the position of goalkeepers to that of the forwards lime players.

Swimming

Cureton⁴⁷ studied Olympic swimming by taking a variety of physical measurements. Sprint swimmers were found to be stronger in arm, leg and body strengths. The middle stance swimmers were found to have great vital capacity and more than the average amount of adipose tissue. Their relatively great floating capacity suggested light bones and less muscular tissue, a trend towards ectomorphy. There were no extreme ectomorphs or endomorphs in the competitive swimming groups. All were average in strength, the sprinters tending towards ectomorphy and the middle distance swimmers towards endomorphy.

Cureton⁴⁸ reported data on another 25 United States champion swimmers. The physique studies showed that only the swimmers with a very high mesomorphic component had broken the world records, but several slightly built ecto-mesomorphic swimmers had succeeded as Olympic or national champions at relatively long racing distances. The Olympic swimmers, on the average were found to be 15.3 lb heavier than the whole track and field group, had a softer musculature, and were somewhat more flexible.

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Weight Lifting

Tappen\(^{49}\) took somatotype photographs of the 57 entrants for the 1947 National Amateur Athletic Union (AAU) weight-lifting champions and these were somatotyped by Sheldon. Outstanding lifters in all weight classes measured and had a mean somatotype 3-6.5-1. These competitors were characterized by very high mesomorphic and low ectomorphic ratings. The ranges of these components were also narrow. On endomorphy, the range was greater, but still at 3.5 units.

Tanner\(^{50}\) studied 29 weight-lifters at the British Empire and Commonwealths Games of 1958 in Cardiff. The somato-chart distribution for these competitors was similar to that of the AAU champion lifters, being predominantly endo-mesomorphs, and with high mesomorphic ratings. The mean for the British Empire Games lifters was approximately 3-6-1.5. Tanner showed that these lifters had a physique that was in some way similar to that of the throwers, when allowance was made for much smaller body size of all, except the heavy weight-lifters. But they differed from the throwers in having much shorter legs and arms for their height. In the relation of legs to the trunk, the throwers did not differed from the middle distance runners and jumpers, but the weight-lifters had relatively


\(^{50}\) J.M. Tanner, *The Physique of the Olympic Athletes*, p. 98.
much shorter legs than even the sprinters and marathon runners. Their arms exactly matched their legs, so they could equally well be looked on as short individuals, with relatively large trunk lengths. Their shoulders and hip widths were in the same proportion to the trunk lengths as in the track athlete were not broad relative to the trunk length as in the throwers, weight-lifters, like throwers had relatively more of muscles in their arms and their arm muscles were large relatively to the underline bone but unlike thrower their calf an thigh muscles were in the same relation to the tibiae and femur and those of the track athletes in lifters both muscle and bone were proportionately wide. Lifters seen to differ from throwers in being less ectomorphic and more short-limbed.

Wrestling

Kroll\textsuperscript{51} studied somatotypes of 36 wrestlers from four universities in the mid western United States. The ratings were done by Cureton. Kroll stated that different types of wrestling, such as free-style or Greco-Roman, might dictate the kinds of people attracted to it. The mean somatotype of his subjects was 2.7-5.0-3.8, and Kroll observed these athletes with agility rather than with more ponderous and bulky characteristics, as reported for European wrestlers.

Summary of Reviewed Literature

The results of reviewed literatures presented in sections, suggested that body size and body type are of greater importance for predictions of motor fitness components although more research is needed in this area.

There seems to be more of a conflict than agreement among the finding of studies done on the relationship of somatotype components to motor fitness components. A repetition of similar studies would be needed to make general conclusions.

Comparative studies have provided to be more conclusive than relationship studies. The endomorphs and endo-mesomorphs exhibited poor cardio-vascular endurance and a higher risk for coronary heart disease then ectomorphs and mesomorphs in almost all of the research report reviewed. The mesomorphs have exhibited good performance in strength events. They were found to be the best performer in most of the motor fitness variables.