CHAPTER II

REVIEW
Many somatotype studies have been carried out on various populations across the world, using different methods of somatotyping. These studies have reported somatotype distributions in relation to somatotype changes in growth of boys and girls, adult men and women, aging, sports and athletic events at various levels of competitions, physical performance, genetics, health, body composition, behavioural traits, occupational choice, art and aesthetics. It may not be possible to refer to each and every report on somatotypes that exist in literature. However, an attempt is being made in this chapter to present a brief review of such somatotype studies, especially dealing with growth, and sports. A brief review of literature is presented for international studies followed by national studies.

**International Studies**

One of the first longitudinal reports using Heath ratings on boys and girls aged 12 to 17 years was that by Zuk (1958), known as the Berkeley Growth Study. Later, the Medford Growth Study (1956-68) was a large mixed longitudinal and cross-sectional study of boys aged 7 to 18 years
(Clarke, 1971). Heath and Carter (1971) described the somatotypes of children and adolescents ranging in age from 2 to 22 years. This study carried out on Manus children of the Territory of Papua and New Guinea, is perhaps the longest mixed longitudinal study. Parizkova and Carter (1976) found substantial individual somatotype changes in a longitudinal study of Czechoslovakian boys measured annually from age 11 to 17 years. The Heath-Carter anthropometric somatotype method was used in a study of boys and girls in two kindergartens in Prague (Parizkova et al., 1984). In another longitudinal study of 210 Belgian boys at ages 13-18 years, Claessens (1981) reported on the stability of anthropometric somatotypes. Tanner & Whitehouse (1982) used Sheldon's somatotype method to assign somatotypes to children when they reached young adulthood. A study of 7 year old Bulgarian boys and girls (Toteva, 1986), who were followed for one year, showed that although there were many changes by component, the mean somatotype did not change much. Longitudinal studies show that both individual and group somatotypes change with age.

Several cross-sectional somatotype studies conducted on different populations of the world have provided information during the growth period of children and adolescents. In a study of Belgian primary school children
Duquet et al. (1975) analyzed anthropometric somatotypes according to age, and found that mean somatotypes proceeded from balanced mesomorphy toward mesomorphy-ectomorphy in boys, and toward a more central somatotype in girls. Stepnicka (1976) reported mean somatotypes of Bohemian and Moravian boys and girls aged 8, 10, 12 and 14 years. Szmodis (1977) obtained anthropometric somatotypes of Hungarian children ranging in age from 5 to 17 years. These children also participated in some sports training. Their mean somatoplots show that from age 5 to 13 the boys tend towards higher ectomorphy, and from age 14 to 17 slightly more toward balanced ectomorphy-mesomorphy. Farmosi (1982) conducted somatotype study of boys between ages 9 and 18 years, and found that mean somatoplots show a decrease in mesomorphy up to age 15 years. At age 16 he (Farmosi, 1982) observed an upward shift in endomorphy and mesomorphy, which continue through ages 17 and 18 years. An extensive growth study in Hungary was conducted by Eiben (1985) in a small town called Kormend. The data for this study was obtained on boys and girls age 6 to 18 years, during 1968 and 1978. The results of this study reveal significant differences in somatotype distributions with age and sex, as well as a secular trend in somatotypes between 1968 and 1978.
In a somatotype study, using Heath-Carter anthropometric method, on 7 to 16 year old children of Central Finland, Halopainen et al. (1984) reported significant differences between somatotype categories by age. Haley (1974) and Fisher (1975) conducted somatotype studies of 15 years old boys and girls in San Diego. In another study 7 to 12 year olds from Illinois, Slaughter et al. (1977) discusses the relationship of somatotype to physical performance. Perez et al. (1985) obtained somatotypes of 8 to 21 year old boys and girls of different socio-economic groups from Caracas, Venezuela. He classified the subjects into pre-adolescents and adolescents, and observed that the boys decreased in mesomorphy and increased in ectomorphy between the two youngest age groups, and reversed these trends slightly in the oldest group.

Bailey et al. (1982) studied the somatotype characteristics of a large sample of 13,599 adult Canadian men and women using Heath-Carter anthropometric rating method. Somatotype distributions for age and sex specific subgroups were compared using analysis of variance to test for differences among the mean somatotype and also a test for differences in the somatotype dispersion among the groups. The findings showed that men aged 30 and over were more endomesomorphic than younger men. No significant shift in male
somatotypes beyond the age 30 was observed. In case of females there were no differences in somatotypes among those aged 15 to 59 years, or among those aged 40 and over, but the elder women were significantly less ectomorphic and more meso-endomorphic than the younger women. All ages sexual dimorphism was similar, women were more endomorphic and less mesomorphic than men, with both sexes similar in terms of ectomorphy.

Beumen et al. (1987) studied the relationship between somatotype and age at peak velocity and peak velocity in height, weight and static strength (arm-pull) are considered in a sample of 155 boys followed longitudinally between the ages of 13 and 18 years. The somatotype was estimated according to the atlas technique of Sheldon. The velocity in height, weight and static strength (arm pull) was calculated at half-yearly intervals using moving polynomials, and age at peak velocity was determined starting from the interval with the largest increment and taking into account the shape of the velocity curve before and after that interval. Comparisons were made between boys with an early, average or late age at peak velocity, and between boys with high, average or low peak in height, weight and static strength.
Sheldon and his associates (1954) have made many interesting observations regarding the somatotype of college football players in America. They have brought out the probable nature of the somatotypes which are successful in the case of players playing at various field positions. Kroll (1954) studied somatotypes of 36 wrestlers from four universities in the mid-western United States. He said that different types of wrestling such as free style or Greco-Roman might indicate the kinds of people attached to it. The mean somatotype of his subjects was 2.7 - 5.0 - 3.8, and he concluded that these somatotypes represented agility as compared to those of European wrestlers who were more ponderous and bulky.

Dupertuis and Emanuel (1956) studied the somatotype description of Turkish, Greek and Italian Military Personnel. The mean somatotypes of Turkish are (3.26 - 4.45 - 2.42); Greek (3.69 - 4.10 - 2.66); and the Italian (3.85 - 4.35 - 2.38); which shows that the Italian and Greek subgroups are significantly more endomorph than the Turkish subgroup, and the Italian subgroup is more mesomorph than the Greek subgroup. Significant differences do not exist in endomorphy between the Italian and the Greek subgroups; nor in mesomorphy between Turkish and Italian subgroups. Somatotype distribution charts show that Turkish subgroup
have the widest distributions of somatotype, particularly in the mesomorphy range of the subjects. The Italian show a strong concentration around the constellation of somatotype in which endomorphy and mesomorphy are well represented but with a rather low third component.

Parnell (1958) plotted somatocharts of competitors in various track and field events and noted differences between events even though these athletes reached only moderate standard of performance. Shelley (1960) found that those athletes who were outstanding in football were largely mesomorphic or midtypes. Many adult samples of athletes and sportsmen which have been somatotyped in different places by different investigators are such as, Morris (1960) who made a comparative study of physical measures of women athletes and unselected college women. Pugh et al., (1960) indicated that channel swimmers may carry large amount of fat primarily for adaptation to their environment in channel swimming. In addition, channel swimmers are considerably shorter and heavier than competitive swimmers. Heath et al. (1961) studied the physique of Hawaii born young men and women of Japanese ancestry and compared these with college men and women of the United States and England.
Damon et al. (1962) took somatotype photographs using standard technique of 434 American, 353 White and 81 Negro Army soldiers. The age of the White soldiers ranged from 18 to 50 years and that of the Negro ranged from 18 to 46 years. It was shown that the Negro were less endomorphic and more mesomorphic than White soldiers by one point each on a seven point scale. Skinfolds and endomorphy were closely correlated with coefficients of 0.72 and 0.75, for White and Negro soldiers. Among White and Negro soldiers, somatotype (mesomorphy) showed only a borderline correlation with grip strength but the Negro had coefficients of correlation between mesomorphy and grip strength of 0.41 for the right hand and 0.48 for the left. Multiple coefficients of correlation, for endomorphy, mesomorphy and ectomorphy were 0.78, 0.66 and 0.90 for White; 0.83, 0.84 and 0.88 for Negro.

Roberts and Bainbridge (1963) using Sheldon's Photoscopic Method somatotype 337 Nilotics age ranged from 18 to 45 years of Southern Sudan and compared with Sheldon's sample of 4000 American Whites, Krous's sample of 544 Japanese and Dauky's 219 East Africans. The somatotypes show an overwhelming predominance of ectomorphy (incidence 93.1%) divided almost equally between endomorphy (incidence 93.1%) divided almost equally between endomorphy and meso-
morphy associations, but with slight emphasis of the latter. The extremes of ectomorph are distributed evenly through the age groups of the sample, and therefore are not due to any aging factor. Nilotics are particularly low in endomorphy and mesomorphy and show an extreme degree of ectomorphy dominance. They contrast in almost every respect with the Japanese physique.

Heath (1963) somatotyped 66 university football players using her modification of Sheldon's method when compared with the means for college students rated by Sheldon and other (1940). These football players were approximately one-half unit higher on the first component, one and three quarter units higher on the second component, and one and one quarter units lower on the third component. Wiley (1963) compared 12 year old non-athletes and football players and found no difference between the somatotype means, but the football players were taller and heavier than the non-athletes.

An outstanding study on track and field competitors is by Tanner (1964), in which 137 olympic and British Empire and Commonwealth Games Competitors were somatotyped. This sample represented a little over a third of all those at Rome who had achieved the olympic standard. Eleven of 22
track and field even winners were included in this highly select group of performers. The largest samples were from Great Britain, the United States, Australia and New Zealand. The subjects were largely Caucasian, but some were Negro and some Oriental. Tanner 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-ectomorph. In general, throwers and sprinters were the most mesomorphic, with jumpers and distance runners tending to be more ectomorphic. Somatotype distributions of Cureton's and Tanner samples were somewhat similar, especially when differences in rating method are allowed for. Tanner (1964) also studied 29 weight lifters at the British Empire and Commonwealth Games in Cardiff 1958. Fifteen weight lifters were European, nine West Indian, and five Asian. The somatochart distribution for these competitors was similar to that of AAU Champion lifter, being predominantly endo-mesomorphs and with high mesomorphic ratings. The mean for the British Empire Games lifters was approximately 3 - 6 - 1.5. Both samples were rated by Sheldon's system, in which the highest mesomorphic rating is seven.

Carter (1966) in his comparative study showed that channel swimmers differed in somatotype and body size from
San Diego, State swimmers and Olympic Swimmers. Carter and Sucec (1966) studied cross country championship team, and compared it with 19 of Tanner's 5000 - 10,000 metre distance runners, and concluded that groups of outstanding distance runners have a relative limited somatotype distribution patterns because they are largely ectomesomorphs or meso-ectomorphs. Olympic runners differed from college champions, being less endomorphic, lighter and older, and having a lower total skinfold values.

Hirata (1966) presented extensive data on differences between countries in regard to the body size of their people, and suggested that countries with people whose general physique was limited to characteristics of champions in certain events should concentrate on those events. Lewis (1966) studying the somatotypes of 'A Grade' provincial representative, and national representative basketball players in New Zealand found that the height and weight 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. The mean somatotype of players was 3.5 - 4.5 - 3.5 and when comparable Heath-Carter rating is made the mean somatotype would be 3 - 5 - 2.5.
Imlay (1966) somatotyped 151 college baseball players from the San Diego country and assigned them M.4 phenotype ratings. Their mean somatotype was 4 - 5 - 2.5. The range of physique was fairly large and included most of the scales on each of the components except there were relatively few somatotypes lower than 4 in the second component. The baseball players differ from the normative population of American males, they had a higher proportion of all other physiques. Imlay compared the sub-groups of players according to their defensive and offensive positions. Many significant differences were noted, and Imlay concluded that somatotype was a selective factor in achieving success at certain position.

McLure (1967) studied the physiques of professional and amateur women golfers. Carter (1968) reviewed the literature and reported the phenotypes of the San Diego football team to be 4.5 - 5.5 - 2. Carter (1970) made somatotype ratings by the Heath criteria on 35 members of the 1964 San Diego State football team and on 20 university of Iowa football team on the 1958 team. Thirty seven percent of the players were drafted by major professional teams. It was shown that players in San Diego State team are approximately a year older than the subjects in the two samples, 2.5 cm taller and approximately 9 kg heavier. As
to somatotype, endomorphy increases from Iowa team (3.2) through the Oregon teams (3.6) and to the San Diego team (4.2). Mesomorphy is at approximately the same value (6.25) for both the San Diego State and Iowa teams and one unit lower (5.5) for both the Oregon teams. The Iowa and San Diego teams are similar on linearity and half a unit lower than the Oregon teams. The somatocharts show that compared to the other two teams the distribution of the San Diego state team is outstanding for its number of extreme endomesomorphs. The Oregon subjects are lower in mesomorphic sector than the two samples. There are small percentages of physiques in each of the samples which are ectomesomorphic.

From the predominance of endo-mesomorphs of the outstanding size, it appears that these characteristics are prerequisites for success in college football.

Berger (1973) explains that physical conditioning is specific to sport. The demand as to what type of conditioning exercise to include in a training programme can be recognised only on systems stressed during a game and the kind of activities which provide this type of stress during practice. The body adopts in time to the type of stress placed upon it. This physiological adaptation is necessary for physical conditioning to occur. However, the nature of adaptation is specific to the kinds of activities used in
training. Bell (1973) studied young adult rugby players and noticed specific physical characteristics with respect to the field positions of the players. Slauhter, Lehman and Mincer (1977) in their study of the relationship between somatotype and body composition on the one hand, and physical performance on the other, concluded that somatotype components had a lower correlation with winning and jumping variables than the body composition or body size variables.

Various other studies include relationship of somatotype to genetics (Osborne & De George, 1959; Kovar, 1977; Skihinska & Sklad, 1979; Chovanova et al., 1981, 1982), family studies (Parnell, 1958; Fischer, 1975; Bouchard et al., 1980; Medekova & Havlicek, 1982), health and disease (Damon, 1965, 1970; Hellersteinn et al., 1969; Spain et al., 1963; Seltzer & Meyer, 1969; Fredman, 1972, 1974; Bailey et al., 1982; Budays & Eiben, 1982; Tanner & Whitehouse, 1982; Anderson, 1985; Eiben et al., 1985; Gyenis, 1985; Greenlee, 1986).

National Studies

Somatotype studies in India began more than three decades ago. The earlier studies made use of Sheldon's method, while majority of the investigations have followed
Heath-Carter Anthropometric Method. These studies are reported on populations inhabiting different areas in the country, with diverse ethnic, economic and dietary samples. Studies on growing boys and adult athletes and sportsmen are more common as compared to those on girls, or in relation to genetics, health and disease, etc.

Berry and Deshmukh (1963, 1964) somatotyped 1000 healthy male college students (age 18-25 years) in Nagpur, Central India, using Heath-Carter Method, and comparison was done with American and British students of the same age. The means somatotype of Nagpur students are (2.95 - 3.30 - 4.58), Oxford students (3.41 - 3.44 - 3.74), London students (2.85 - 4.20 - 3.83) and the American students (3.20 - 3.77 - 3.53) which shows that Nagpur students are predominantly ectomorphic, least endomorphic and less mesomorphic. These students are greater in ectomorphy and much less in mesomorphy than London students or American students though not much less than Oxford students.

Sidhu and Singh (1975) studied the somatotype distribution of sportsmen specializing in different events. Singh and Sidhu (1980) investigated the changes in the somatotype components of an Indian tribal population of the Gaudi Rajput boys, age ranging from 4 to 20 years, using
Heath-Carter Anthropometric Method. It is reported that the maximum adolescent velocity is observed during 15-16 years. The nutritional inadequacies and the altitudinal factors may have their influence on the physical growth of the Gaddis apart from the genetic constitution. It was shown that the somatotype of the general population changes in component dominance, and it is the mesomorphic component at age 4 which dominates whereas, at age 20 its position is taken by the ectomorphic component. Endomorphic and mesomorphic components show lower values at successive ages up to 12 years and a small increase afterwards, however, ectomorphy increases with age 11, 12, 13 years and decreases thereafter.

Somatotype studies on Indian adult male population include those by Sidhu and Kansal (1974), Sodhi (1976), Kansal (1981), and Singh et al. (1985). Singal and Sidhu (1984) and Singal and Kaur (1993) have studied adult females. They include Banias and Jat Sikh adult girls and general Punjabi adult girls of Urban and Rural background. Banias were found to more endomorphic and less ectomorphic than the Jat Sikh girls at all ages. Somatotype studies on adolescent, national athletes, and other athletes in various sports disciplines have been reported by Kansal et al., (1980, 83); Sethi and Sidhu (1992), Sharma and Shukla
Nehru (1985) investigated the somatotype distribution of young North Indian females residing in the hostels of Panjab University Campus. The girls ranged in age from 18 to 25 years, and the Heath-Carter anthropometric method was used. Endomorphy component rating was seen to be predominant in the North Indian females indicating the accumulation of more body fat. Mesomorphy component was the least and ectomorphy rating showed the value of 3.5 which was neither more nor less indicating that they were not linear in physique. A comparison was done with Jat Sikh and Bania females and it was found that endomorphy was maximum in Bania females, ectomorphy showed highest in Jat Sikh females and mesomorphy rating was least in Panjab University girls.

Kahlon (1987) conducted a study of the somatotype distribution of 17 to 22 years old Punjabi girls of Chandigarh, using Heath-Carter Anthropometric Rating Method. The findings show that Punjabi girls, generally tend to be balance endomorphs. Except at 19 years where girls mostly fall in the meso-endomorph region of the
somatochart, all girls tend to distribute in the meso-endomorph and ecto-endomorph sections of the endomorph region. A comparison of the sample was made with female athletes and non-athletes of Mexico and Canada. Whereas Punjabi females were similar in age, they were shorter in height, lighter in weight, more endomorphic, less mesomorphic and somewhat less ectomorphic than all female athlete and non-athlete sample except urban Mexican females.

Malhotra (1987) studied 167 Jat Sikh females of Chandigarh. The girls ranged in ages from 14 to 18 years, Heath-Carter somatotype rating method was used. Endomorphy component rating (4.9) was seen to be predominant in these girls while mesomorphy component was the least being 1.9 and ectomorphy component lies in between the endomorph and mesomorph with a value of 3.1. So Jat Sikh girls of Chandigarh are generally shorter and lighter, they are more endomorphic and less mesomorphic but somewhat similar with respect to ectomorphy in comparison to female athlete from outside India.

Singh et al., (1987) conducted a study on the somatotypes of some categories of sportsmen. The study is based on 152 sportsmen taking part in various games and sports events, viz., hockey, football, basketball, cycling, and throwing events. Most of the subjects were Jat Sikhs
and have been studied during 1972. Besides, a group of 100 Jat Sikh men who had been actively taking part in sports were chosen as the control group. All subjects were in the age range of 17-25 years. Somatotypes were estimated from the anthropometric measurements with the help of Heath-Carter method. All the sports categories have shown significantly higher ratings of mesomorphy associated with lower ratings of ectomorphy as compared to the control group. Compared to the olympic level players, players of this study are much below in the development of musculo-skeletal system. The effect of training on subcutaneous and lean tissues of female volleyball players has been investigated by Grewal and Sidhu (1984). The somatotypes of 50 selected state level women participants of hockey, basket ball, volleyball and athletics are presented by Sidhu et al., (1989b).

The concept and method of anthropometric somatotype, with an example from the Oraon tea garden labourers of Jalpaiguri District, West Bengal was conducted by Roy (1990). The anthropometric somatotype method of Heath-Carter has been used. The aim of the study, is to find out whether any relationship exists between somatotype and actual work performance or productivity. Among all the pluckers categories the third component, i.e., ectomorphy,
predominates, followed by mesomorphy and endomorphy, respectively. Low pluckers of both sexes have relatively higher values of endomorphy than high pluckers. The somatochart for males do not show any striking differences, but in case of females the high pluckers tend to occupy the ectomorphic zone, while the low pluckers tend to have a diffused distribution relatively closer to centre. The result of F-test between high and low pluckers show that there is significant differences between the two categories of male pluckers in respect of mesomorphic and ectomorphic scores, but in case of females show differences in respect of ectomorphic scores only. And the preponderance of high ectomorphic scores in all pluckers, especially the high pluckers, suggested that ectomorphs are physically more active.

Dkhar (1991) studied the somatotype of football players of Meghalaya. A total of 143 football players participating at local (urban, rural), Districts and State level, and 117 control subjects were investigated, age ranged from 18 to 35 years. Heath-Carter anthropometric method was used. The result shows that football players of Meghalaya are predominantly ectomorphic-mesomorphs significant differences are observed for all the three components of physique between football and control on the basis of
mean somatotype ratings. The mean somatotype of Meghalaya State level players is 1.28 - 4.65 - 1.94, while that of control sample is 1.55 - 4.65 - 2.89. On comparison with others, it was found that Meghalaya football players are more mesomorphic, but less ectomorphic and endomorphic than other Indian football players; with American football players it was found that the American are high on endomorphy and mesomorphy but low on ectomorphy. And with an Indian players of all other sports, they are more endomorphic and ectomorphic and less mesomorphic than Meghalaya football players. And when compared with olympic players of various sports the Meghalaya football players are less endomorphic but high mesomorphic and ectomorphic than olympic players of the sports.

Bhasin and Singh (1991) studied age changes in somatotypes of Gujjars and Tibetans of Jammu and Kashmir. Cross-sectional sample of 84 Gujjars and 123 Tibetan boys ranging from 8+ to 18+ years have been conducted, Heath-Carter anthropometric method of somatotyping were using. The results show that there is not much change in the somatotype during adolescence in both Gujjars and Tibetan boys. It was found that ectomorphy remain dominant through growth phase, followed by mesomorphy and endomorphy. On
somatochart, Gujjars lie in meso-ectomorphic sector whereas, Tibetans are falling in balanced mesomorphic sector.

Sethi and Sidhu (1992) studied the somatotype changes of sports and control boys from 13 to 18 years of age. The data were collected from Sports Meets held at Patiala between February 1989 and March 1990, Heath-Carter anthropometric method of somatotyping were using. The results indicated that sports boys are increased in endomorphy and mesomorphy ratings with age and reduce in ectomorphy ratings, whereas, control boys increase in endomorphy rating and show a decreased trend in mesomorphy and ectomorphy. Increase in mesomorphy in sports boys with age seem to be due to their physical activity.

A cross-sectional study of anthropometric somatotype in two high-altitude populations of Bodhs and Baltis of Ladakh division of Jammu and Kashmir has been studied for 1009 males from 8+ to 50 years by Bhasin and Singh, (1992). In which Bodhs show higher endomorphy and mesomorphy than Baltis, whereas, Baltis are more ectomorphs than Bodhs. Relationship of somatotype and genetics has been looked into by Kaul et al., (1994) in a familial study of somatotypes of 14 and 15 years old Punjabi girls. Significant correlations were detected between mid-parent and
daughter for mesomorphy and ectomorphy while endomorphy showed non-significant correlations. Relationship between somatotype and socio-economic status has been investigated by Talwar et al., (1994) who found that the average somatotype of the upper socio-economic status girls aged 9 to 16 years lies in the balanced ectomorph sector (2.84 - 2.82 - 3.85) and that of the lower socio-economic status girls of the same age range in the mesomorph-ectomorph sector (2.18 - 3.85 - 2.70).

Handa et al., (1995) studied the somatotype changes during adolescence in Jat Sikh boys of Chandigarh. Following the Heath-Carter anthropometric somatotype method, age changes in the somatotyped are reported for cross-sectional sample of 169 Jat Sikh boys aged 13 ± to 17 ± years. Results show that there is a change in somatotype component as age progresses. While there is an overall increase of 0.5 and 0.1 units in the endomorphic and the ectomorphic components respectively, a decrease of 0.6 units is seen in the mesomorphic component. The subjects tend to distribute themselves around the ectomorph-endomorph axis of the somatochart. A comparison with Jat Sikh girls reveals that the latter tend to be more endomorphic than the former, at all ages. Dkhar & Pathak (1996) studied the Khasi and Jaintia males aged 18 to 33 years, and found
the mesomorphy component dominating in both tribal groups. Recently Kaul et al., (1996) has reviewed somatotype studies in various population groups in India.