AGE CHANGES IN SOMATOTYPES OF 11 TO 18 YEAR OLD PNAR BOYS OF MEGHALAYA

JOHNSLY WELL DKHAR

THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ANTHROPOLOGY

DEPARTMENT OF ANTHROPOLOGY
NORTH-EASTERN HILL UNIVERSITY
SHILLONG

1996

पूर्वोत्तर पर्वतीय विश्वविद्यालय
मयूरभंज परिसर, शिलांग-७९३०१४ (मेघालय)
North-Eastern Hill University
Mayurbhanj Complex, Nongthymmai, Shillong - 793014 (Meghalaya)
Phone :
Grams : NEHU

Dr. R.K. Pathak
Reader
Department of Anthropology

CERTIFICATE

Certified that the subject matter of the thesis is the record of work done by **JOHNSLY WELL DKHAR**, that the contents of the thesis entitled **"AGE CHANGES IN SOMATOTYPES OF 11 TO 18 YEAR OLD PNAR BOYS OF MEGHALAYA"**, did not form a basis of any previous degree to him or to the best of my knowledge to anybody else, and the thesis had not been submitted by him for any research degree in any other University.

In habit and character, **JOHNSLY WELL DKHAR** is a fit and proper person for the **Degree of Doctor of Philosophy.**

R.K. Pathak

(R. K. PATHAK)
Supervisor

SHILLONG

THE 5TH DECEMBER 1996

DECLARATION

The content embodied in this thesis is original and has not been submitted in part or full for any other diploma or degree of any University/Institution. The contents of this dissertation are true to the best of my knowledge and belief.

SHILLONG

THE 5TH DECEMBER 1996

(JOHNSLY WELL DKHAR)

ACKNOWLEDGEMENTS

I wish to express my deep and sincere heartfelt gratitude to Dr. R.K. Pathak, Reader and Head, Department of Anthropology, North-Eastern Hill University, Shillong, for his inspiring and invaluable guidance rendered to me in carrying out this research work. Without him this work could not have been completed.

I also wish to place my gratefulness to Prof. P.K. Misra, Prof. A.K. Ghosh, Dr. T.B. Subba, Reader, and to all other teachers of the Department, who provided me with facilties to successfully carry out this work.

My sincere thanks go to all the Principals of the Schools from where I had collected the data for my study. I would also like to express my thanks and gratitude to all the subjects of this study for their cooperation.

I extend my heartful thanks to my beloved mother, brothers and sisters for their moral and financial support throughout my academic career.

Lastly, I would wish to thank Mr. Joseph F. Khongbuh for his help in giving a final beautiful shape to the manuscript.

SHILLONG
THE 5TH DECEMBER 1996

(JOHNSLY WELL DKHAR)

CONTENTS

******

CHAPTER I

INTRODUCTION

GROWTH

Physical growth and development is the most important and fascinating subject to anthropologists. Various scientists have put forward different views and definitions from time to time to explain the concept of growth. According to Richard and Kavanagh (1945), growth is a fundamental attribute of all organisms that manifests itself by change in size of an individual or in the number of organisms in unit environment. Mitchell (1962), defines it as the summation of those coordinated biological and chemical processes that are initiated with the fertilization of the ovum and terminated with the attainment of body size and conformation of the physiological capabilities characteristic of the species and the hereditary background of the individual. Garn (1952) says,

> The term growth and development as used in physical studies refer to the processes common to all living organisms, processes intimately linked in time but partially indpendent, unquestionably genetically determined yet uniquely susceptible to environmental modifications.

Meredith (1957), conveys somewhat similar ideas when he writes,

> Physical growth includes a gamut of changes sometimes subgrouped under such captions as morphologic differentiation, dimensional growth, proportional development and structural maturation. Associated with growth is another phenomenon called development, in which in addition to increase in size differentiation and change in the form also take place.

The organism becomes more and more complex, it acquires specialized parts that it did not have to begin with and arrange these parts in a more elaborate way. There is, however, no clear cut distinction between growth and development.

All living organisms grow with distinctive patterns which are peculiar to themselves. During the growth period from birth to maturity, many developmental stages are covered by a human child during which the rate of growth does not remain constant. It is sometimes fast but slow at other times. The rate of growth of height shows a sharp decline during the first few years of life, decreases slightly or remain almost constant till before adolescence. Then follows the revolutionary period of increased velocities and sexual maturation when a boy and a girl suddenly develop into a mature man and a woman, respectively. The change is very quick and proceeds at an astonishing rate.

The process of growth is highly organized. A child is to grow along a pre-destined curve under the optimal environmental conditions. There is a complex interaction between the genetic make up of a person and his environment. While the genetic make up sets the upper limits of growths, the favourable and optimal environmental factors help to accomplish that target. Thus this nature-nurture interaction is complimentary to each other during growth. That the growth process is highly organized, has led to the construction of norms or standards for judging the growth of children. The children usually follow any line in these standards which are population, age and sex specific. Only during adolescence do the children sometimes wander across the lines of growth norms whereas at all other ages they generally follow a given centile line. This deviation during adolescence happens because there are some children who enter their adolescence spurts earlier or later than the others of their age.

It is interesting to note that during adolescent period the boys and girls can be seen in all stages of their development. For example, at 14 years, in any population their will be certain number of boys who are still to enter their adolesecent or puberal periods. They will look like preadolescent children, having no growth of sexual hair, and no abrupt increase in height. There can be another group of children midway through their adolescent cycles. They may show certain level of development of sexual maturation characteristics and may exhibit increased velocities. Still some others may have completed their full sexual growth. The children who enter adolescence later are called late maturers and those entering early are referred to as early maturers. There is no indication that the late maturers will end up smaller than their early maturing counterparts. Rather they will get more years to grow and have tendencies of linearity. Not only do the variations in ages at entry of various pubertal characteristics exist but the duration of various development stages and complete maturation processes also vary greatly. It is largely their genetic make-up which sets up the tempo of growth and development.

Human growth can be evaluated from longitudinal and cross-sectional studies. In longitudinal studies the same child is repeatedly measured over a given time span. The total growth period in human is very long. The limitation of time and energy are major handicaps in the execution of longitudinal type of studies. The merit of longitudinal studies is in the construction of velocity standards where the peak height velocity of every subject can be studied and used in the construction of the velocity standards, by taking into account the peak height velocities. When it is difficult to complete the longitudinal study then the growth period can be divided into small parts and children at various ages can be followed for some years. The study which includes some subjects studied for a long time, others followed for short periods and still others only once is called a mixed longitudinal study. In cross sectional studies every child is measured only once in a study. For studying various problems, children in various ages are simultaneously measured and the complete growth period can be covered within a very short time. Such studies are usually in constructing distance standards and in evaluating the effect of various factors affecting the growth and maturity phenomena of children.

Human race has been growing taller in height, bigger in various body dimensions and heavier in body weight and maturing faster over the last 150 years or so. These are called secular trends or secular growth shifts. There are some indications that human race is becoming slightly thinner over this period. The findings on secular trends have been reported from various countries of the world and are universal in character. Various factors responsible for it may include better quality of life, greater medical and health care, lower risks of disease and infections, heterosis due to changing values due to modernisation and greater mobility etc. The rate of secular shifts has been fast in the beginning but slow thereafter. There may be a possibility of these trends coming to a gradual halt in the near future (Singh and Malhotra, 1989).

Growth studies have lately assumed greater significance in the understanding of interrelationship between man and the environment. Lasker (1960) demonstrated convincingly the effects of change of environment in altering some of the physical dimensions of the descendants of immigrants. Greulich (1957) compared the American born and native born Japanese and found the former to be taller and heavier and skeletally more mature than the taller.

World-wide observations have established the fact that inadequate diet and malnutrition may produce stunted growth and malnutrition in the years preceding adolescence delays the appearance of the adolescent spurt (Tanner, 1962). Both animals and man, however, have great recuperative powers provided the adverse conditions are not carried too far. According to Macy and Kelly (1960) food factors are basic to growth and development processes. Nutritional factors determine how body uses the individual nutrients in the construction of new organs, maintain the physiological functions and increasing body size. Holtker (1949), Wilson and Sutherland (1950, 1953), Roberts (1953) and Whitacre and Grimes (1959) have highlighted the affects of climate and race on human growth. These authors have found that the growth is faster in warmer than in the colder regions. Fitt (1941), Reynolds and Sontag (1944) and Bransby (1945 a, b) have demonstrated that there are seasonal variations in the velocity of growth. They found that height increases maximally on the average during spring and weight during autumn. Other geographical factors such as altitude, forest and desert have also been found to affect growth.

PHYSIQUE

Interest in classifying human physique dates from at least the time of Hippocrates (460-370 B.C.), and the various systems developed since then have been well documented in summaries reported in Tucker and Lessa (1940) and Sheldon *et al*. (1940). Hippocrates classified mankind into two fundamental physical types: The *Phthisic habitus* having a long, thin body, dominated by the vertical dimension, and the *Apoplastic habitus* being the short, thick set individual, strong in horizontal dimension.

Viola (1932), the greatest constitutionalist of the first half of the century defined constitution as "the total of all the morphological and functional characters by virtue of which an individual differs from other individuals". Viola's school of thought (Italian) was fundamentally a metric one and unlike the previous one's was much concerned with niceties of technique and accuracy of procedure; Viola was the first to give a comprehensive scheme for the external measurement of the entire body. Subjects were placed along a linearity-non-linearity continuum on the basis of a rather complicated combination of 10 body measurements, but the final assessment was into longitype, branchitype, normotype or mixed type. The difference between the last two was chiefly that of dysplasia, the mixed being more dysplastic than the normotype. Viola's school collected large volumes of standardized data for people of all ages and regions, since the initial step in calculating the type was to work out the amount that each of the subjects 10 measurements deviated from the mean of his age, sex and region.

Kretschmer's system of classification of physique is much less objective than Viola's, however, relying entirely on anthroposcopic inspection. Kretschmer described and illustrated three types, the pyknic, the leptosome, and the athletic. The pyknic is broad, round and fat, sturdy and stocky; the leptosome long, thin, and linear; and the athletic heavily muscled with large thorax and shoulders and narrow hips. This system is now entirely outmoded, for it supposed people are classifiable into separate discrete types, with only a few unfortunates left out.

Sheldon's system of classification physique has some relation to Kretschmer's, being a three-way rather than a two-way classification. It starts from the outset with the idea, now universally accepted, that there are no discrete types but only continuously distributed components of physique. Sheldon's choice of three components sprang from his initial observational technique. He began by taking nude standardized photographs showing front, side, and rear views of some 4000 college students. Disregarding the attribute of largeness or general body size, he sorted for extreme of body shape, and found three. Each extreme represented the end of the distribution of a component. This was done anthroposcopically, using a rating scale of 1 to 7 with equal-sized intervals between the numerals. Thus the first extreme example is rated 7-1-1, the second extreme 1-7-1, the third 1-1-7, and the components are named endomorphy, mesomorphy, and ectomorphy, respectively.

A problem in the classification of body shape is that it is difficult to measure and quantify, although it is relatively simple to observe (Tanner, 1953). Part of the problem relates to measurement (anthropometric versus observational, anthroposcopic or photoscopic) procedures. Anthropometric quantification of body types has been described by many investigators and is exemplified by the methods of Lindegard (1953), Behnke (1961) and Conrad (1963).

Damon (1970) states that, "to physical anthropologists, psychologists, and behavioral scientists generally, constitution means physique in relation to environmental adaptation, disease or behaviour. As such, constitution is one application to man of the structure-function relationship, the central concern of physical anthropologists. In addition, physique can be correlated with other characteristics of the individual partly because it is 'obvious and easily described'.

The strong constitutional bias of physique lasted until the 1950s. Thereafter, the shift in thinking has been from fixed classification to plasticity of humans and is supported by Pollitzer (1981), Hulse (1981), Hunt (1981), who see more emphasis on process and cause than classification, i.e., a shift from static to the dynamic viewpoint. Physique refers to the shape, the size and the form of an individual. Of course, the three factors are intimately linked with each other and are manifestation of the internal structure and tissue components which in turn, are influenced by the environmental and genetic factors (Sodhi and Sidhu, 1984).

The basic method of evaluating physique applied on athletes and sportsmen opened new dimensions for the development of the science of Kinanthropometry. The results of the studies conducted on Olympians are available. The results of analysis of physique, ratios and proportionality in other athletes and sportsmen are also available. By using these results, athletes from any country can be compared in order to understand the gaps of development for future development of sport in the country. The research on the Indian athletes has been, by far the most suitable example in this regard (Sodhi and Sidhu, 1984).

SOMATOTYPING

The notion of classifying physique into some meaningful system has considerable appeal and has been the stimulus for repeated efforts in this direction. If, for example, exercise, behavioural, disease and functional characteristics of humans can be associated with certain physiques, then knowledge and understanding of those characteristics and their manipulation can be enhanced. In addition, if a large number of observational or metric characteristics of the physique can be reduced to relatively simple categories, or to a single rating as in the somatotype, analysis of the data can then be simplified. Body type classifications, however, do result in a loss of precise data about single metric characteristics. Body types are by nature "Summaries" or generalisations of many characteristics and as such cannot be expected to answer specific questions about single measurements. On the other hand, a classification is only useful if it can shed light on problems and can connect one set of facts to another (Sodhi, 1991).

Somatotyping is a valuable technique to quantify the overall morphological conformation of human body for which many characteristics can be summarised. It is also a generic term that means the quantitative description of the morphological conformation and composition of the body. It is an appealing concept since a simple rating can be given for any particular body form.

There are several methods in describing the characteristics of humanphysique. Surface dimensions, body height and weight and dimensions of body segments are measured by anthropometry. While many of these procedures are precise, they necessarily give values for only a single parameter; they do not evaluate total body form. A technique attempting the latter was described by Sheldon et al. (1940, 1954), who called it 'Somatotyping'. Somatotyping can be thought as a numerical shorthand method of describing human physique. The technique is used as a means of assessing body shape and composition independent of size. It has been applied in its original and modified forms in a variety of ways for measuring the effects of nutritional insult on physique (Lasker, 1947) to the description of many different groups and individuals including children, athletes, etc. (Parnell, 1958; Heath and Carter, 1966).

METHODS OF SOMATOTYPING

Sheldon pioneered the origin and development of somatotyping. However, he, as well as his associates and other authors modified and changed the somatotype method in different ways. Some somatotype method were based on different premises and used different procedures. The various methods of somatotyping are as detailed below (Carter and Heath, 1990).

(i) Sheldon's Method

Earlier systems of classification characterized a total physique as belonging to a broad category based on some anthropometric measurements plus visual impressions. Sheldon recognized the need for classifying the variations of human physique on continuous scales expressed in simple numerical values, and introduced the word somatotyping in 1940. Sheldon defined somatotyping as,

> A quantification of three primary components determining the morphological structure of an individual expressed as a series of three numerals, the first referring to endomorphy, the second to mesomorphy, and the third to ectomorphy.

The components are best described by reference to their extreme manifestations.

The extreme in endomorphy (7-1-1) according to Sheldon, means relative predominance of soft roundness throughout the various regions of the body. The extreme in mesomorphy (1-7-1) means the relative predominance of muscle, bone and connective tissue. The extreme in ectomorphy (1-1-7) means relative predominance of linearity and fragility.

Sheldon chose an arbitrary scale that permitted no rating more than 7 or less than 1 in any component. He stated that 'the variables are independent but their sum is limited by the boundaries given by the numbers 9 and 12.' For the purpose of validation Sheldon and his associates constructed a series of tables based on ratios of 17 transverse measurements (taken from the photographic negatives) to height, and entered these in a machine for determining somatotypes from the indices. The procedure was laborious and obviously not feasible for general use. He received widespread criticism of the subjectivity of his method, nonetheless Sheldon had laid the groundwork for future modifications in a useful research area.

(ii) Hooton's Method

Hooton (1951) modified Sheldon's somatotype method for rating a large series of United States Army men. He used the term body build, not somatotype, and made ratings based on the height-weight ratio and inspection of standard somatotype photographs. He defined the first component as a concept dealing with fat development, the second component as a concept of bone size and muscle relief, and the third component as a concept of relative elongation of the body. He rated the first and second components by apprising the areas of the thorax, abdomen, and upper and lower extremities, and averaged separately the four regional ratings to give a total body rating for fat and bone muscle development. He made third component ratings from 1 to 7 from a table of distribution of HWRs (height-weight ratios).

(iii) <u>Bullen and Hardy's Method</u>

Bullen and Hardy (1946) found no published data on female somatotypes while conducting a study of physiques of 175 college women. Therefore, they derived from Sheldon's criteria a checklist of 105 specific points based on observable criteria for predominance of a component. They believed that their checklist could be used for comparisons between all age and sex groups, and could serve as universal scale to be applied to all groups. They calculated the final somatotype from five regional ratings. Their endomorphy ratings ranged from 1 to 6, mesomorphy from 2 to 7, and ectomorphy from 1 to 7. They did not report whether they gave the same absolute rating values for women as for men. However, Bullen (1952) raised the question of relative versus absolute scales.

(iv) <u>Cureton's Method</u>

Cureton (1947) devised a somatotype method that combined inspectional ratings of the photographs, palpation of the musculature, skinfold measurements, HWRs, and assessments of strength and vital capacity. He simplified physique rating method rates '(1) external fat, (2) muscular development and condition, (3) skeletal development' on a scale of 1 to 7. In 1951, he added an objective scale, which was normally distributed, as the horizontal base of the somatotype distribution triangle. He also used various physical performance tests to explain the vertical distribution in terms of strength.

(v) Parnell's M. 4 Deviation Chart Method

A substantial contribution to make the somatotype method more objective was made by Parnell (1954, 1958). He developed a scoring method for using anthropometric measurements, which he recorded on the 'M.4 Deviation Chart to use in conjunction with somatotype photographs.' The M.4 Deviation Chart includes tables for obtaining an anthropometric somatotype. Parnell substituted the terms fat (F) muscularity (M) and Linearity (L) for Sheldon's component names. The estimate for F, or endomorphy is derived from the skinfold measurements. The estimate for M, or mesomorphy, is derived from height, bone diameters and limb girths. The estimate for L, or ectomorphy, is derived directly from the HWR. For rating muscularity (Sheldon's mesomorphy) the M.4 Chart is based upon the assumption that a rating of 4 in muscularity bears a constant proportional relationship to stature. Parnell emphasized that his ratings are phenotypic, but his provisions for age correction give the impression that he tried to preserve the constancy of the somatotype over time.

(vi) **Damon's Anthropometric Method**

For predicting somatotypes of Black and White soldiers Damon *et al*. (1962) used a multiple regression technique based on anthropometric measurements. Their list of 49 anthropometric measurements included weight, lengths, breadths, depths, circumferences, skinfolds, grip strengths, and pulmonary function. On a 7. point scale 80% of the predictions came within one-half rating unit of the photoscopic ratings made by Damon. As many as ten different measurements were used in some of the equations for predicting a given component.

(vii) **Conrad's Method**

Conrad (1963) described a modified method for somatotyping. He classified the human body considering the body growth and muscular mass. His method for studying the body types involves six anthropometric measurements. Conrad's Method for studying body type has been very popular in German Democratic Republic where it is frequently used to study the somatotype of athletes and sportsmen. The method has been used for both sexes.

According to Conrad's Method, the constitutional types are not seen as polar extreme basic types but they are rather valued as deviations in a normally distributed totality in which not extreme forms, but the means represent the normal and according to the laws of normal distribution, the most frequent.

Any normal distribution shows two poles excluding one another influenced by growth tendencies respectively. According to Conrad, these are leptomorphic and pycnomorphic types. The leptomorph physique deviates from the mean by an emphatic upwards growth and a limited depth growth. The pycnomorph physique deviates from the means by an emphatic depth growth and limited upward growth.

However, the athletic body build result mainly from a functional adaptation defined by a specific character of the physique. It is possible that both growth tendencies including each other (lepto and pycno) and the forms in between them, can adopt within the limits of the individual reaction capacity. Accordingly, both body types are athletically shaped joining characteristics in an opposite trend and may be formed non-athletically.

Conrad calls these forms 'hyperplasia' and 'hypoplasia' respectively. In which the degree of leptomorph and pycnomorph are based on the basis of matric index. Whereas the degree of hyperplasia and hypoplasia are based on the plastic index. The matric index is estimated from the body height, chest depth, chest breadth. The value of plastic index is estimated from biacromial breadth, forearm circumference and hand circumference.

(viii) Petersen's Method

Petersen's (1967) atlas contains 560 somatotype photographs of children aged 6 to 15 years, selected from a study of 12,000 school children in Holland. He gave somatotype ratings, but included no measurements. He used no objective criteria. The photographs are presented in order of ascending endomorphy beginning with the 1s and progressing to 7s.

(ix) Medford Equations

Clarke (1971) used equations for predicting somatotype components for boys aged 9 to 17 years in the Medford Growth Study, wherein Sinclair (1966, 1969) and Munroe *et al*. (1969) derived regression equations from anthropometric and performance measures for predicting somatotype components rated by Heath. A variety of equations with multiple regression correlations were quite high for the first and third components, but lower for the second component. The regression equations were specific to the age at which the measurements were taken.

(x) The Leuven Method

The Leuven Growth Study of Ostyn et al. (1980) is a mixed longitudinal study of growth and motor performance in 12-17 years old Belgian boys. The investigators developed a modified method of somatotyping, based on comparisons of the methods of Sheldon (1954), Parnell (1957), and Heath and Carter (1967).

(xi) Heath and Carter Somatotyping Method

Heath and Carter (1967) further objectified Heath's system by incorporating anthropometric measurements and redefining somatotype and the component scales as follows.

A somatotype is a description of present morphological conformation. It is expressed in a three numeral rating, consisting of three sequential numerals, always recorded in the same order. Each numeral represents evaluation of one of the three primary components of physique which describe individual variations in human morphology and composition.

First component (or endomorphy) refers to relative fatness in individual physique; it also refers to relative leanness. That is, first component ratings are evaluations of degrees of fatness which lie on a continuum from the lowest recorded values to the highest recorded values.

<u>**Second component (or mesomorphy)**</u> refers to relative musculo-skeletal development per unit of height. Second component ratings are evaluations of musculo-skeletal development which lie on a continuum from lowest to highest degrees recorded. The second component can be thought of as Lean Body Mass relative to height.

<u>**Third component (or ectomorphy)**</u> refers to relative linearity of individual physique. Third component ratings are based largely, but not entirely, on height/ $\sqrt[3]{weight}$ ratios. These ratios and third component rating are closely related, so that at the low ends of their distributions both connote relative shortness of the several body segments, and the high ends connote elongation or linearity of the several body segments. Ratings evaluate the forms and degree of longitudinal distribution of the first and second components.

The various methods described above support one or the other of the two basic premises, (1) a somatotype rating attempts to assess the constitutional, unchanging pattern of somatotype; (2) a somatotype rating estimates the phenotypic (i.e., present) somatotype. The methods are based on various combinations of photoscopic estimates, planimetry, anthropometry and functional performance. The Sheldon, Parnell and Heath-Carter methods attempted to provide systems suitable for both sexes at all ages. Hooton combined Sheldon's genetic concept with a phenotypic concept, but did not include corrections for age. Bullen and Hardy, Cureton, Damon, Clarke and Ostyn and associates all attempted to adhere as closely as possible to Sheldon's concept, except for phenotypic ratings. The Heath-Carter method, derived from modifications and simplifications of Sheldon's system, and designed to provide an objective phenotype method, has become the most widely used somatotype method.

APPLICATIONS OF SOMATOTYPING

(i) Growth and Somatotype

The primary objective of growth studies is to screen children for their growth performance, which is made possible by anthropometric techniques of body measurements. In addition to the assessment of size, shape, proportion, etc., growth and maturation studies also help in the evaluation of body mass into its skeletal and fat components. This helps in identifying children who may be obese, and those who may be malnourished. During adolescence growth is characterized by profound changes in physical as well as mental development. The lean body mass increases while the fat mass decreases during adolescent period. There may be small children at a particular age who may actually be late maturers, or large sized children at the same age who may be in fact the early maturers. Somatotype ratings describe wide variations in size, shape, proportions and body composition. Therefore, somatotyping is useful for analysing the growth changes during childhood, adolescence, and maturation. In many studies it is observed that somatotypes of children change during adolescence, and usually reverse component dominance. Although there are a number of studies on somatotypes, there are no specific studies on early and late maturing somatotypes. It has also been established by many studies that somatotypes of adults followed from adolescence into adult ages continue to change. However, if the environmental conditions are held more or less constant the adult somatotype may remain almost unchanged upto old age.

(ii) **Genetics and Somatotype**

The relationship between the genotype and the phenotype is a dynamic one, so that the phenotype must be the consequence of interactions between a certain genotype and a certain environment. Hulse (1981) stressed the importance of biological plasticity during development and noted that present diversity in human species is due partly to evolution which had led to varying gene frequencies in different breeding populations, and partly to the effect of environment on the developing organism, so that gene action will lead to different consequences under different circumstances.

One question that arises is 'In a given population in a given environment, how much physique variation can be attributed to genes, how much to environment and how much to interaction between them?' The answers to this are the well-known demonstrations of genetic control from pathology, in which simply inherited and chromosomal syndromes show characteristic physique, as in Down's syndrome. But these are rare, and most physique variation is continuous. Biologically related persons often have in common similar and measurable phenotypic characteristics. To measure the genetic contribution to such characteristics in behaviour and biological sciences, twin, sibling and parent-offspring studies are used to study these relationships.

It is apparent that the somatotype is the outcome of interaction between genotype and phenotype, but there has been relatively little investigation of the extent of genetic influence on normal somatotype variation with a population. Estimates from the several twin and family investigations that have been made vary from one study to another, but cluster about moderate hereitability levels, while experimental and comparative studies indicate the type of environmental variable that contributes to non-genetic variation.

(iii) Sports and Somatotype

The characteristics of physique apparently associated with success in sports and other forms of physical performance have always greatly interested scientists. Till about half-a-century ago most studies of physique and physical performance were based on selected anthropometric dimensions and ratios. Somatotyping introduced a promising method for investigating relationships between physical structure as a whole and performance in sports. The Heath-Carter somatotype method shifted emphasis from the static model of physique to the dynamic model, which allowed research to take advantage of anatomical and biomechanical models of physique changes and performance.

A large number of studies conducted at different levels of sports competition show that the nature and level of performance influence the degree of association with somatotypes. In theory it is epxected that the most successful athletes have physical structures best suited to their particular sport, and that differences in physique will emphasize the importance of aspects of physique such as somatotype. The general hypothesis is that (Tanner, 1964) without the required physique an athlete is unlikely to reach a high level of success. Data for athletes shed light on limitations to human performance due to morphological characteristics like absolute size, proportional size, body composition, maturation and somatotype. Somatotype quantification may throw light on performance and improve understanding of biomechanical limitations and physiology of performance. Sports scientists and coaches may find these insights helpful in making effective choice for their young athletes. It is important to extend the options to the sport that most closely fits the somatotype and to the training methods appropriate for a given somatotype in a given sport.

Now-a-days coaches, sports scientists and athletes have started recognizing that the somatotype is an important variable in performance. Somatotype studies clearly show that distributions for a specific sport differ significantly from distributions for other sports. According to Arnot and Gaines (1984) somatotyping is useful for grossly describing the structural requirements for various sports. Somatotyping is also useful in helping to guide both children and adults to sports appropriate for their present and potential somatotypes.

Male and female somatotypes differ consistently by sport and event just as males and females differ in general population (Carter 1981). Physical fitness and motor ability tests have been used as criterion measures in studying the relationships between somatotype and physical performance. The gross motor performance areas of strength, endurance, flexibility, speed and balance are the most likely to be related to somatotype.

(iv) <u>Health, Disease and Somatotype</u>

There is continued research and investigations on relationships among morphological variation, general predisposition to certain diseases and the important influence of environment on suppression or enhancement of disease. Damon (1970) pointed out that in constitutional medicine there are a number of reasons for studying physique. The phenotypic somatotype allows for noting somatotype changes which may be associated with onset or arrest of disease.

The relationship of somatotypes and cardiovascular disease has received considerable attention. There have been studies relating to somatotype to blood pressure, rheumatic heart disease, risk and occurrence of coronary heart disease. In general, these studies have shown that individuals with somatotypes high in mesomorphy or endomorphy are at high risk. Obesity is commonly regarded as an important contributing factor to diabetes, hypertension and coronary heart disease. It is well-known that the obese have excess fat and high endomorphy ratings. Tanner (1956) suggested that physique reflected a gene complex that affected penetrance of genes predisposing the organism to particular disorder.

Among the genetic disorder of man, subjects with Down's syndrome having easily recognizable physical characteristics also have remarkably similar somatotypes. Both male and female are high in endomorphy and mesomorphy but low in ectomorphy. There are some extreme and apparently characteristic component values among the growth disorders, like achondroplasia, Marfan's and Klinefelter's syndrome.

(v) Occupational Preference, Behaviour and Somatotype

Damon and McFarland (1955) investigated the relationships between occupations and somatotype, and the part played by genetic or constitutional factors in choices of employment. They noted that generalized descriptions of physique such as somatotype differentiate occupational groups more clearly than separate dimensions. They further observed that the evidence favours selection and adaptation over occupational influences; that is, an occupation itself does not cause mesomorphy or ectomorphy to be associated with success in it. People choose jobs for various reasons, among them physical and temperamental affinity are important.

In Sheldon's (1940, 1942, 1949) concept, constitutional typology embraced morphological, temperamental and psychiatric levels. Somatotype is the morphological level, temperament is the normal functional or behavioural level, and temperamental pathology is the psychiatric level. From the lists of temperamental traits he developed three temperamental components that he called viscertonia, somatotonia and cerebrotonia, which roughly correspond with the somatotype components endomorphy, mesomorphy and ectomorphy. For viscertonia the emphasis was on relaxation, love of physical comfort, pleasure in eating and sociability; for somatotonia it was a tendency towards assertiveness, energetic activity, love of risk and power, and physical courage; for cerebrotonia it was a tendency toward restraint, introversion, love of privacy and solitude, and inhibition.

Present Study

Scientists motivated by persistent wishes to quantify and compare the infinite patterns of morphology and characteristics of Homo sapiens have invented many systems for classifying physical variation. The early system classified persons in two, three or four extreme categories. The need to describe heretofore unclassified persons led to more objective and comprehensive systems. A somatotype is a quantitative overall appraisal of body shape and composition, and 'anthropological identification tag', a useful description of human physique.

Samples from populations around the world reflect extensive variations suggesting differences due to genetics, sex, nutrition, physical activity and age. There is distributional overlap between some somatotype samples and clear differences between others. The range of childhood somatotypes is more limited than that of adults. Longitudinal studies show that children's somatotype change in a generally consistent pattern that is different for each sex. Upto about age twelve there is less sexual dimorphism than in adolescents and adults. During growth some somatotypes change dramatically in an unexpected manner, while some are relatively stable and change predictably. According to Carter (1975), the somatotypes of children above ten years of age can reasonably be assessed whereas before ten years, it may be questionable, and there is need to combine the photoscopic somatotypes with anthropometric somatotypes in order to obtain the real somatotype. The errors in assessing the somatotypes in small children may be because of a large proportion of their bones being cartilagenous. Varying degrees of compressibility of the subcutaneous fatty tissue and the small size of subjects.

It may be emphasized that shape and size are but two determinants of success in a particular sport since performance is determined by the interaction of these variables with psychological status, physiological capacities, technique skill and socio-economic factors (Jackson et al., 1987). It is also probable that anthropometric limitations are more evident (Stepnicka, 1977) in habitual skills like weight lifting than in perceptual pursuits like field games where the performance requirements are more complex. A man will not be attracted to a particular sport because he has a particular physique, nor that because he succeeds he will necessarily be of a particular physique, for many factors make 'champion' (Carter, 1970).

Interest in talent search in all sports has dramatically increased in recent years in our country. Talented sportsmen in comparison with less gifted players, do have a greater chance of success, given the same amount of training and coaching. Talent spotting, till recent years in our country was purely based on personal experience and intuition except that a few efforts have been made for talent event by the Indian Hockey Federation in 1969, Laxmibai National College of Physical Education, Gwalior, in 1977-78, and at present by the Sports Authority of India (Mall, 1989). Now-a-days, especially in Eastern Europe, teams of sport scientists, working with the top class coaches, in the concerned sport, single out the basic physical characteristics of body and psychological qualities which might be the performance-limiting factors for the sport concerned. It is necessary then to find individuals with these attributes and characteristics at the grass-root level, using a series of scientifically prepared tests, having objectivity, reliability and validity.

The search for the identification of young children gifted in sports and games has gained increasing importance over the years as competition at almost all levels has intensified. This has been accompanied by a corresponding increase in the overall quality of sporting performance. It is realized that while genetic predispositions are of importance of a successful sports career, nevertheless studies carried out in many countries have proved that while there are also many parents who had never competed in any sport in their life. In vast countries like India, where climatic conditions vary food habits are different and wide gaps in socio-economic level exist, the identification and selection of correct material assumes more significance for preparation of elite sports persons (Sports Authority of India, 1990).

In an earlier study by the present author (Dkhar, 1991) on the "Somatotypes of Football Players of Meghalaya", it was suggested that one of the major applications of somatotyping is to explore age changes in the physique. How the physique of a child is transformed into that of an adult? Which component registers major changes on the trajectory to adulthood, and which component dominates over others and at what age? It was also suggested that extensive somatotype survey should be conducted among the children of different tribes of north-east India, particularly in Meghalaya. This would help in spotting and training such children who later on grown as adult would possess the type of physique which is best suited for a kind of sport at Regional, National or International level.

Keeping in view the above, the present study proposes to report age changes in somatotypes of 11 to 18 year old Pnar boys living in Jaintia Hills of Meghalaya.

The objectives of the present study are:

i) to report the somatotype of 11 to 18 years old boys,

ii) to investigate age changes in their somatotypes,

iii) to compare the present findings with other studies, and,

iv) to make suggestion in the light of the above.

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 Czechoslovaking 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 upto 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 endo-mesomorphic 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.

Beunen 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 polyxomials, 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 endomrphy, 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 mesomorphy 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 somatotyped 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 ecto-mesomorphs 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 accoding 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 per cent of the players were drafter 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 endo-mesomorphs. 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

(1981, 82, 85, 88, 89), Sidhu et al., (1984, 89), Sodhi and Sidhu (1984), Grewal and Sidhu (1984) and Sharma et al., (1987).

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 Jät 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 endormorphic 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.

CHAPTER III

LAND AND PEOPLE

LAND

Meghalaya was created as an Autonomous State within the state of Assam on April 2, 1970. It becomes a full-fledged State on January 21, 1972, with Shillong as its capital. Situated in the North-Eastern Region of India, it lies between 25°47' and 26°10' North Latitude and 89°45' and 92°47 East Longitude. It is bounded on the north by Goalpara, Kamrup, Nowgong and Karbi-Anglong districts of Assam and on the east by the districts of Cachar and North Cachar Hills of Assam. On the south and the west lies Bangladesh.

The State is interspersed with many high and low hills, valleys, rivers, plateaus and waterfalls. Since cloudiness is generally common over the hills, we see different types of clouds over the hills of Meghalaya from season to season. Fog, mist, and nimbus clouds loom large during the rainy season, and during other seasons patches of cumulus and stratus clouds are seen floating overhead the high hills. Hence the State has rightly been called 'Meghalaya' meaning 'the abode of clouds'.

The State covers a total geographical area of 22,429 square kilometres with a population 17,60,626 (1991 Census) and a forest area of 8,784.85 square kilometres. It is now divided into seven districts, viz., Jaintia Hills District, East Khasi Hills District, West Khasi Hills District, Ri Bhoi District, East Garo Hills District, West Garo Hills District, and South Garo Hills District.

The State can be broadly divided into three physico-geographical divisions:

(a) Central Plateau

It lies at 900 to 2000 metres elevation. It serves as a catchment area or watershed for rivers and streams flowing through the State. The average annual rainfall of this division ranges from 250 to 400 cm and the climate is temperate.

(b) Southern Border Area

This area stretches down wards from where the central plateau ends towards the plains of Bangladesh on the South. The average rainfall in this area is very high.

(c) Sub-Montane Region

This region begins from where the temperate region of the central plateau ends and gradually descends towards the plains area in the West and North. But unlike the Southern slope which is generally steep and abrupt it is gradual and gentle. It has less rainfall and has a sub-tropical climate.

The climate is neither too hot nor too cold and during the winter season no snowfall occurs. During the months of February, March, October and November the weather is very pleasant. The maximum temperature recorded at Shillong (East Khasi Hills) and Tura (West Garo Hills) are 28° and 34° Celsius, respectively. The rains begin by the second weak of May and continue till the end of September. It is observed that Mawsynram is now receiving highest rainfall in the world with an average (month of July) of 9,591 mm (Mawsynram) and 5,421 mm (Cherrapunjee).

The soil of Meghalaya may be broadly grouped into hill soils and plains alluvium. In some places, we find red loamy soils and fine silt constituting the major fractions. They are also characterized by a very high organic matter and nitrogen content. At other places, we find clayey to fairly heavy clays. The soil of the paddy lands are heavy loams and contain a fairly large amount of organic matter.

Meghalaya is rich in mineral resources but due to lack of proper survey and difficult means of communication they have not been properly tapped and assessed. Recent survey by the State and the Central Geological Department have led to the discovery of gold and uranium in the State. Phosphate prospecting is in progress in Jaintia Hills. The principal minerals found in the State are coal, limestone, mica, sillimanite, dolomite, refractory clay, fireclay, corrundum, koalin, glass sand, feldspar, garnet, gypsum, China clay and lithomargic clay.

The flora is rich both in extent and number. There are about 2,000 flowering plants, 150 species of ferns and a profusion of mosses, fungi and liches. More than 250 species of orchids of palm and 150 species of grass are also available. Wild apples, scarlet rhododendrous abound in the higher parts of central plateau. There are also different types of fruits like orange, pineapple, banana etc. There are dense forests in which different types of trees like, sal, teak, tita-champa, hoollock, bola, gogra, birch, toon, chaplash, pine, chilawni, walnut and mahogany are found. In the altitude of about 1,500 metres, pine trees are found in the Khasi and Jaintia Hills and in the Garo Hills rich sal forests abound. There are also dense forests of cane and bamboo.

The dense jungles are the habitat of various wild-life such as, elephant, tiger, bison, boolock, bear, barking deer, sambhar, leopard, and slow lorris. Monkeys, reptiles mammals, and birds are also common. In the higher altitudes, small birds like fly-catcher, thrush treepie, magpie, miniret, grey-tit and backed-tit, hoopoe and woodpecker are found. In the lower altitude and in the deeper forests, hornbill (Danish) including the great hornbill, impeyon pheasant (monal), partridge, wood-cook, florican, barn owl, maina, black drongo, whistling thrush and the Himalayan Great Barbet (Newool) are commonly found. Meghalaya is also called the land of butterflies. Diverse climatic conditions, rich and luxuriant vegetation, evergreen hills and everglades make the hills of Meghalaya the perfect breeding grounds for rare species of butter-flies. Some 500 species of butterflies are said to have found in the State.

Crops and cropping pattern vary widely from region to region in this State. In the valleys, the farmers practise permanent cultivation. On the high slopes, they practise shifting or jhuming cultivation. It is estimated that roughly about 40% of the rural population in this State depend on shifting cultivation. The total area under various food crops in the State is estimated at about 126 lakh hectares and the production of total foodgrains during 1980-81 has been estimated at 1.50 lakh tonnes. The major food crops are paddy, maize, wheat, millet and pulses. The cash crops are potatoes, jute, mesta, cotton, ginger, turmeric, sugarcane, oilseed, tapioca, black pepper, arecanut and betelvines. Cattle, poultry, pigs, goats, buffaloes and sheep are important livestock of Meghalaya. There are at least 4 lakh cattle heads which form the most significant livestock of the state. The state offers immense scope for the development of fishery.

The Jaintia Hills District

The Jaintia Hills District is the easternmost district of the State. The altitude of this district varies from 1220 metres to 1830 metres above sea level. It is bounded by Umkhen river and Mikir Hills on the North, North Cachar Hills on the East, Bangladesh and Cachar District on the South, and Khasi Hills and Umngot river on the West. Jaintia Hills covers an area of 3819 square kilometres, with a population of 2,19,186 (Census 1991). The drainage pattern shows that the control portion of this district is marked by hills with east-west alignment (DIPR 1991). It has 412 inhabited villages of which half have less than 200 population. The headquarters of the district - Jowai - is situated on the central plateau at an altitude of 4560 feet above mean sea level.

The Jaintia Hills district is predominantly inhabited by the _Bhoi_ on the North, the _War_ on the West, the _Biate_ or _Hadem_ on the far east, and the _Pnar_ or _Synteng_ in the central portion of the district. The people belonging to all the four tribes are collectively known as the Jaintia. The climate is largely influenced by seasonal winds; the four seasons being Spring (March and April), Summer or rainy season (May to September), Autumn (October and November), and Winter (December to February). The maximum temperature recorded is 28°C.

Jowai town is developing rapidly over the past years. The town has a density of 1144 persons per square kilometres (Census 1971); whereas the population density of the district is 57 (Census, 1991). The sex ratio, i.e., number of females per thousand males, is 976 (Census, 1991). Since the Jowai town is the headquarters of the Jaintia Hills district, many government offices are located there. In addition, there are a number of Primary and High Schools, as well as one Government College. Many people from rural areas of the Jaintia Hills come to the town to secure education, job, business etc., and all this is further leading to urbanization and consequent growth in the density of population.

The Jaintia Hills District is in pre-industrial stage. About 80% of the population depend mainly on agriculture. But compared to some other tribes in North-East India, the agricultural economy of the Jaintia Hills is quite advance. The Jaintia were terrace cultivators even before the coming of the British. They had also used small irrigation canals for bringing water to their fields for wet rice cultivation (Rep Hali). Unlike other tribes in North-East India, the Jaintia had been using the plough (Ka Lyngkor) drawn by the bullocks long before the British came to their hills. The staple crops raised by the Jaintia are wet rice, dry rice, and various kinds of millets, maize, potatoes etc. and different kinds of fruits, betelnut, betel leaves, bay leaves and host of vegetables. Orange plantation extends from the foot of the hills to a height of about 1,500 feet. Betel nut is a profitable crop and ranks in importance with oranges and betel leaves. It is grown mainly in the War area along with oranges.

Almost invariably, every Jaintia family has beautiful homestead cultivation (Rep Kper). Their gardens are surrounded by earth walls or stone walls, or fencing made of bamboos or timber. It is in these gardens that they grow sweet potato, yam, maize, fruit-trees, seasmum, job's tears, sugarcane, etc. Occasionally, jute and coffee are also grown. The only part where a sort of shifting cultivation (Rep Khloo) may be found was in the neighbourhood of Narpuh and Saipung Reserved Forests. Under this cultivation, oranges, betel-leaf, bay-leaf, black pepper, other fruit trees, sugar cane, etc. are usually grown.

The other type of cultivation is high land or dry cultivation (Rep Loom) where high grassland is cleared by turning over slods of earth by hoes. Later on, these slods, when dry, are burnt and the ashes are raked over the field either by hoes or by ploughs and harrow (Ka Yumoi). In this cultivation, besides rice, they also grow millet, soyabean, rye, cocumber, pumpkin, gourd, U Sohphlang (Flemingiovestita benth), etc. In northern part of the Jaintia Hills cotton and lac are also grown under this cultivation.

The District is endowed with rich mineral resources. But the exploitation and economic utilisation of these minerals have been very slow. In many cases, the people have just started using the minerals available, especially coal, for commercial enterprises. As a rule the carboniferous strata are not extensive and they are for the most part found in localities more or less inaccessible. Coal has been discovered in Amwi, Lakadong, Narpuh, Sutnga, Rymbai, Bapung and Shyrmang. Among these, Lakadong has the most extensive coal beds. The area of the coalfields in the Jaintia Hills is to extend over 0.394 of a square mile, and the estimated yield of this mineral is about 1,100,000 tonnes. There are thus vast reserves of coal which are found both in cretaceous and nummulitic formations.

Besides coal, limestone of excellent quality is also found in abundance. The need and demands of the people from the plains areas in the neighbourhood are therefore provided through the supply of limestone from the Hills. The limestone quarries are found in Chunchhora, Lama-pushi, Lithang, Myrlipunji, Nongtalang, Rupnath, and Rowai and also deposits are found to be extensive at Lakadong, Syndai, Sutnga, Nongkhlieh and near Hari Prang and Lubha. Many of them are engaged in the trade of this mineral. The trade of limestone inside and outside has brought many employment opportunities and wealth to the Jaintia people.

Besides mining of coal, quarrying of limestone, and cultivation of oranges and other fruits, the Jaintias also grow cotton to a limited extent. Having their own local production of cotton, they got themselves engaged in the spinning and dyeing of cotton thread and weaving of cloth especially of eri silk in the past and are continuing even today though to a very limited extent. Some villagers still have the tradition of producing specimens of Khor ryndia (errandi/endi) and other minor loom crafts. Weaving may be considered as an important cottage industry among the Jaintias. They also weave sleeveless coats (Ka Yingki), coarse cotton clothe (Ka That Subrap), Yellow small square clothe (Ka Ryndia Stem), black and white big square clothe (Ka Thoh Saru), and clothe like a shawl made of endi (Ka Ryndia Tlem). To some extent the people have been able to maintain their own indigenous artistic forays but many of these had died away. These traditional arts and crafts faced severe strain and stiff competition with the coming of modernised dress and textile materials. For example, weaving received serious set back since the British entered the country. As days passed on, more and more textile goods were used. The traditional dress being abandoned especially in the case of menfolks, the people started adopting more and more to textile materials. As such the original costumes are used only during community and religious dances and festivals which have existed as heir-looms.

The other industry in which the Jaintia people were and are still engaging themselves the 'smelting of iron ore' for manufacturing of plough shares hoes, bill hooks, etc. Now-a-days, people have also taken to horticulture, pisciculture, poultry keeping etc. Among the Jaintia, the Pnar are good stock breeders and cattle dealers.

THE PEOPLE

The Pnar (or Synteng), like the Khasi, have no recorded history of their own until the advent of the British. Even the recorded history written by the British officials who had worked among the Khasi and Jaintia, in most of the cases, treated the two together as one people or tribe without keeping any separate accounts and references to the Jaintia in particular. Of course, there are many aspects common to both the Khasi and Jaintia, yet we find some traits which are particularly observed either by the Khasi or by the Jaintia. The Jaintia do not have their own script and the same applies to Khasi also. In the absence of any script, it is difficult to construct the origin and past history of the people under study, which is therefore remains shrouded in mystery. All that the people did in the past before they could put anything in black and white was to narrate their past history in an oral form from one person to another through many generations. Similarly, history of their migration is shrouded in mystery as the people cannot tell us exactly where they first came from and the route(s) of their migration before they finally settled in their present habitat - Jaintia Hills - as we know today. Many a time, the people narrate the history of their origin in the form of stories and legends. Till the middle of the last century, the Syiems

(Chiefs) used the scripts of their neighbours like Devanagri, Assamese and Bengali and even Persian. Border conditions and the relation of the rulers with their subjects in the plains necessitated the use of such scripts for official purposes as well as the medium of expression. In another account it is mentioned that 'the Jaintia had to use different script for different purposes. For example, in their dealing with Assam or Bengal, they used the Assamese and the Bengal scripts, respectively. Similarly, in the sixteen specimens of Jaintia coins we find traces of an old Devanagri script. The Devanagri script can also be found in the rock inscriptions between Sunapur and Kuliang. Moreover, the fifteen silver-plated coins recently unearthed in Jowai bearing Arabic and Persian inscriptions.

One of the local scholars (Pakem, 1979) an authority on the Jaintia, is of the opinion that 'when the Jaintia entered the present hills they came in batches and were variously known by different names of these different batches such as the Amwis, Changpungs, Jowais, Nartiangs, Sutngas and many others'. It is therefore inferred that all the Jaintias did not migrate to this present area at a time, but batch-wise and later all the batches joined together to form a single group under the administration of a traditional chief. This does not mean, of course, that the various batches belonged to different races or groups of people: they are no doubt of the same stock and origin.

As regards the route to migration, 'the Jaintia were supposed to have come from South East Asia, with the probability that they could have started their migration from Mongolia via West Asia and along the foothills of the Himalayas to South East Asia, thence to their present habitat through Burma. They appear to have been one of the earliest waves of migrants to North-East India, among the present day highlanders of the region. Hence, unlike the later waves of migrants to North-East India, they were more or less leading a more settled way of life. (Pakem, 1979).

Yet another account (Bareh, 1979) shows that many Khasi settled first in the Jaintia Hills and the northern part of the state before they spread over to the interior. This account refers to the traditions which say that the Khasi arrived here from the eastern part of the globe. It further tries to locate the original place somewhere in Western China from where various tribes spread over to the Indo-China, Cambodia, Burma, and other regions in the East. The Synteng, the War, and the Bhoi are all Khasi. They are the descendants of the original folk who came somewhere from the East and found a home in beautiful hills between the Kupli and Rangdi rivers in the mountain ranges between the Assam valley and Sylhet. Their language indicates that the Khasi belong to the family of the earliest powerful Mongolian invaders of India.

Many scholars opined that the Jaintia came from the East. There can be no two opinions about this. But it is worthwhile to exercise our minds and place here the opinions of others who tried to throw new lights on this issue. These sources say that the Jaintia people could have come from directions other than the East.

The Burmese account indicates that the Jaintia could have come from the West. Other writers also believe that it was the early Mediterraneans, a branch of the Proto-Australoids from Palestine, who gave the world the Austro-Asiatic speech. There are also accounts that the Mediterranean Dravidian passed through Assam to Indonesia. And finally, the relation between the Austro-Asiatic and the Sumarians had also been established by another writer. In addition, there has been a local tradition about their coming from the region around West Asia. The gist of this tradition is that from Palestine, a branch of the tribe of Manassah under a female line had crossed over into Egypt and Ethiopia. From Africa they crossed the Red Sea into ancient Sumer and Akkad and ultimately to India. In the process, the Jaintia Sun-goddess (Ka Blei Sngi) of Changpung might have been just the female counterpart of the Sun god (Ra) of Egypt.

There are a host of other sources (Bareh, 1967 of information relating to the earlier migration route of the Jaintias. Many writers agree that they have similarities with the Mons of Burma and cultural similarities with that of the Malagasians at least in the matter of metallurgy.

On the basis of the different historical sources mentioned above, it may be stated that the Jaintia are a group of people known as such since twelfth century A.D. Before that they were known by various terms and as the Amwis, Changpungs, Jowais, Nartiangs, Sutngas, etc. It was by the twelfth century A.D., that they were brought under one Central Administration and known as the Jaintia. Most of the accounts of Jaintia migration were based on racial, linguistic, cultural, social and political factors. The earlier theories of their migration had simply mixed up the racial linguistic and cultural questions. It is to be noted that racially the Jaintias came from the East as Austro-Asiatics, and culturally from the West as Proto-Australoids or Turanians.

As regards the source materials relating to the history of Jaintia people, much have been written especially after the British annexation of the land. But most of these sources are secondary in nature. Local sources in the form of oral history could also be found. Such indigenous sources which appear in the form of what is locally called Ki Parom (literally, stories) play an important role in constructing the ancient history of the people. It is through Ki Parom that the nobility of their (the Jaintias) race and their celestial origin are indicated; also in those Paroms the story of the origin of the Sutnga Kings, the growth and development of that Kingdom until we come to the recorded period of the Jaintia Kings. But actually ki Parom contained nothing but marvellous tales mixed up with very little truth. In the process of handing them down from one generation to another, the accounts may have got either contracted or exaggerated. The Paroms are therefore simply mythical stories.

Recently a good number of writings and research papers on the Jaintias have discussed at length about the origin of the name 'Jaintia'. An explanation on the subject could be found in the writings of both external or non-local and the internal or local scholars. As far as the external sources are concerned, there was almost a concensus that the Jaintia Kingdom got its name from the

Southern plains tract, which was orginally known as Jaintiapur for its reputation for the shrine of Jayanti Devi, an Incarnation of goddess Durga or Gauri, as mentioned in the Puranic and Tantric texts. An alternative explanation as to how the name Jaintia originated is given by Chatterji (1974). He believes that the name Jaintia might have been derived from Synteng, the racial name of the people from whom came the Kings of the Jaintia Kingdom. He says:

> The form Synteng (= Santen) gives the modern pronunciation but it is quite in the nature of things that an early pronunciation of the word some 500 years ago was 'Zainten'.... In same dialect, we find frequently initial Z - in place of the 'S' - in other dialects. It was thus easy for Synteng = Zainten or Zanten, to be Sankritised in the mouth of the Aryan speakers as Jayanta Jayanti ('J' has the value of 'dz' or 'z' in East Bengal and Assamese); and the capital of the Jaintia or Hindu Khasi kingdom came to be known as "Jayanta-Pura or Jayanti-Pura".

Edward Gait (1967), while giving his opinion on the origin of the word 'Jaintia' mentions that the plains country South of the hill known as Jaintia Parganas, the inhabitants of which are Bengali Hindus and Muhammadans, first bore the name of Jaintia and which is mentioned in Puranic and Trantric literature as containing one of the fifty-one famous shrines sacred to Durga. But the local scholars and the authorities on the Jaintia would not accept the above viewpoints without questioning their authenticity after considering the views given by the local people themselves. Thus, Pakem (1979) drew our attention to the fact that:

> The viewpoint that the Jaintias derived their present name from the goddess Jayantesvari Devi, or from the Puranic and Tantric literature or from their subject people in the plains, is still debatable. This is so because the Jaintia believe that the term is entirely local in origin. In support of their contention, they say that the Sanskritised term Jaintia (Zantein) is derived from the word Synteng.

However, Bareh (1967) is of the opinion that:

> Synteng holds a similar significance as the word Khasi which is a combination of '<u>Khas</u>' and '<u>Si</u>' meaning born of the mother. According to the traditions, <u>Teng</u>, was the ancient mother and therefore '<u>Synteng</u>' means the children of the ancestral mother .... Jaintia seems to have been an Aryanization of the original Khasi word <u>Synteng</u> (<u>Zaintein</u>) which develop into <u>Jaintia</u>. The association of Khasi-Synteng with the mother seems, therefore, very significant.

Rymbai (1979) another local scholar opines that:

> The Jaintia always call themselves <u>Pnar</u>. There were never any people known as Jaintias among the original inhabitants of these hills.... The Pnar invaded the Jaintia Parganas and subdued them. It was after the occupation of the Jaintia

> Parganas that the Syiem of Sutnga went to settle in Jaintiapur. His conflict or contact with the Kacharis, the Ahoms and the British was after his settlement in Jaintiapur, and so to them he was known as the Jaintia Raja and this name 'Jaintia' was wrongly applied to the people and their land. The Jaintia Raja was never known as such among the people living in the hills now known as the Jaintia Hills, but he was so known simply because the British said so.

Jaintia Hills had an old name of 'Ka Ri Khadar Doloi' is now rarely used in writing though in day-to-day talk the people refer to their land as 'Ka Ri Khadar Doloi' and to themselves as Ki Pnar. In their talks they seldom refer to themselves as the Jaintia and to their land as 'Ka Ri Jaintia' (Jaintia Kingdom). Nor do they refer to themselves as Ki Synteng which they consider as derogatory. This word which was commonly used before is now dying out both in writing and in day-to-day conversation.

The 'Pnar' or 'Synteng' tribe is the dominant community in Jaintia Hills. In anthropological studies, one does not find the name 'Pnar', because the earlier scholars included them under the Khasis. It is a recent phenomenon that the Pnars are claiming to belong to a separate identity and not as an offshoot of the Khasis. Haddon (1925) describes their physical features as having cephalic index 78.6, nasal index 86.3, and stature 1.569 metres. He further states, "it may be tentatively suggested that, there is an ancient dolicocephalic platyrrine type (pre-Dravidian) which is strong among them ...." Das (1978) in his anthropometric study has treated the Pnar as a section of the Khasi. According to him, both the groups speak the same language, though different dialects, which come under the Monkhmer language of the Austro-Asiatic language group. They have a short stature and they have dolichocephalic and mesocephalic head.

The Pnar are short in height and the males are extremely muscular. The trunk is long in proportion to the rest of the body, and broad at the waist; calves are very highly developed. They are of light brownish complexion. The hazel eyes are not uncommon, especially amongst females. Eyelids are somewhat obliquely set, but not so acutely as among the Chinese and some other Mongols; jaws frequently are prognathaus; mouth large, with sometimes rather thick lips; hair black, straight, and worn long, the hair of people who adopt the old style being caught up in a knot at the back. Some males cut the hair short with the exception of single lock at the back, which is called u niuhtrong or u niuh 'iawbei (i.e., the grandmother lock). The forepart of the head is often shaven. It is quite an exception to see a beard, although the moustache is not infrequently worn. This tribal community is of a cheerful nature, peace-loving, hospitable, humorous and sociable.

There are some wrong notions about the Pnar that they are unbelievers in the sense that they do not believe in God and some even thought of them as worshippers of snakes, idols, stones, hills and rivers. These impressions are contrary to what they are. According to Rymbai (1979):

> The Khasi-Pnar believed that God is omnipotent, omnipresent and omniscient. Accordingly they hold it a sacrilege to symbolise God or to picture him in any shape or form.... Neither do the Khasi-Pnar practise ancestors worship, another misconception of the western missionaries about the reverence of the Khasi-Pnar for their ancestors who, they believe, keep watch on them.

The Jaintias believe in one Supreme God ('Tre-kirot'), the Creator of the Universe. The religion of the Pnar strikingly resembles Hinduism. Taro (goddess) was worshipped by the Pnar to whom pigs were sacrificed. In olden days, human sacrifices were also performed for Yale goddess at Kupli river by the Sutnga King. At present, almost half of the Pnar population have given up old beliefs and the practice of sacrifices and converted themselves to Christianity.

The Pnar, by and large, have discarded their traditional customs and have adopted western dress. The traditional dress of male was '<u>dhoti</u>' and '<u>turbani</u>', and also sleeveless coat. But the women have stuck to their traditional dress called '<u>dhara</u>' or a '<u>jainsem</u>' made of pure silk and is worn on special ceremonies/festivals. The dress of Jaintia women can be distinguished from that of the Khasi women. The former are fond of decorating themselves with beautiful ornaments made of pure gold.

The <u>Pnar</u> trace descent through the mother. Property is transmitted through women. Women amongst the Pnar enjoy a position of unusual dignity and importance. Women have, for generations, been custodians of property. But the authority and control are in the hands of the maternal uncles. The woman is the mistress of the household and the custodian of wealth but not a proprietress. The woman has certain rights over the house and property sanctioned by customs and religious tradition. She does not enjoy any control or rights to sell property without the consent and counsel of her maternal uncle. She is the custodian, the perserver of her clan, her family and her lineage. In her capacity as a mother of the house, she is entrusted with the important duties of performing rites and ceremonies and prepare the necessary items and instruments of sacrifice. She occupies the position of a family priestess though in actual practice, males who are her brothers perform the task of sacrifice and other religious celebration of the house.

In Pnar society the husband is like a stranger in his wife's house and can hardly interfere in the family matters. He has to provide the family finance but it is not his business to bother about the domestic affairs. The woman is in overall control of the household affairs of the family. It is the husband's brother-in-law and the uncles of the wife who play the vital role in his wife's family matter. Men seldom care to know about the daily needs of their family although they work hard to earn as much as possible in order to provide for the needs of the family and for the savings.

The property is transmitted usually through the youngest daughter (Ka Khadduh). Sometimes, the youngest son (in absence of a daughter) may also inherit ancestral properties. He can also have self-acquired property in addition. Marriage within the clan is strictly prohibited. After marriage, the son-in-law does not go to live in the wife's house. He comes at sunset to his mother-in-law's house to spend the night with his wife. Early next morning he leaves the house to do his work in his mother's house.

Women of the society occupy a high status but with certain restrictions especially in political affairs. Traditionally, a woman is not allowed to participate in political decision-making process. They are not allowed to attend durbar or council. They are not given the right to speak or attend any public meeting concerning political affairs of either the village, Elaka or Hima (state). It is a taboo to see women in political platforms. They do not have the right to vote in the election to the office of the traditional chiefs.

The staple food of the Pnar is rice, with dry fish, pork, beef, and fried potatoes. Fresh fish and chicken are also consumed by the people. Sweet potatoes is a very common food, especially for those living in the interior areas. Pumpkin and cucumber are also common in the Pnar dietry. Green vegetables like mustard leaves, cabbage, etc. are consumed frequently. Various types of tubers, green leafy vegetable flowers and mushrooms which grow wild in the forest are also consumed. The availability as well as intake of these wild food products are usually high during the monsoon (rainy) period. Besides, they consume locally grown seasonal fruits like orange, pineapple and lemon and varieties of wild fruits, nuts and berries. Different birds and wild animals are also consumed by them whenever available. But most of the people depend for their foodstuff on the nearby market.

Betel nut chewing with betel leaf and a little slaked lime (called '<u>Kwai</u>') is very common among both males and females. Many males have the habit of smoking. Even young children have the habit of smoking and with no restriction from the parents. Though the females are by and large non-smokers many of them chew tobacco along with '<u>Kwai</u>'. Generally the people are not addicted to opium or other intoxicating drugs. They are, however, hard drinkers and consume large quantities of spirits locally distilled from rice or millet. Rice beer is used not only as a beverage, but also for ceremonial purposes. In some families, especially belonging to the Hindu customs (i.e., non-Christian), their is a tradition of consumption of liquor in which females also participate (during festival). The entire population is very fond of taking tea (without milk).

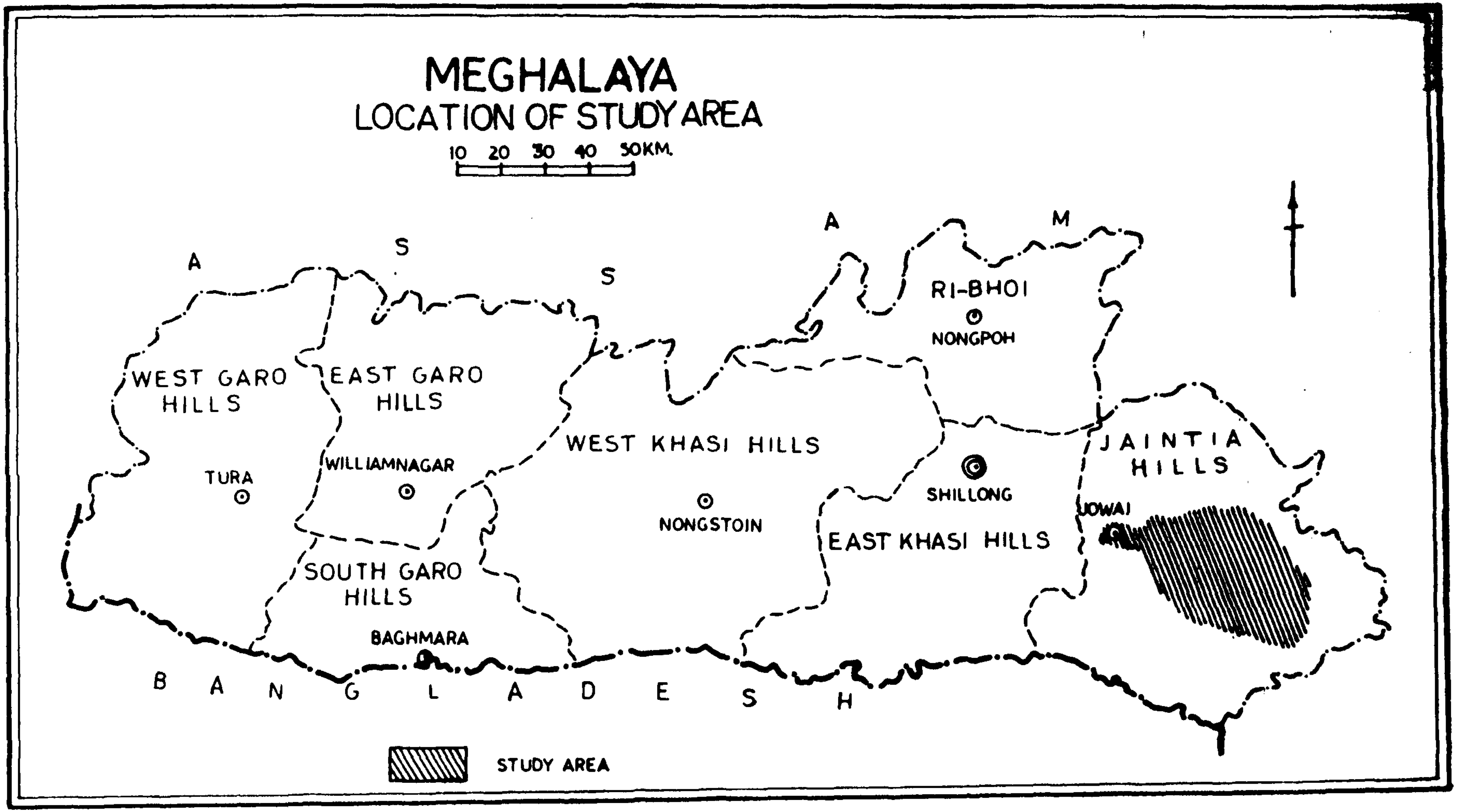
The state of health of a community is generally dependent on the type of environment in which it lives. The environment in which man exists and to which he adapts himself, and which he also moulds, includes not only the physical aspects but also the socio-cultural aspects. This adaptation to environment takes different forms and involves different reactions (Julian, 1970) for adjustments through a number of physical as well as socio-cultural mechanisms.

Among the Pnar, the native concept of health, disease, treatment, and life and death is as varied as their culture. They believe that there are some diseases caused by hostile spirits (ghosts) and what is spiritually caused has to be cured spiritually. Thus they visit their traditional medicinemen (Kombirait) who have their own systems of diagnosis, treatment and cure. In the Jaintia Hills District, especially the rural areas, modern medical facilities are still lacking to a great extent. Broadly speaking, they are quite healthy people. The common bodily oilments among them are gastro-intestinal troubles, malaria, and to some extent tuberculosis. Children usually suffer from common cold, cough and diarrhoea.

They are acknowledged to be very hard working people. Majority of them are engaged in agricultural and related activities. Now-a-days more and more men as well as women are moving into State Government services, teaching etc. Even the Pnar children perform lot of physical activity, such as, working on the fields, tending the cattle, collection of firewood from forest, carrying water etc.

CHAPTER IV

MATERIAL AND METHODS



MEGHALAYA
LOCATION OF STUDY AREA
10 20 30 40 50KM.
A S S A M
WEST GARO HILLS
EAST GARO HILLS
TURA
WILLIAMNAGAR
SOUTH GARO HILLS
BAGHMARA
WEST KHASI HILLS
NONGSTOIN
RI-BHOI
NONGPOH
SHILLONG
EAST KHASI HILLS
JAINTIA HILLS
JOWAI
B A N G L A D E S H
STUDY AREA

The Subjects

The Jaintia Hills District of Meghalaya is inhabited by at least four indigenous groups of people, i.e., the Pnar, the Bhoi, the War and the Hadem or Biate. Though the demographic details of the four individual groups are not recorded in the census, the Pnar happen to be the dominant group of people in the District. All four groups collectively are known as the Jaintia. For the present study, the Bhoi, the War and the Hadem have not been considered. This study takes into account only the Pnar. The subjects of the present study are 11 to 18 years old boys whose both parent are Pnar. All subjects considered here are school-going boys, and apparently normal and healthy.

The Area

The Pnar people are spread over a large geographical area in the central, and western to eastern part of the Jaintia Hills District. Relatively speaking, smaller geographical areas are being inhabited by the Bhoi in the northern, the Hadem in the north-eastern, and the War in the south-western part of the district (see Map).

The area of field work for the present study is the central part of the Jaintia Hills District which is inhabited by the Pnar people. The subjects of this study hails from rural as well as urban area. The rural subjects belong to 20 different villages namely, Sutnga, Moopala, Narwan, Jalaphet, Mookympad, Tluh, Jarain, Latyrke, Moolamylliang, Lamyrsiang, Tongseng, Sakhain, Lelad, Khliehriat, Myndihati, Lumshnong, Dkhiah, Rymbai, Bapung and Moolamynnoh. While the urban subjects are derived from the town of Jowai which also happens to be the headquarters of the Jaintia Hills District. The field work for the present study has been conducted during July through November 1993 and March 1994.

The Data

The data for the present study has been collected from 8 schools located in the rural area (i.e., Sutnga Presbyterian High School, Sutnga Government M.E. School, Khliehriat High School, Dkhiah Presbyterian High School, Rymbai Presbyterian High School, Tluh High School, Latyrke M.E. School and Lumshnong M.E. School) and 2 schools located in the urban area (i.e. Jowai Government Boys' High School and Government Senior Basic School, Jowai).

The present study comprises of cross sectional data on a total of 509 boys belonging to eight different age groups, i.e., age 11 to 18 years. The age groups are based on decimal age following the Decimal Age Calendar given by Tanner (c.f. Weiner & Lourie, 1981). Age group 11 years, for example, includes all those subjects whose decimal age falls between 10.500 to 11.499 years, and so on.

Out of a total of 509 subjects, 256 belong to rural and 253 belong to urban area. Urban subjects are those who have been born and brought up in the town only; similarly, rural subjects are born and brought up in their respective villages, and they never had prolonged stay in any urban area, or vice versa for the urban subjects. Age groupwise distribution of the sample is presented in Table 1.

Table 1. Age Groupwise Distribution of Sample.

Age group (years)	Urban	Rural	Total
11	32	32	64
12	31	32	63
13	33	32	65
14	31	34	65
15	33	32	65
16	30	31	61
17	30	31	61
18	33	32	65
Total	253	256	509

The data on basic background information on each subject includes, name, date of birth, place of birth, residence since birth, class in which studying, parents' clan, education, occupation and total family income. In addition, information on the subjects' general food habits and personal habits (like smoking, drinking, chewing) has also been gathered.

METHODS

For evaluating individual's somatotype a total of ten anthropometric measurements have been taken on each subject. The human body which is subjected to exercise may elicit bilateral differences. Considering the aims and significance of the present study, the bilateral measurements have been recorded on the right side of the body of the subjects. All measurements are taken according to techniques standardized by Weiner & Lourie (1981).

ANTHROPOMETRIC MEASUREMENTS

1. Stature - It is the straight distance between horizontal floor (on which the subject stands with his heels together) and vertex, when the head is kept in Frankfurt Horizontal plane. The Anthropometer was used to record this measurement.

2. **Weight** - It is a three-dimensional measurement, and records the total bulk of the body. The subject stands in the centre of the platform of the accurate scale, with minimal clothing. Weight was recorded (using light weight personal weighter) to the nearest 0.5 kg with an allowance deducted for the clothing.

SUBCUTANEOUS FAT

GENERAL INSTRUCTIONS

Instrument: Harpenden Skinfold Caliper.

Technique: The objective is to measure the thickness of a complete double layer of skin and subcutaneous tissue without including any underlying muscle tissue. A double layer of skin and subcutaneous tissue is grasped with the thumb and forefinger, the fold being large enough to get a complete double layer, but not so large as to get so much skin and fat as may cause excessive amounts of tension beyond the finger-tips. The fold of skin and fat is held somewhat loosely while the centres of the caliper faces are 1.0 cm from the edges of the thumb and forefinger.

The reading on the dial of the caliper is taken after applying the full spring pressure of the instrument for all measurement. Time was allowed for the full pressure of the caliper to take effect, but not so long that the fat is being 'squeezed out' of the skinfold (Firmer pressure of the fingers on the skinfold will normally arrest the movement of the indicator if the movement is excessive). The measurement is recorded to the nearest 0.1 mm.

3. Triceps

The subject stands with the arm by the side and the elbow extended but relaxed (muscle fibres are excluded, if necessary, but locking the elbow joint momentarily in full extension). The skinfold is raised with the thumb and forefinger of the left hand over the triceps muscle on the back of the right arm, halfway between the acromion and the elbow. The skinfold runs parallel to the long axis of the arm.

4. Subscapular

The subject stands with shoulders erect but relaxed and arms by the sides. The skinfold is raised with the thumb and forefinger of the left hand lateral to the inferior angle of the right scapula, the skinfold running downward and outward in the direction of the ribs.

5. Suprailiac

The subject stands in normal erect position. The subject is instructed to draw in a medium breath and hold it. The skinfold is raised with the thumb and forefinger of the left hand in a position one to two inches above the right anterior superior iliac spine so that the fold runs forward and slightly downward.

6. Calf

The subject sits on a chair with his foot on the floor and the leg vertical. The skinfold is raised with the thumb and forefinger of the left hand on the medial side of the right calf just above the level of the maximum calf girth so that the fold runs vertically.

BONE DIAMETERS

GENERAL INSTRUCTIONS

Instrument: Sliding caliper.

Definition of Measurement: Bi-epicondylar diameter of the distal extremity of the humerus and femur.

Landmarks: The points on either epicondyle of the distal extremity of the humerus or femur most lateral to the medial plans of the bone.

Technique: The discs on the branches of the caliper are applied against the epicondyles in such a manner as to bisect the angle of the joint and to lie in the same plane as the limb. Firm pressure is applied and the measurement is recorded to the nearest .05 cm.

7. **Humerus**

The arm of the subject is raised forward to approximately the level of the shoulder and the forearm is flexed upward at a right angle to the arm. The cross-arms of the caliper are applied to the epicondyles, bisecting the angle of the elbow, and lying in the same plane as the arm and forearm.

8. **Femur**

The subject sits on a chair with his foot on the floor and the leg vertical.

The observer kneels in front of the subject and applied the cross-arms of the caliper to the epicondyles, bisecting the knee angle and keeping the caliper branches in a parallel to the thigh and the leg.

MUSCLE GIRTHS

Instrument: Flexible steel tape.

Definition of measurement: The maximum girth of the muscle when measured at right angles to its long axis.

Technique: The tape is passed around the limb and the region of the muscle explored with the tape always at right angles to the long axis of the bone, until the largest reading is obtained. The tape is in light contact with the skin (so as to produce defomation of the tissue), and maximum girth is recorded to the nearest 0.1 cm.

9. <u>Biceps</u>

The arm of the subject is horizontal, the forearm is separated and the elbow fully flexed. The subject is instructed to clench his fist and contract his 'biceps' as strongly as possible.

The tape is passed around the arm approximately midway between the acromion and the elbow, at right angle to the long axis of the arm.

10. <u>Calf</u>

The subject stands on a floor with his feet six to nine inches apart, with his weight equally distributed through both lower limbs.

The tape is passed around the leg near the top of the calf muscle and lowered until the greatest girth is located a right angle to the long axis of the leg.

<u>**SOMATOTYPING**</u>

According to the method of Heath and Carter (1967), the somatotype is expressed in a 3 numeral rating system consisting of 3-sequential numerals, always recorded in the same order. The first component (Endomorphy) refers to the relative fatness and leanness in individual physique. The second component (Mesomorphy) refers to the musculo-skeletal development per unit of height and can be treated as the relative lean body mass. The third component (Ectomorphy) refers to the relative linearity of individuals and is based on ponderal index. Before obtaining the somatotype rating, appropriate data were entered in the appropriate place at the left side of the rating form given by Heath & Carter (1967).

First Component Rating

1. Calculate the sum of three skinfolds (Triceps, Subscapular and Suprailiac) and record it at right side of total skinfolds.
2. Go to the numeral section (right side block) and choose the appropriate value which is very close to the value of total skinfolds. Then encircle that value.
3. Look to the row of 'First Component' and observe carefully which value is directly under (vertically) the column which have already encircled. Again encircle that value and now we get the first component.

<u>Second Component Rating</u>

1. Go directly to the numerical section and consider only the horizontal row of height, mark the point of the subject's height by a downward arrow (↓) to the nearest value of height (regard the height row as a continuous scale).

2. For each of the measurement of left side (Bone: humerus and femur) go directly to the right side block, consider each horizontal row and encircle the value which is nearest to the value of the left side.

3. Subtract the triceps skinfold thickness value from muscle: Biceps (note that triceps skinfold thickness has been measured in mm unit and muscle: Biceps in cm unit, so it would be best to divide skinfold thickness measurement by 10, then subtract the value from muscle: Biceps). In case of calf, again subtract the calf skinfold thickness (keeping in mind for the transformation of the unit).

4. For each corrected value obtained from 3 (muscle: Biceps/Calf go along the row on the right side block and encircle the value which is nearest to the value on the left side.

5. Now, do not look at the numerical values. Consider only columns, ignore height row and take the other

four rows (Humerus, Femur, Biceps and Calf) of the right side block.

6. There will be four encircled figures in the four rows out of these four, take the left most encircled column as '0' (Zero) or as the 'base point', then count the column deviations of the three encircled figures along the row. Add the total deviation of the three encircled figures along the row and divide the total by 4.

7. Take the number obtained by division described in point 6. Still consider the left-most encircled column as the base point and count the number (obtained by division) horizontally towards the right side column (count each column as 1). Mark a point (.) to the column position reached after counting; it may be fraction between two consecutive columns. Then go vertically up along the column marked with a point to the height row and mark a point with a asterisk (*) on the row.

8. Consider the column only, count horizontally the column deviation from asterisk (*) to mark of height (↓) or vice versa.

9. Remember the column (done in 8), look to the row of 'second component' and '4' as the base point. Then more towards left or right horizontally (depending

upon the direction of the asterisk from the height marker). Now, count the number of column deviation from 4 and encircle the second component figure. Note: If the asterisk is to the right of height then count 4+ figures and if the asterisk is to the left then count 4- figures. Caution: In this row, the unit in consecutive columns has a half unit increment.

Third Component Rating

1. Calculate the ratio height/ $\sqrt[3]{weight}$ (Ponderal index, except that here multiplication by 100 is not done.
2. Look to the right side block and encircle the value very close to the ratio.
3. Look to the row of 'third component' and locate the value directly under (vertically) the column already encircled. Encircled the value. Now, the third component is obtained.

Limitations of the Rating Form

Although the rating form provides a simple method of calculating the anthropometric somatotype, it has some limitations. First, the mesomorphy scales do not include some of the values found at the low and high ends with unusually small and large subjects. Second, some rounding error may occur in calculating the mesomorphy rating, because the subject's height often is not the same as the column height. The following procedures described by Carter (1980a) can correct these problems, and has been used in the present study.

1. Endomorphy = $- 0.7182 + 0.1451(x) - 0.00068(x^2) + 0.0000014(x^3)$

   x = sum of triceps, subscapular and suprailiac skinfolds.

2. 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) + 4.50.

3. Ectomorphy = Height-Weight Ratio x 0.732 - 28.58.

Somatotyping Children

With minor modifications, the Heath-Carter somatotype method can be applied to children. The extended scales are required for calculating mesomorphy in children. These scales may be added to those on the rating form or the rating is calculated using the equation for mesomorphy (as above). Hebbelinck et al. (1973) recommended an adjustment of 170.18 cm, a combined universal mean for adult men and women. Before determining the rating for endomorphy the sum of the three skinfolds is multiplied by the reference

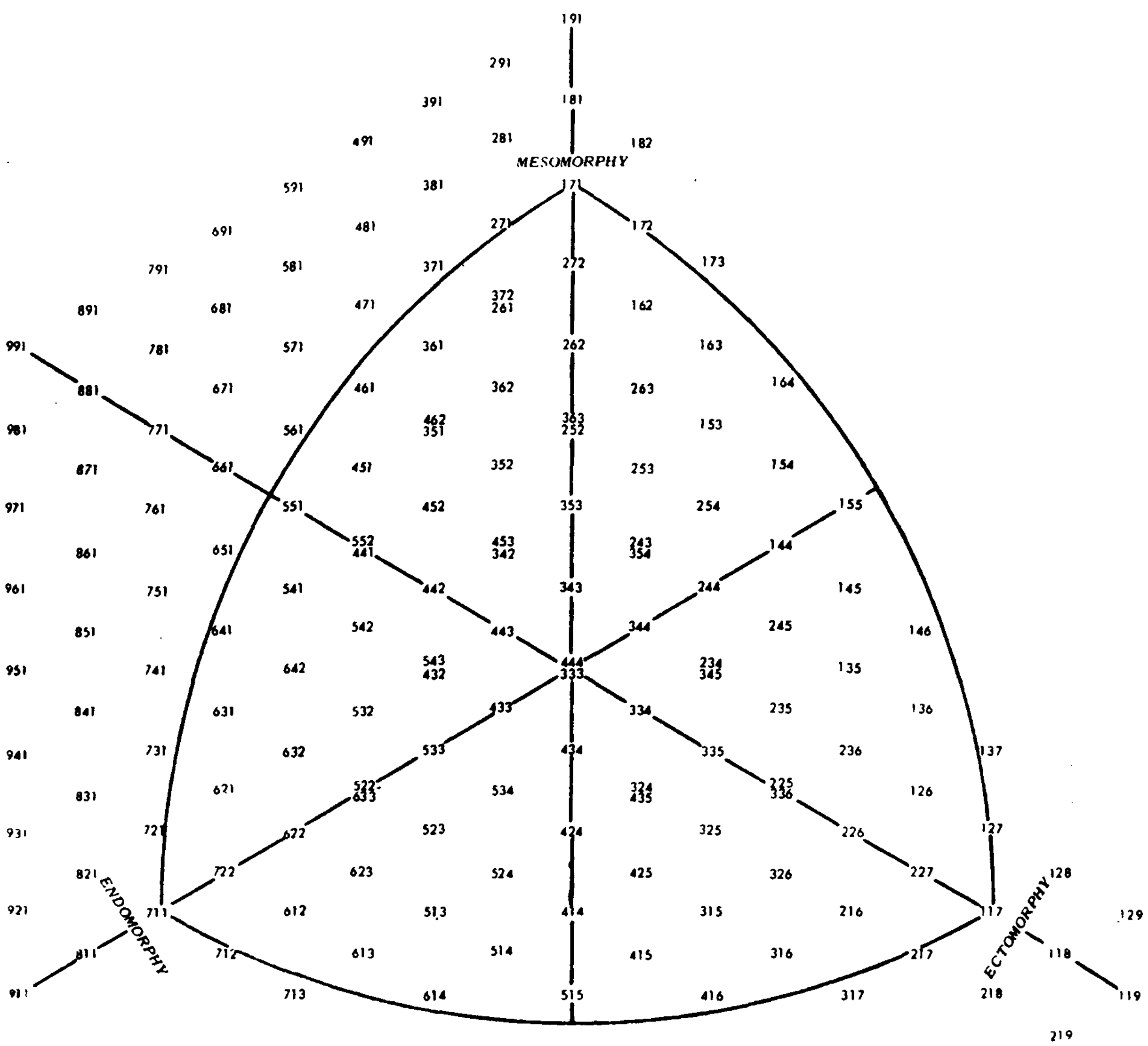


FIG.I SOMATOCHART

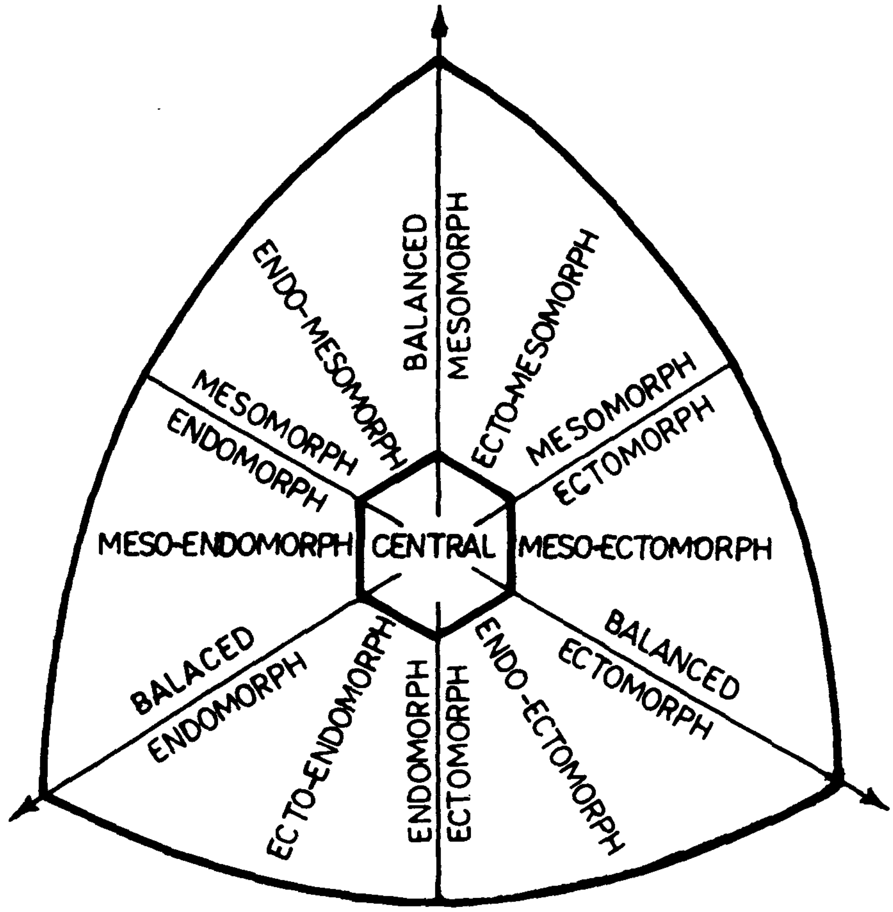


FIG.2 SOMATOTYPE CATEGORIES

height (170.18/height in cm) to adjust for body size.

The above adjustments recommended by Carter (1980d) and Hebbelinck et al. (1973) have been applied to the present data, before determining each individual's somatotype.

SOMATOCHART

Sheldon used a somatotype triangle to represent individual somatotype in it. The somatotype triangle has all the three sides of equal length and are arc-shaped. The corners of the triangle represent the extremes in each component. The left corner at the base of the triangle represents extreme in endomorphy, the right corner at the base represents extreme in ectomorphy and the top corner represents extreme in mesomorphy. The somatotypes can be plotted on the somatotype triangle as 'dots' whose visual inspection can be very useful in interpreting the somatotypes. Heath-Carter (1967) and Carter (1975) utilized the same concept of triangle to design the somatochart (Fig. 1). A typical somatochart has been displayed where the individual somatotypes can be plotted which are called somatoplots. The somatotypes can be divided into following categories depending upon the position of the somatotypes on the somatochart (Fig. 2).

(i) Balanced endomorph: The first component dominates over second and third which are either equal or differ no more than 0.5 units (5-3-3, 5-3-2.5, 5-2.5-3).

(ii) Balanced mesomorph: Second component dominates, the first and third components are either equal or differ no more than 0.5 units (3-5-3, 2.5-5-3, 3-5-2.5).

(iii) Balanced ectomorph: Third component dominates, first and second components are either equal or differ no more than 0.5 units (3-3-5, 3-2.5-5, 2.5-3-5).

(iv) Mesomorph-endomorph: First or second components either equal or differ no more than 0.5 units and dominates over third component (5-5-3, 4.5-5-3, 5-4.5-3).

(v) Mesomorph-endomorph: Second and third components either equal or differ no more than 0.5 units and dominates over the first component (3-5-5-, 3-5-4.5, 3-4.5-5).

(vi) Endomorph-ectomorph: First and third components either equal or differ no more than 0.5 units and dominate over second component (5-3-5, 4.5-3-5, 5-3-4.5).

(vii) Mesomorphic endomorph: First component greater than second and the third is the smallest (5-3-2, 5-4-2)

(viii) Ectomorphic endomorph: First component greater than the third and the second is the smallest (5-2-3).

(ix) Endomorphic mesomorph: Second component greater than first whereas the third is the smallest (3-5-2).

(x) Ectomorphic mesomorph: Second component greater than third and the first is the smallest (2-5-3).

(xi) Endomorphic ectomorph: Third component dominates over first and the second is the smallest (3-2-5).

(xii) Mesomorphic ectomorph: Third component greater than second and the first is the smallest (2-3-5).

(xiii) Central: All components are either equal or differ no more than one unit from other two, the rating of all components should be within and consist of rating of 2, 3 or 4 (3-3-3, 4-4-4, 3.5-4-4, 4-3.5-4, 4-4-3.5, 3.5-4-3.5).

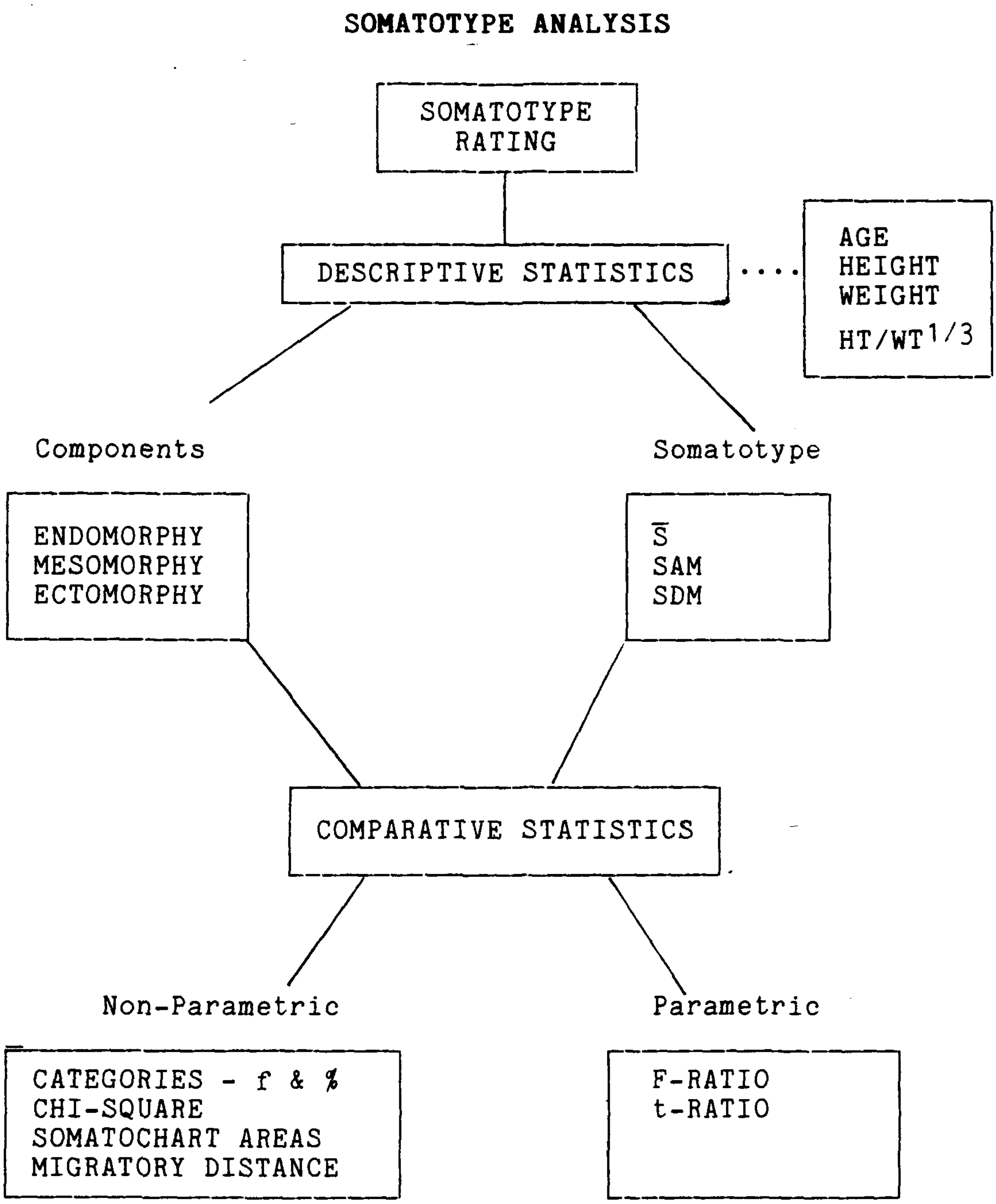


Fig. 3. A Summary of Descriptive and Comparative Statistic.

Statistical Analysis

The nature of the data, the numbers of subjects and the kinds of groups to be compared determine exact procedures of an analysis. A summary of descriptive and comparative statistics which may be used in somatotype analysis is given in Fig. 3. The data for the present study has been subjected to the following statistical treatment.

Descriptive Statistics

For analysis of somatotype ratings for one or more samples, the mean, standard deviation, etc., for each component are calculated. To provide further information on each sample, the same statistics is calculated for age, height, weight, and height-weight ratio (HWR). Somatocharts (two dimensional) for each sample are also plotted.

Mean Somatotypes ($\overline{S}$)

The somatotype ratings are also analysed one at a time, for which simple descriptive statistics is also used.

Somatoplot Coordinates

Calculation of X-Coordinate

$$X = \text{Ectomorphy} - \text{Endomorphy}$$

Calculation of Y-Coordinate

$$Y = 2(\text{Mesomorphy}) - (\text{Endomorphy} + \text{Ectomorphy})$$

Somatotype Dispersion Distances (SDD)

Somatotype dispersion distances (SDD) is the distance between the somaplots which have the coordinates (X_1, Y_1) and (X_2, Y_2) and is calculated as follows:

$$SDD = \sqrt{3(X_1 - X_2)^2 + (Y_1 - Y_2)^2}$$

The 3 under the square root sign is a constant which converts X distances into Y distances units. The location of the somatotype in terms of (X, Y) coordinates on the somatocharts is referred to as its somatoplot.

Somatotype Dispersion Mean (SDM)

A somatotype dispersion means (SDM) is the mean SDD of the somatoplots in a distribution from the $\bar{S}$ (mean) somatoplot. This may be obtained by the following formula:

$$SDM = \sum_{i=1}^{n} \frac{SDD_1}{n}$$

Where SDM is the somatotype dispersion mean and the SDD_1 are the somatotype dispersion distances from the plot of the calculated mean somatotype $\bar{S}$ of the distribution to each somaplot for any given number of subjects (n) in the distribution.

Somatotype Attitudinal Distance (SAD)

The SDD is used for distances on the two dimensional somatochart. However, somatotypes are best represented by a point in three dimensional spaces called Somatopoint. This distance between any two somatopoints is the Somatotype Attitudinal Distance (SAD) and is calculated in component units.

$$SAD_{A,B} = \sqrt{(I_A - I_B)^2 + (II_A - II_B)^2 + (III_A - III_B)^2}$$

Where I, II and III represent endomorphy, mesomorphy and ectomorphy components of a somatotype, and A and B are the two somatotypes.

Somatotype Attitudinal Mean (SAM)

The somatotype attitudinal mean is the average of the somatotype attitudinal distances (SADs) of each somatotype.

$$SAM = \sum_{i=1}^{n} \frac{SAD_i}{n}$$

Comparative Statistics

Somatotype Categories

The relative frequencies of somatotypes by category is the most commonly used non-parametric statistics. The distribution of the somatotypes on the somatocharts may be described by simple counting the number of somatotypes in the area of the somatochart.

Chi-Square

A Chi-square test can be applied to test for significance of the differences between the distribution of somatotypes by category or area.

F- and t-Ratios

F- and t-ratios are used for comparisons between two or more mean somatotypes. In these comparisons the distances between the means in terms of SADs or SDDs are tested for significance. These tests determine whether there is a difference between the somatoplots or somatopoints seen on the somatochart.

Compogram

Compogram is a simple method for presenting the results of comparisons between the mean somatotypes of two samples. The means from the three components from two samples are plotted, and then the means for each are connected.

Per-cent Overlap

The urban and rural samples are compared graphically by circumscribing the limit of each pair of somatotype distribution on a somatochart and counting the number and percentage of somatoplots that overlap in each distribution (Hebbelinck *et al*. 1980; Carter *et al*., 1983).

CHAPTER V

RESULTS

A total of 509 boys ranging in age from 11 to 18 years have been measured for 10 anthropometric dimensions for the present study. After recording the measurements on the Heath-Carter Somatotype Rating Form, the three components of somatotype are calculated for each child. Thereafter, the entire data has been subjected to various statistical analysis as described in the preceding chapter. The results of these analyses are being presented in this chapter. First of all the somatotype distributions of urban and rural samples are presented, followed by age changes in somatotypes, and urban-rural comparisons.

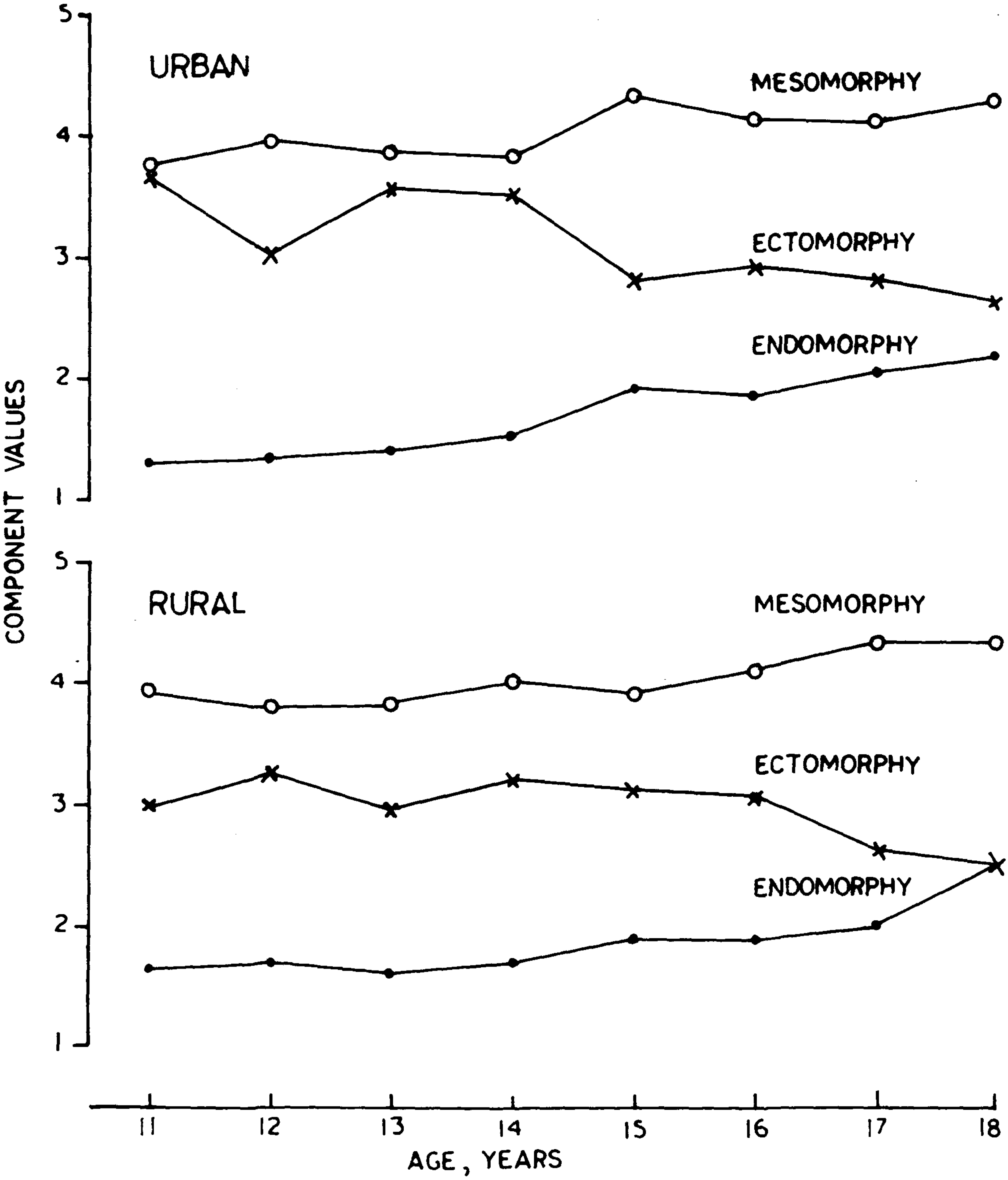
SOMATOTYPE DISTRIBUTION OF URBAN SAMPLE

Mean Somatotypes: Age-wise distribution of the mean somatotypes and other descriptive statistics for the urban sample of 253 Pnar boys is presented in Table 2. At the age of 11 years urban boys are mesomorph-ectomorph with almost equal values for the two components. However, at age 12 years they show a change in the component dominance, and are observed to be ecto-mesomorphic. The urban subjects remain ecto-mesomorphic at age 13 and 14 years as well, though the value for ectomorphy is higher at these ages as compared to that among 12 year old boys. From 14 upto 18

Table 2. Age-wise statistics for Somatotypes of urban Pnar boys.

Age	N	Statistics	Somatotypes: Endomorphy	Somatotypes: Mesomorphy	Somatotypes: Ectomorphy	Two Dimensions: Plot Coordinates X	Two Dimensions: Plot Coordinates Y	SDM	Three Dimensions: SAM
11	32	Mean	1.29	3.76	3.65	2.36	2.92	1.65	1.02
		Variance	0.12	0.28	0.39	0.61	2.04	0.95	0.41
		SD	0.34	0.53	0.62	0.78	1.43	1.01	0.64
12	31	Mean	1.31	3.98	3.01	1.69	3.63	2.27	1.66
		Variance	0.11	0.42	1.22	1.30	4.64	3.41	1.61
		SD	0.33	0.65	1.10	1.14	2.15	1.85	1.27
13	33	Mean	1.37	3.87	3.55	2.18	2.83	2.25	1.35
		Variance	0.07	0.45	0.74	0.80	3.89	1.41	2.04
		SD	0.26	0.67	0.86	0.89	1.97	1.19	1.43
14	31	Mean	1.52	3.82	3.51	1.98	2.63	2.55	1.66
		Variance	0.12	0.57	0.96	1.21	5.57	2.58	0.59
		SD	0.35	0.76	0.98	1.10	2.36	1.61	0.77
15	33	Mean	1.94	4.31	2.80	0.80	3.86	2.33	1.49
		Variance	0.15	0.54	0.55	1.12	3.54	1.55	0.77
		SD	0.39	0.74	0.74	1.06	1.88	1.24	0.88
16	30	Mean	1.86	4.12	2.92	1.09	3.43	2.90	1.72
		Variance	0.31	0.80	1.12	2.23	5.61	4.05	1.25
		SD	0.56	0.90	1.06	1.49	2.37	2.01	1.12
17	30	Mean	2.02	4.10	2.79	0.80	3.37	2.56	1.58
		Variance	0.24	0.58	1.12	1.89	4.96	3.81	0.66
		SD	0.49	0.76	1.06	1.38	2.23	1.95	0.81
18	33	Mean	2.17	4.26	2.63	0.46	3.71	2.24	1.42
		Variance	0.15	0.52	0.56	0.88	3.93	1.68	0.81
		SD	0.38	0.72	0.75	0.94	1.98	1.30	0.90

FIG. 4 AGE WISE SOMATOTYPE COMPONENT VARIATION IN URBAN AND RURAL PNAR BOYS



years the ectomorphy component decreases, while the mesomorphy component increases. The endomorphy component reveals a steady increase from 11 to 18 years. On the whole, it can be said that the urban Pnar boys are ecto-mesomorphic from 11 to 18 years of age. Of the three components of somatotype, the lowest values are observed for endomorphy and the highest for mesomorphy. In other words, these boys show a high musculo-skeletal development with relatively least fat in their physique.

Between 11 and 18 years of age, an overall increase of 0.88 units in endomorphy, 0.50 units increase in mesomorphy, and 1.02 unit decrease in ectomorphy is observed in the mean component ratings. The values for somatotype dispersion means and somatotype attitudinal means (Table 2) indicate that the somatotypes at different ages considered do not differ in the dispersion about their means.

Fig. 4 presents age-wise component variation in the somatotypes of urban and rural boys. It is clear from the figure that from 11 to 18 years though the urban boys of the present study are generally ecto-mesomorphic, they reveal a change in the values of the three components of their physique.

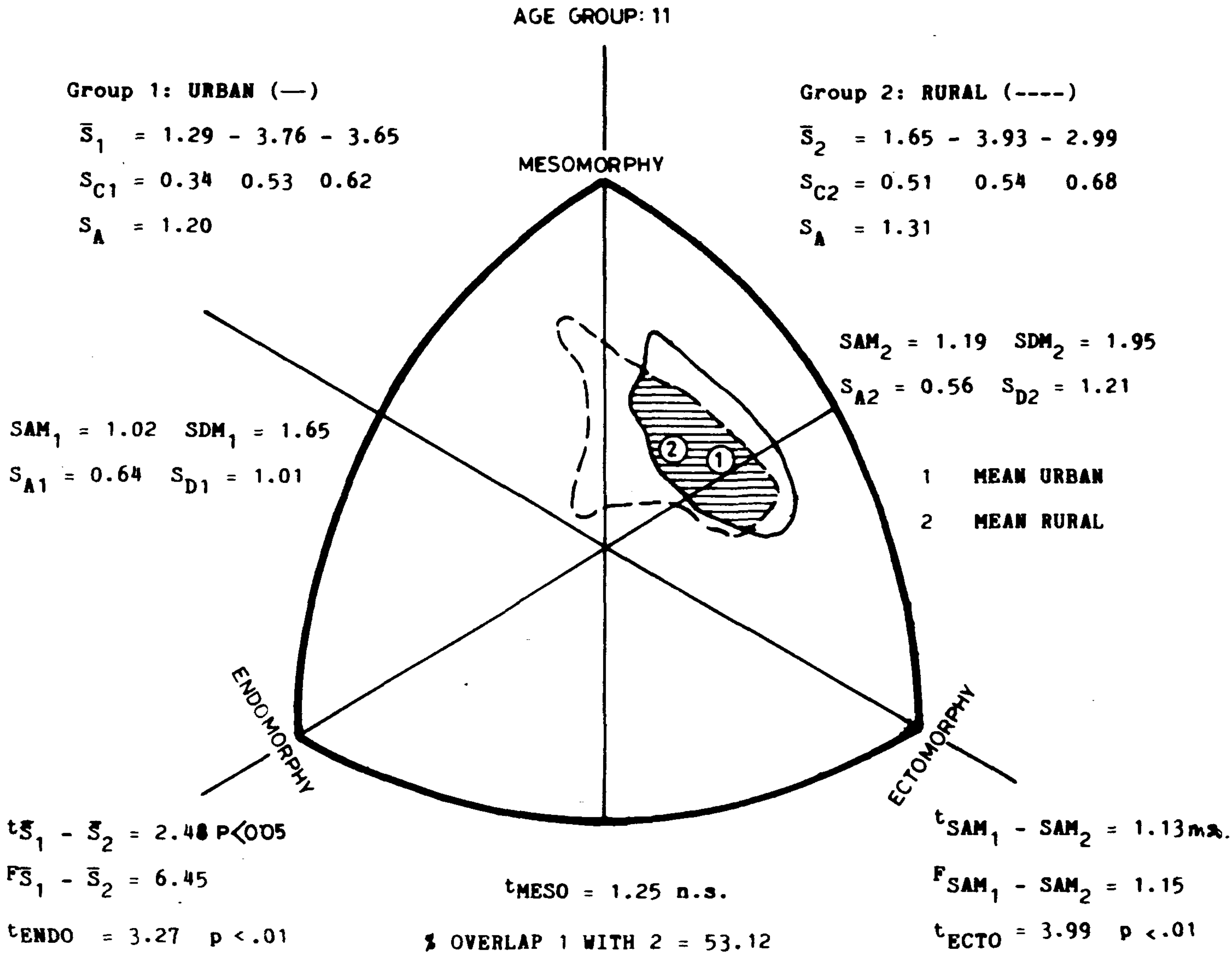


FIG. 5 DESCRIPTIVE AND COMPARATIVE SOMATOTYPE STATISTICS IN URBAN AND RURAL SAMPLES.

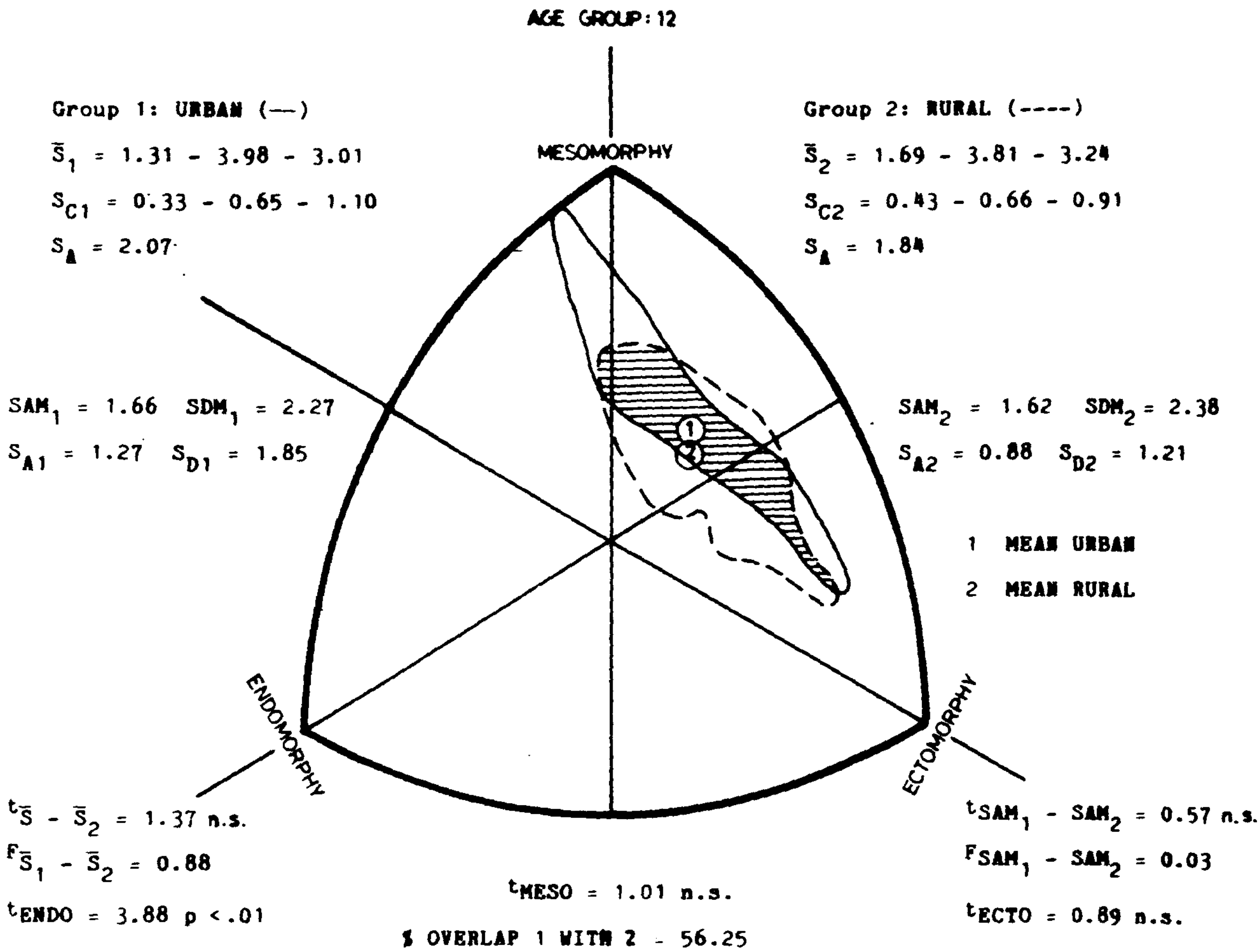


FIG. 6 DESCRIPTIVE AND COMPARATIVE SOMATOTYPE STATISTICS IN URBAN AND RURAL SAMPLES

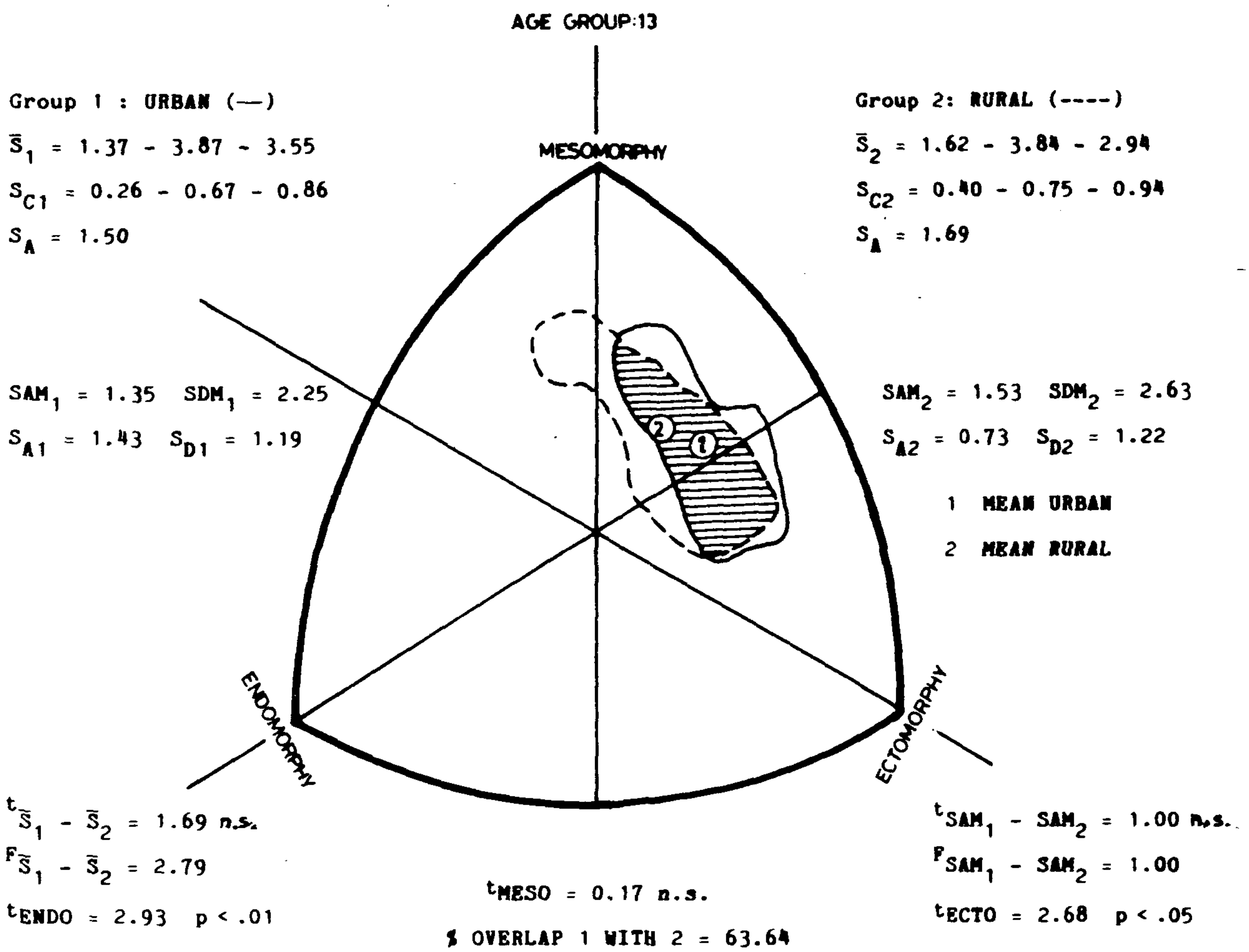


FIG. 7 DESCRIPTIVE AND COMPARATIVE SOMATOTYPE STATISTICS IN URBAN AND RURAL SAMPLES.

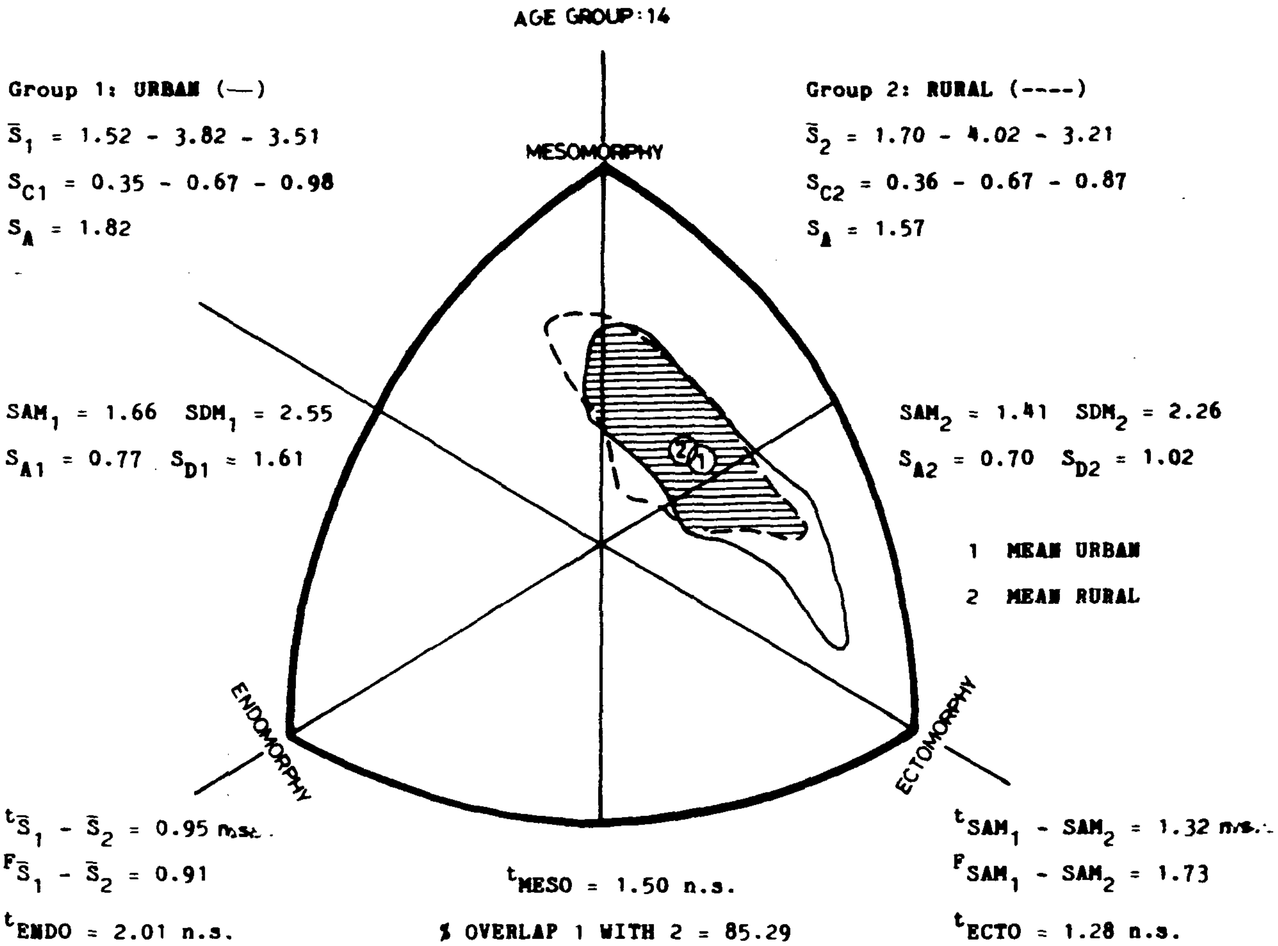


FIG. 8 DESCRIPTIVE AND COMPARATIVE SOMATOTYPE STATISTICS IN URBAN AND RURAL SAMPLES

AGE GROUP: 15

Group 1: URBAN (—)

$\bar{S}_1$ = 1.94 - 4.31 - 2.80

S_{C1} = 0.39 - 0.74 - 0.74

S_A = 1.73

Group 2: RURAL (----)

$\bar{S}_2$ = 1.89 - 3.89 - 3.10

S_{C2} = 0.54 - 0.69 - 1.10

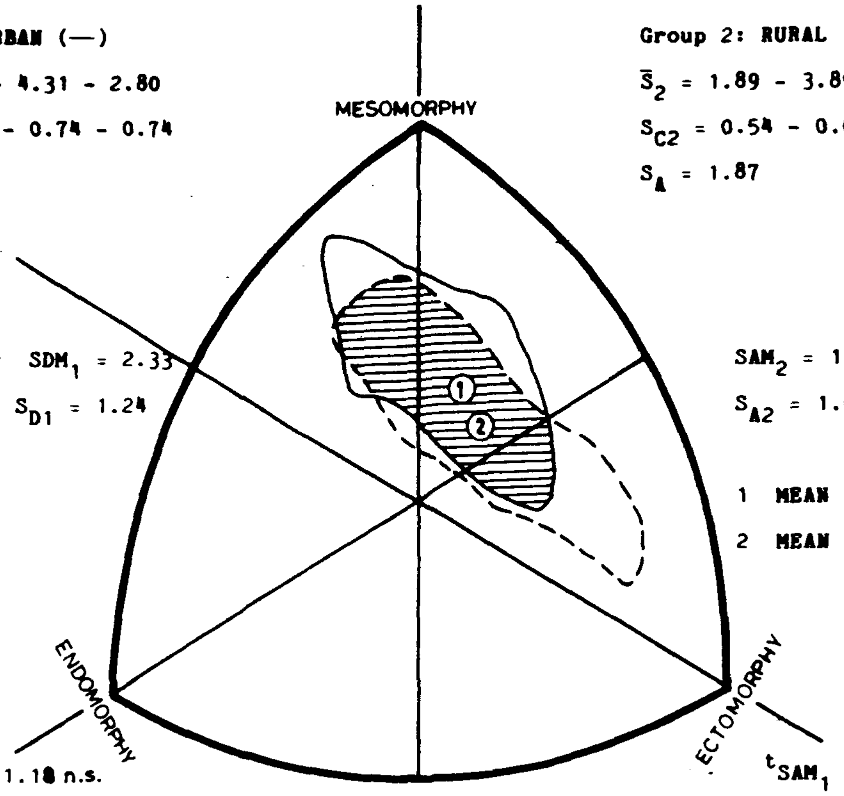
S_A = 1.87

SAM_1 = 1.49 SDM_1 = 2.33

S_{A1} = 0.88 S_{D1} = 1.24

SAM_2 = 1.62 SDM_2 = 2.54

S_{A2} = 1.05 S_{D2} = 1.74



1 MEAN URBAN

2 MEAN RURAL

$t_{\bar{S}_1 - \bar{S}_2}$ = 1.18 n.s.

$F_{\bar{S}_1 - \bar{S}_2}$ = 1.36

t_{ENDO} = 0.42 n.s.

t_{MESO} = 1.77 n.s.

$t_{SAM_1 - SAM_2}$ = 0.57 n.s.

$F_{SAM_1 - SAM_2}$ = 0.32

t_{ECTO} = 1.66 n.s.

% OVERLAP 1 WITH 2 = 69.70

FIG. 9 DESCRIPTIVE AND COMPARATIVE SOMATOTYPE STATISTICS IN URBAN AND RURAL SAMPLES.

Group 1: URBAN (—)

$\bar{S}_1$ = 1.86 - 4.12 - 2.92

S_{C1} = 0.56 - 0.90 - 1.06

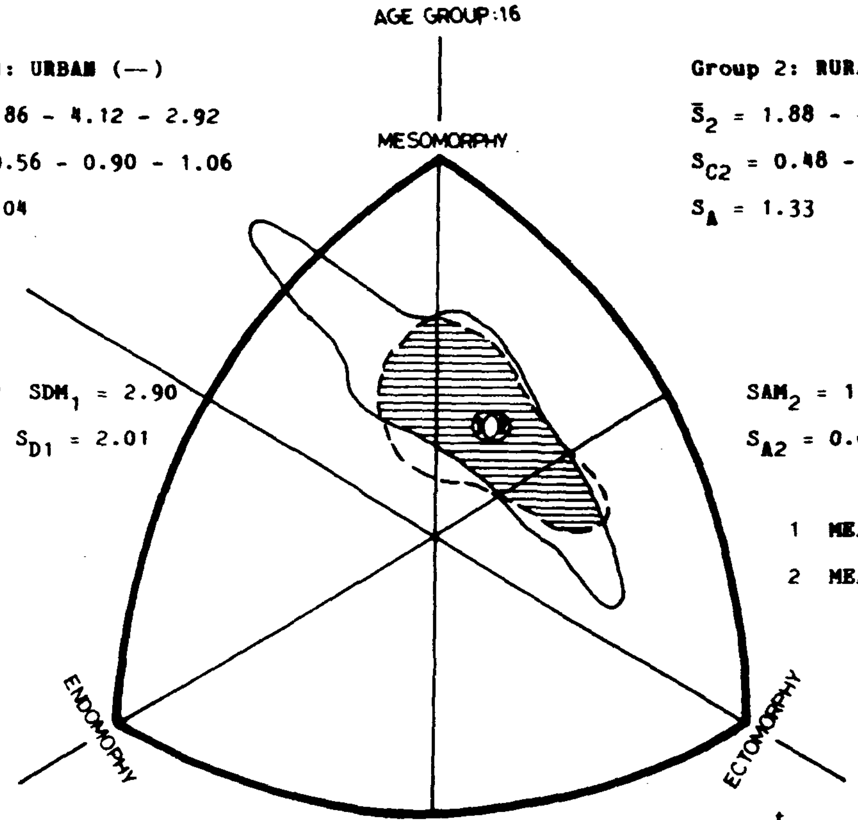
S_A = 2.04

Group 2: RURAL (----)

$\bar{S}_2$ = 1.88 - 4.10 - 3.06

S_{C2} = 0.48 - 0.60 - 0.77

S_A = 1.33



SAM_1 = 1.72 SDM_1 = 2.90

S_{A1} = 1.12 S_{D1} = 2.01

SAM_2 = 1.24 SDM_2 = 2.25

S_{A2} = 0.63 S_{D2} = 1.11

1 MEAN URBAN

2 MEAN RURAL

${}^{t}\bar{S}_1 - \bar{S}_2$ = 0.67 n.s.

${}^{F}\bar{S}_1 - \bar{S}_2$ = 0.10

t_{ENDO} = 0.15 n.s.

t_{MESO} = 0.10 n.s.

% OVERLAP 1 WITH 2 = 83.87

${}^{t}SAM_1 - SAM_2$ = 2.00 P<0.05

${}^{F}SAM_1 - SAM_2$ = 4.44

t_{ECTO} = 0.58 n.s.

FIG. 10 DESCRIPTIVE AND COMPARATIVE SOMATOTYPE STATISTICS IN URBAN AND RURAL SAMPLES.

AGE GROUP: 17

Group 1: URBAN (—)

$\bar{S}_1$ = 2.02 - 4.10 - 2.79

S_{C1} = 0.49 - 0.76 - 1.06

S_A = 1.77

Group 2: RURAL (----)

$\bar{S}_2$ = 2.01 - 4.34 - 2.62

S_{C2} = 0.45 - 0.72 - 0.90

S_A = 1.68

SAM_1 = 1.58 SDM_1 = 2.56

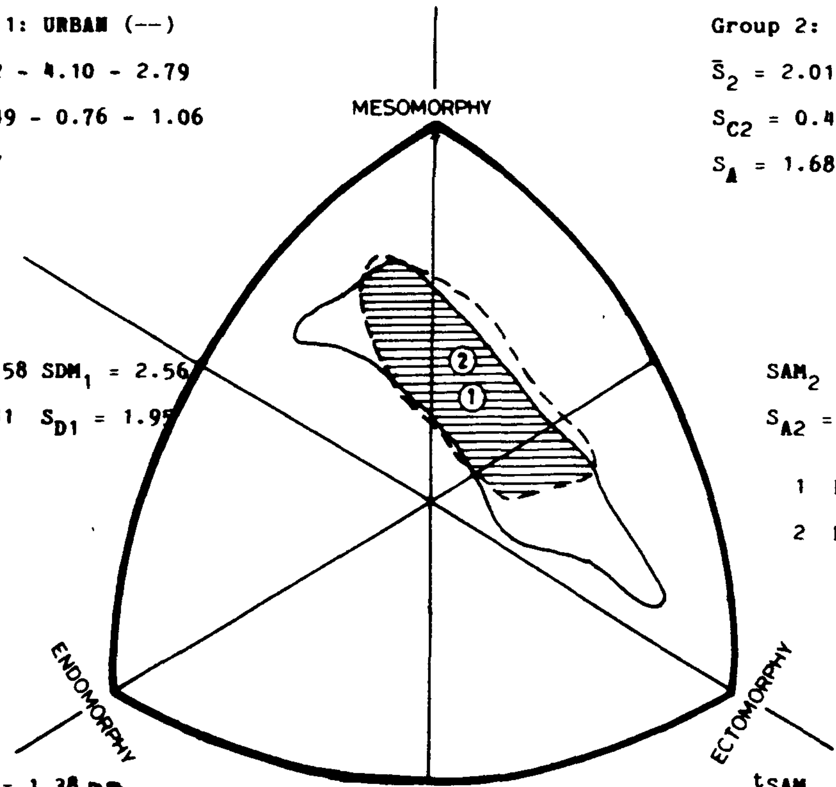
S_{A1} = 0.81 S_{D1} = 1.95

SAM_2 = 1.49 SDM_2 = 2.61

S_{A2} = 0.79 S_{D2} = 1.26

1 MEAN URBAN

2 MEAN RURAL



$t_{\bar{S}_1 - \bar{S}_2}$ = 1.38 n.s.

$F_{\bar{S}_1 - \bar{S}_2}$ = 0.44

t_{ENDO} = 0.08 n.s.

t_{MESO} = 1.11 n.s.

% OVERLAP 1 WITH 2 = 80.65

$t_{SAM_1 - SAM_2}$ = 0.41 n.s.

$F_{SAM_1 - SAM_2}$ = 0.19

t_{ECTO} = 0.91 n.s.

FIG. 11 DESCRIPTIVE AND COMPARATIVE SOMATOTYPE STATISTICS IN URBAN AND RURAL SAMPLES.

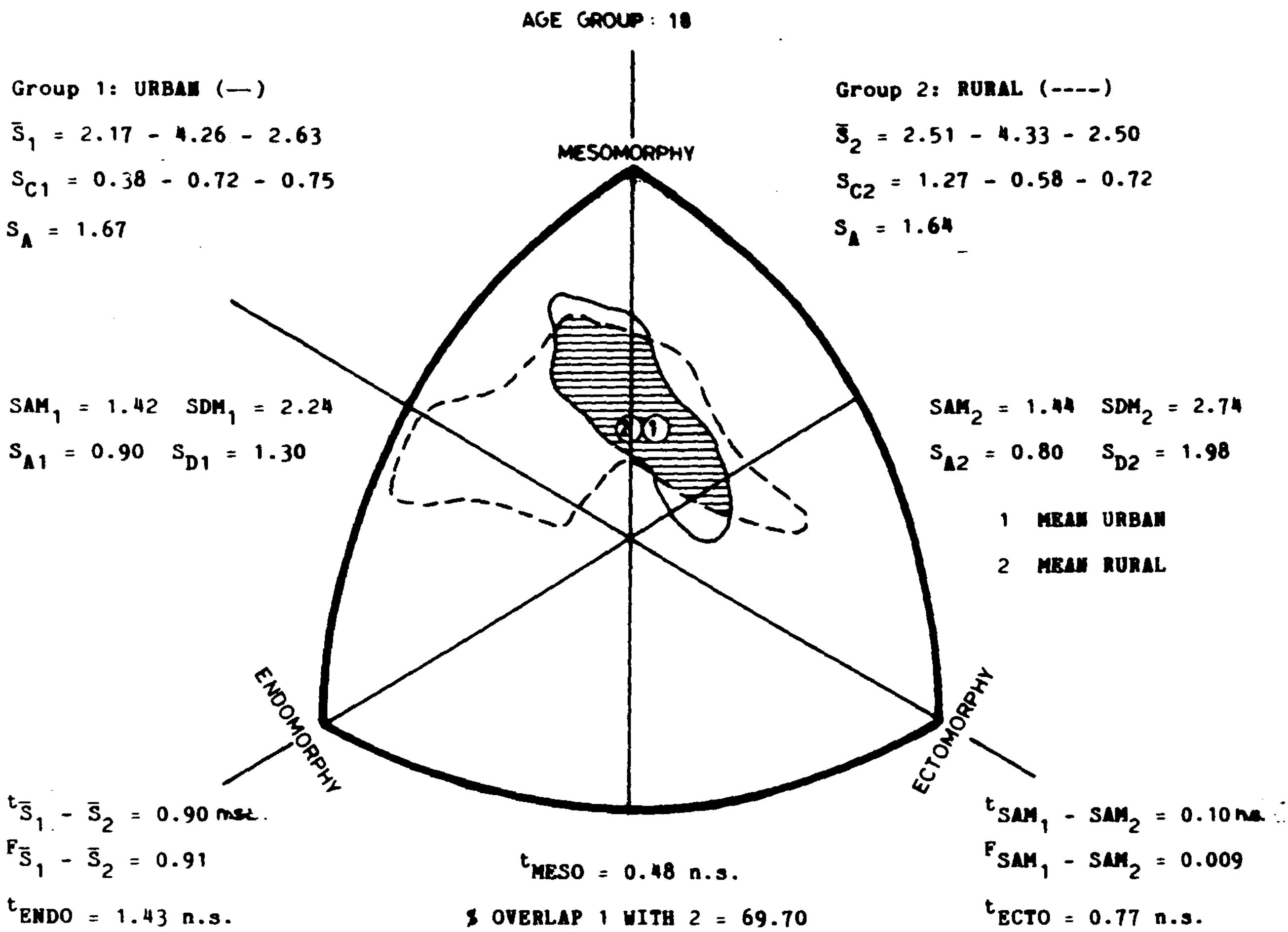


FIG. 12 DESCRIPTIVE AND COMPARATIVE SOMATOTYPE STATISTICS IN URBAN AND RURAL SAMPLES.

Somatocharts: The somatotype of each subject of the urban sample is plotted on somatochart according to age-group. Thereafter, the area of somatotype distribution for each age group is drawn, along with the depiction of mean somatotype of an age group. These age-wise somatocharts and other descriptive statistics are presented in Fig. 5 to 12.

It is clear from these somatocharts that at all ages the somatotypes of urban boys are distributed in the ectomorphy-mesomorphy sector above the ectomorphy axis. At age 11 years a majority of the somatotypes cluster around the upper side of endomorphy axis, in the ectomorphy-mesomorphy sector. However, as age increases, somatotypes show a general tendency to shift towards the upper side of mesomorphy axis. At all ages the mean somatotype lies between the upper mesomorphy and upper endomorphy axes. Some extreme somatotypes are found to occur only in age groups 12, 14, 16 and 17 years.

Range of Component Ratings: Considering the total urban sample of 253 boys together, ratings of the three components range between 0.7 and 3.7 for endomorphy, 1.9 and 6.8 for mesomorphy, and 0.2 and 6.0 for ectomorphy. However, a majority of the subjects show values falling within the range of 1.0-2.0 for endomorphy, 3.0-5.0 for mesomorphy, and 2.0-4.0 for ectomorphy.

Table 3. Age-wise frequency and percentage of urban boys in various somatotype categories.

Sl. No.	Somatotype Categories	AGE GROUP							
		11 Year	12 Year	13 Year	14 Year	15 Year	16 Year	17 Year	18 Year
		f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
1.	Balanced endomorph	-	-	-	-	-	-	-	-
2.	Mesomorphic endomorph	-	-	-	-	-	-	-	-
3.	Mesomorph-endomorph	-	-	-	-	-	-	-	-
4.	Endomorphic mesomorph	-	-	-	-	2(6.061)	3(10.000)	1(3.333)	3(9.091)
5.	Balanced mesomorph	2(6.250)	9(29.032)	3(9.091)	6(19.355)	13(39.394)	9(30.000)	17(56.667)	18(54.546)
6.	Ectomorphic mesomorph	3(9.375)	8(25.807)	9(27.273)	5(16.129)	6(18.182)	3(10.000)	4(13.333)	1(3.030)
7.	Mesomorph-ectomorph	25(78.125)	11(35.484)	13(39.394)	14(45.161)	11(33.333)	11(36.667)	4(13.333)	10(30.303)
8.	Mesomorphic ectomorph	2(6.250)	3(9.677)	7(21.212)	5(16.129)	1(3.030)	3(10.000)	2(6.667)	1(3.030)
9.	Balanced ectomorph	-	-	1(3.030)	1(3.226)	-	1(3.333)	2(6.667)	-
10.	Endomorphic ectomorph	-	-	-	-	-	-	-	-
11.	Endomorph-ectomorph	-	-	-	-	-	-	-	-
12.	Ectomorph endomorph	-	-	-	-	-	-	-	-
13.	Central	-	-	-	-	-	-	-	-

Somatotype Categories: The somatotype data on urban sample has been grouped into different categories following the component dominance method of Carter (1980). The age-wise frequency and percentage of urban subjects falling under various categories is listed in Table 3. On the whole it can be seen from the table that out of 13 generalized categories of somatotypes, the urban boys of different age groups of the present study are distributed only among 6 categories, viz., Endomorphic-mesomorph, Balanced mesomorph, Ectomorphic mesomorph, Mesomorph-ectomorph, Mesomorphic-ectomorph and Balanced ectomorph. The 11 year old urban boys are found to be distributed into 4 categories, i.e., Balanced mesomorph (6.25%), Ectomorphic-mesomorph (9.38%), Mesomorph-ectomorph (78.13%) and Mesomorphic-ectomorph (6.25%). In 12 year old boys also the somatotype distribution are found in four categories with a majority (35.48%) being Mesomorph-ectomorph. The somato-types of 13 and 14 years old boys are distributed in the same five categories with a majority (39.39%) in 13 year and (45.15%) in 14 year age group, falling under Mesomorph-ectomorph. In 15 year old, the somatotypes are distributed into 5 categories with a majority (39.39%) being Balanced mesomorph. The somatotypes in age group 16 year and 17 year are found to be distributed into 6 categories, while, in 16 year old maximum number of boys (36.67%) are Mesomorph-ectomorph, whereas in 17 year old boys a majority (56.67%)

are Balanced mesomorph. And in the age group 18 years the somatotypes are distributed into 5-categories with a majority (54.55%) being Balanced mesomorph, while only (30.30%) of the boys falls under the Mesomorph-ectomorph category.

SOMATOTYPE DISTRIBUTION OF RURAL SAMPLE

Mean Somatotypes: Age-wise distribution of the mean somatotypes and other descriptive statistics for the rural sample of 256 Pnar boys is presented in Table 4. At 11 years of age rural boys are ecto-mesomorphic, with mesomorphy dominating over ectomorphy component by almost 1.0 unit. Among the 12 year old boys mesomorphy value decreases a little while the value for ectomorphy increases, but these boys still remain ecto-mesomorphic. From 12 to 18 years the value for mesomorphy increases steadily, however, the value for ectomorphy first decreases between 12 and 13 years, then increases between 13 and 14 years, thereafter from 14 to 18 years decreases steadily. On the other hand, the value for endomorphy component increases steadily from 11 to 18 years, and at age 18 both ectomorphy and endomorphy component show equal values. On the whole, it can be said that the rural Pnar boys, like their urban counterparts, are also ecto-mesomorphic from age 11 to 18 years. Among the three components of somato-

Table 4. Age-wise statistics for somatotypes of rural Pnar boys.

Age	N	Statistics	Endomorphy	Mesomorphy	Ectomorphy	Two Dimensions Plot Coordinates		SDM	Three Dimensions
						X	Y		SAM
11	32	Mean	1.65	3.93	2.99	1.34	3.20	1.95	1.19
		Variance	0.26	0.29	0.47	0.98	2.27	1.46	0.31
		SD	0.51	0.54	0.68	0.99	1.51	1.21	0.56
12	32	Mean	1.69	3.81	3.24	1.54	2.72	2.38	1.62
		Variance	0.19	0.43	0.83	1.08	3.81	1.46	0.77
		SD	0.43	0.66	0.91	1.04	1.95	1.21	0.88
13	32	Mean	1.62	3.84	2.94	1.33	3.13	2.63	1.53
		Variance	0.17	0.57	0.87	1.15	4.64	1.49	0.53
		SD	0.40	0.75	0.94	1.07	2.16	1.22	0.73
14	34	Mean	1.70	4.02	3.21	1.50	3.12	2.26	1.41
		Variance	0.13	0.45	0.76	1.09	3.71	1.04	0.49
		SD	0.36	0.67	0.87	1.05	1.93	1.02	0.70
15	32	Mean	1.89	3.89	3.10	1.24	2.76	2.54	1.62
		Variance	0.29	0.47	1.21	1.99	3.87	2.96	1.10
		SD	0.54	0.69	1.10	1.41	1.97	1.72	1.05
16	31	Mean	1.88	4.10	3.06	1.18	3.27	2.25	1.24
		Variance	0.23	0.35	0.59	1.16	2.79	1.23	0.40
		SD	0.48	0.60	0.77	1.08	1.67	1.11	0.63
17	31	Mean	2.01	4.34	2.62	0.61	4.14	2.61	1.49
		Variance	0.20	0.52	0.81	1.41	3.92	1.59	0.62
		SD	0.45	0.72	0.90	1.19	1.98	1.26	0.79
18	32	Mean	2.51	4.33	2.50	-0.01	3.65	2.74	1.44
		Variance	1.61	0.33	0.52	2.95	2.47	3.92	0.64
		SD	1.27	0.58	0.72	1.72	1.57	1.98	0.80

type the lowest values are observed for endomorphy and the highest for mesomorphy, whereas ectomorphy lies in the middle. In other words, an observed for the urban boys, the rural boys of the present sample also show a high musculo-skeletal development with relatively less fat in their physique.

An overall increase of 0.86 unit in endomorphy, 0.40 unit in mesomorphy and 0.45 unit decrease in ectomorphy is observed in the mean component ratings between 11 and 18 years of age. The values for somatotype dispersion means as well as somatotype attitudinal means (Table 4) indicate that the somatotypes at various ages considered here do not differ in the dispersion about their means.

Age-wise component variation in the somatotypes of rural boys is depicted in Fig. 4. It can be seen from the figure that though the rural boys of the present study are generally ecto-mesomorphic as they grow in age a change in the values of the three components of their physique is observed.

Somatocharts: The age-wise somatocharts and other descriptive statistics for the rural sample is presented in Fig. 5 to 12. It is obvious from these somatocharts that, excepting for age 18 years, at all ages the somatotypes of rural boys are distributed in the ectomorphy-mesomorphy sector above the ectomorphy axis. At age 18 years the somatotypes of only 4 boys fall in the endomorphy-mesomorphy sector below the ectomorphy axis. A majority of the somatotypes of 11 and 12 year old boys tend to cluster around the upper side of endomorphy axis in the ectomorphy-mesomorphy sector. With increasing age from 13 years onwards, however, somatotypes show a general tendency to shift towards the upper side of mesomorphy axis. A few extreme somatotypes are observed in age groups 11, 12 and 18 years. The mean somatotypes for age groups 11 to 17 years are located between the upper mesomorphy and upper endomorphy axes. However, the mean somatotype of 18 year old rural boys lies on the upper mesomorphy axis.

Range of Component Ratings: Based on the total rural sample of 256 boys, ratings of the three components range between 0.9 and 6.3 for endomorphy, 2.5 and 5.7 for mesomorphy, and 0.4 and 6.3 for ectomorphy. However, most of the rural subjects show values falling within the range of 1.0-2.0 for endomorphy, 3.0-5.0 for mesomorphy, and 2.0-4.0 for ectomorphy.

Somatotype Categories: The age-wise frequency and percentage of rural subjects falling under various categories according to component dominance is presented in

Table 5. Age-wise frequency and percentage of rural boys in various somatotype categories.

Sl. No.	Somatotype Categories	AGE GROUP							
		11 Year	12 Year	13 Year	14 Year	15 Year	16 Year	17 Year	18 Year
		f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
1.	Balanced endomorph	-	-	-	-	-	-	-	
2.	Mesomorphic endomorph	-	-	-	-	-	-	-	1(3.125)
3.	Mesomorph-endomorph	-	-	-	-	-	-	-	5(15.625)
4.	Endomorphic mesomorph	-	-	1(3.125)	-	2(6.250)	1(3.226)	4(12.903)	2(6.250)
5.	Balanced mesomorph	10(31.250)	8(25.000)	10(31.250)	9(26.471)	11(34.375)	13(41.936)	14(45.161)	15(46.875)
6.	Ectomorphic mesomorph	4(12.500)	5(15.625)	3(9.375)	5(14.706)	5(15.625)	2(6.452)	3(9.677)	3(9.375)
7.	Mesomorph-ectomorph	17(53.125)	15(46.875)	14(43.750)	18(52.941)	10(31.250)	14(45.161)	10(32.258)	5(15.625)
8.	Mesomorphic-ectomorph	1(3.125)	4(12.500)	3(9.375)	2(5.882)	2(6.250)	1(3.226)	-	1(3.125)
9.	Balanced ectomorph	-	-	1(3.125)	-	2(6.250)	-	-	-
10.	Endomorphic ectomorph	-	-	-	-	-	-	-	-
11.	Endomorph-ectomorph	-	-	-	-	-	-	-	-
12.	Ectomorphic endomorph	-	-	-	-	-	-	-	-
13.	Central	-	-	-	-	-	-	-	-

Table 5. The somatotypes of different age group of rural boys are distributed into 8 categories, viz., Mesomorphic-endomorph, Mesomorph-endomorph, Endomorphic-mesomorph, Balanced mesomorph, Ectomorphic-mesomorph, Mesomorph-ectomorph, Mesomorphic-ectomorph and Balanced ectomorph are observed. The 11 year old rural boys are found to be distributed into 4 categories, Balanced mesomorph (31.25%), Ectomorphic-mesomorph (12.50%), Mesomorph-ectomorph (53.13%) and Mesomorphic-ectomorph (3.13%). The somatotypes of the 12 year old boys also distributed into the same 4 categories with a majority (46.88%) falls under Mesomorph-ectomorph. In age group 13 year the somatotypes are distributed into 6 categories with a majority (43.75%) falls under mesomorph-ectomorph. Whereas, in the age group 14 year, the somatotypes are distributed into 4 categories with a majority (52.94%) falling under Mesomorph-ectomorph. In the age group 15 year, the somatotypes are distributed into 6 categories with a majority (34.38%) being Balanced mesomorph. In 16 year old boys, the somatotypes are distributed into 5 categories with a majority (41.94%) falling under Balanced mesomorph. The 17 year old boys are found to be distributed into 4 categories with a majority (45.16%) being Balanced mesomorph. And in the age group 18 year, the somatotypes are distributed into 7 categories with a majority (46.88%) as Balanced mesomorph, whereas only (15.63%) falls under Mesomorph-ectomorph.

Table 6. Age-wise comparisons (t-values) of three components of mean somatotype in urban and rural Pnar boys.

Age groups compared	URBAN BOYS			RURAL BOYS		
	Endomorphy	Mesomorphy	Ectomorphy	Endomorphy	Mesomorphy	Ectomorphy
11-12 Yrs	- 0.233	- 1.446	2.787**	- 0.334	0.784	- 1.225
12-13 Yrs	- 0.792	0.656	- 2.144*	0.664	- 0.167	1.277
13-14 Yrs	- 1.906	0.372	0.170	- 0.839	- 1.010	- 1.191
14-15 Yrs	- 4.468**	- 3.366**	3.203**	- 1.645	0.567	0.562
15-16 Yrs	0.641	0.895	- 0.508	0.077	- 0.930	0.213
16-17 Yrs	- 1.158	0.091	0.548	- 1.082	- 1.215	2.286*
17-18 Yrs	- 1.326	- 1.024	0.853	- 2.062*	0.048	0.716
11-18 Yrs	- 9.693**	- 3.146**	5.892**	- 3.906**	- 2.810*	2.755**

* $p < 0.05$
** $p < 0.05$

Age Changes in Somatotypes

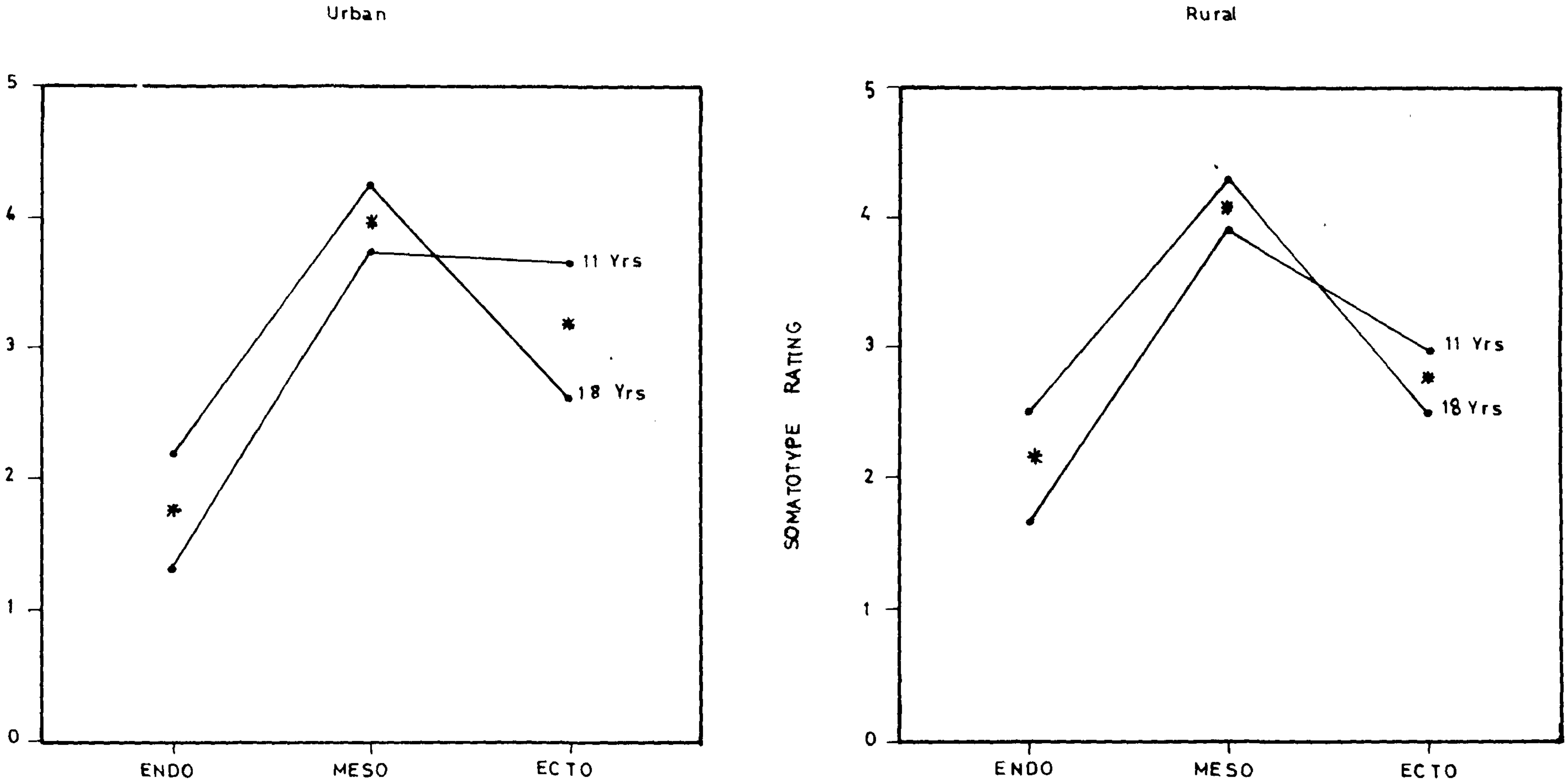
It is known that some children change somatotype while others have relatively stable somatotypes. Many cross-sectional and longitudinal studies (reviewed in Chapter II) have provided information on the question of stability of somatotypes. The present study also makes an attempt to answer this question. The age changes in somatotypes are being analyzed here by using t-test and chi-square test as applied to mean somatotype ratings and somatotype categories, respectively.

Mean Somatotypes: Age-wise comparisons of three components of mean somatotypes in urban and rural Pnar boys are presented in Table 6. The table gives t-values between preceding and succeeding age groups for endomorphy, mesomorphy and ectomorphy. It is clear from the values that from age 14 to 15 years a statistically significant change in all the three components of physique occur among urban boys. These boys also reveal a significant change in ectomorphy between age 11 and 12, and 12 and 13 years. On the other hand, the rural boys show statistically significant change in ectomorphy between age 11 and 12, and 12 and 13 years. On the other hand, the rural boys show statistically significant changes only between age 16 and 17 years for ectomorphy, and 17 and 18 years for endomorphy. The

Table 7. Age-wise comparisons (X^2-values) of the distribution of somatotype categories in urban and rural Pnar boys.

Age groups compared	Urban Boys			Rural Boys		
	X^2	d.f.	Significance	X^2	d.f.	Significance
11-12 Yrs	4.402	3	n.s.	0.283	3	n.s.
12-13 Yrs	0.908	4	n.s.	0.190	5	n.s.
13-14 Yrs	0.470	4	n.s.	0.363	5	n.s.
14-15 Yrs	1.252	5	n.s.	1.153	5	n.s.
15-16 Yrs	0.492	5	n.s.	0.555	5	n.s.
16-17 Yrs	2.002	5	n.s.	0.451	4	n.s.
17-18 Yrs	0.872	5	n.s.	0.905	6	n.s.
11-18 Yrs	7.613	4	n.s.	3.126	6	n.s.

FIG.13 COMPOGRAM SHOWING AGE CHANGES IN MEAN COMPONENT RATINGS OF URBAN AND RURAL PNAR BOYS (* $P < 0.05$)



last row of Table 6 shows t-values between 11 and 18 years for different components of mean somatotypes, and the same comparison is depicted in Fig. 13. From 11 to 18 years of age statistically significant changes are observed for all components of physique in urban as well as rural boys.

Somatotype Categories: Age-wise comparisons of the distribution of somatotype categories in urban and rural Pnar boys are given in Table 7. Though some age changes in the frequency distribution of somatotypes into various categories are observed (Tables 3 and 5). However, no statistically significant changes in somatotype categories are observed among any age group comparisons of urban as well as rural boys. As seen from X^2 values listed in the last row of Table 7, no statistically significant changes in the distribution of somatotypes into different categories occur from the youngest to the oldest age groups of urban as well as rural Pnar boys of the present study.

Urban-Rural Somatotype Comparisons

After describing the somatotypes and the age changes in urban and rural samples separately, an appropriate comparison between the two samples based on parametric as well as non-parametric statistics has been attempted. These comparisons are for mean somatotypes, component ratings, somatotype categories, per cent overlap.

Table 8. Age-wise urban-rural comparisons (t-values) of somatotypes of Pnar boys.

Age Group	Sample	Mean Somatotype	$t_{\bar{S}_1-\bar{S}_2}$		$t_{SAM_1-SAM_2}$		t_{Endo}		t_{Meso}		t_{Ecto}	
11	Urban Rural	1.29-3.76-3.65 1.65-3.93-2.99	2.48	$p < 0.05$	1.13	n.s.	3.27	$p < 0.01$	1.25	n.s.	3.99	$p < 0.01$
12	Urban Rural	1.31-3.98-3.01 1.69-3.81-3.24	1.37	n.s.	0.57	n.s.	3.88	$p < 0.01$	1.01	n.s.	0.89	n.s.
13	Urban Rural	1.37-3.87-3.55 1.62-3.84-2.94	1.69	n.s.	1.00	n.s.	2.93	$p < 0.01$	0.17	n.s.	2.68	$p<0.05$
14	Urban Rural	1.52-3.82-3.51 1.70-4.02-3.21	0.95	n.s.	1.32	n.s.	2.01	n.s.	1.50	n.s.	1.28	n.s.
15	Urban rural	1.94-4.31-2.80 1.89-3.89-3.10	1.18	n.s.	0.57	n.s.	0.42	n.s.	1.77	n.s.	1.66	n.s.
16	Urban Rural	1.86-4.12-2.92 1.88-4.10-3.06	0.67	n.s.	2.00	$p<0.05$	0.15	n.s.	0.10	n.s.	0.58	n.s.
17	Urban Rural	2.02-4.10-2.79 2.01-4.34-2.62	1.38	n.s.	0.41	n.s.	0.08	n.s.	1.11	n.s.	0.91	n.s.
18	Urban Rural	2.17-4.26-2.63 2.51-4.33-2.50	0.90	n.s.	0.10	n.s.	1.43	n.s.	0.48	n.s.	0.77	n.s.

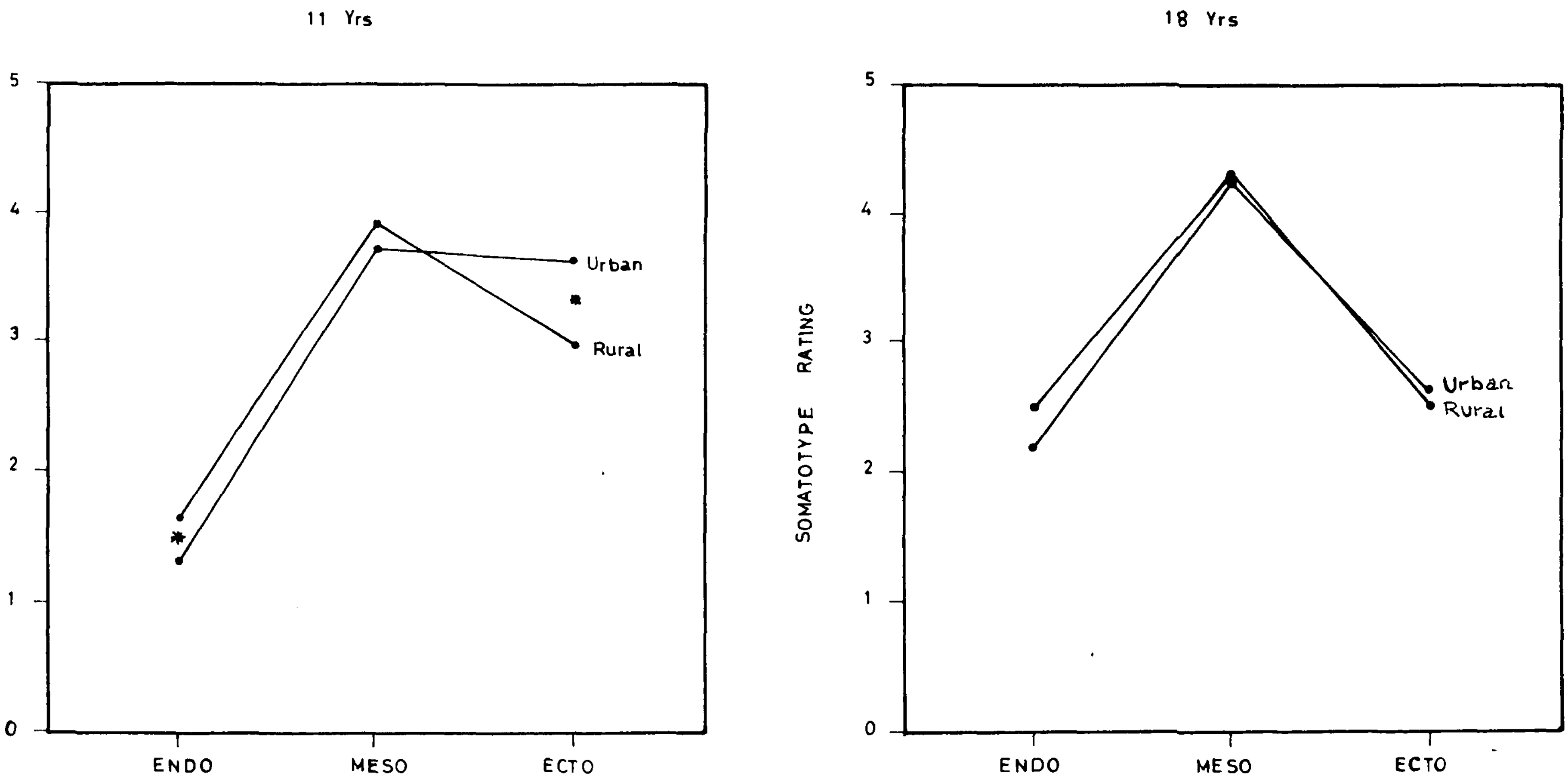
The comparative statistics used include t-ratio, F-ratio, and Chi-square. According to Carter et al. (1983), "The F- and t-ratios appear to be valid when the scatter of somatotypes about their mean is approximately uniform in all directions (i.e., circular). They are less likely to be valid when one or more samples of somatoplots is ~~are~~ asymmetrical (i.e., elliptical)." In the preceding analysis it is observed that ignoring a few extreme somatotypes for both urban and rural samples of the present study the scatter of somatotypes about their means is more or less uniform in all directions. Therefore, an attempt is being made here to find out somatotype similarities/differences between the urban and rural Pnar boys.

Mean Somatotypes: Table 8 shows age-wise urban-rural comparisons (t-values) based on mean somatotypes ($\overline{S}$), somatotype attitudinal means (SAM), and the three somatotype components (Endo, Meso, Ecto). Mean somatotypes reveal statistically significant differences between urban and rural samples at age 11 years only ($t = 2.48$, $p < 0.05$). At all other ages considered in the present study urban and rural Pnar boys are observed to have similar somatotypes. For somatotype attitudinal means the urban-rural difference is statistically significant at age 16 years only ($t = 2.00$, $p < 0.05$). Among the three somatotype components,

Table 9. Total frequency and percentage of Urban and Rural boys in various somatotype categories.

Sl. No.	Somatotype Categories	Urban f	Urban %	Rural f	Rural %	$\frac{(f_1-f_2)^2}{ft}$
1.	Balanced endomorph	-	-	-	-	-
2.	Mesomorphic endomorph	-	-	1	0.39	.002
3.	Mesomorph-endomorph	-	-	5	1.95	.049
4.	Endomorphic mesomorph	9	3.55	10	3.91	.002
5.	Balanced mesomorph	77	30.44	90	35.16	.332
6.	Ectomorphic mesomorph	39	15.42	30	11.72	.159
7.	Mesomorph-ectomorph	99	39.13	103	40.23	.031
8.	Mesomorphic ectomorph	24	9.49	14	5.47	.196
9.	Balanced ectomorph	5	1.76	3	1.17	.007
10.	Endomorphic ectomorph	-	-	-	-	-
11.	Endomorph-ectomorph	-	-	-	-	-
12.	Ectomorphic endomorph	-	-	-	-	-
13.	Central	-	-	-	-	-
	Total	253		256		X^2=.778 n.s.

FIG.1 4 COMPOGRAM SHOWING URBAN RURAL COMPARISONS IN MEAN COMPONENT RATING AT AGE 11 AND 18 YEARS ($* P < 0{\cdot}05$)



Mesomorphy shows similar mean values for urban and rural samples at all ages considered. At age 11, 12 and 13 urban and rural boys reveal significantly different (Table 8) values for mean Endomorphy, while from 14 to 18 years both samples do not differ with regard to this component. On the other hand, the urban and rural boys are similar in their Ectomorphy component at almost all ages except at age 11 ($t = 3.99$, $p < 0.01$) and 13 years ($t = 2.68$, $p < 0.05$) where the two samples show statistically significant differences. An overall perusal of Table 8 reveals that urban-rural differences assume statistical significance only during the earlier years (i.e., 11, 12, 13) for two components, while the mean somatotypes of both urban and rural boys are almost similar from age 14 upto 18 years (also see Fig. 14).

Somatotype Categories: Total frequency and percentage of somatotype categories in the urban and rural samples are compared and the X^2 values presented in Table 9. It is obvious from these results that the overall distribution of somatotypes into various categories are more or less similar between the urban and rural samples.

Per cent Overlap: In order to visualize the extent of commonality between urban and rural samples of the present study, a graphical comparison of somatotype distributions is made. For this 100% of somatoplots of the two samples are taken, and Figures 5 to 12 represent the somatocharts showing limits and overlap of somatotypes between urban and rural Pnar boys, at each age from 11 to 18 years. The percentage of overlap is listed under each figure. It can be seen that the minimum overlap (53.12%) occurs at age 11, and the maximum overlap (85.29%) is seen at age 14 years. Ignoring the extreme somatoplots, almost all distributions of the two samples are more or less circular in shape and are lying above the ectomorphy axis in the ecto-mesomorphy region. The area of overlap shows a tendency to shift from upper axis of endomorphy towards upper axis of mesomorphy with advancing age. On the basis of per cent overlap it may be said that in general the younger age groups (11, 12, 13 years) show less commonality while the older age groups (14, 15, 16, 17, 18 years) of Pnar boys show more commonality between urban and rural samples of the present study.

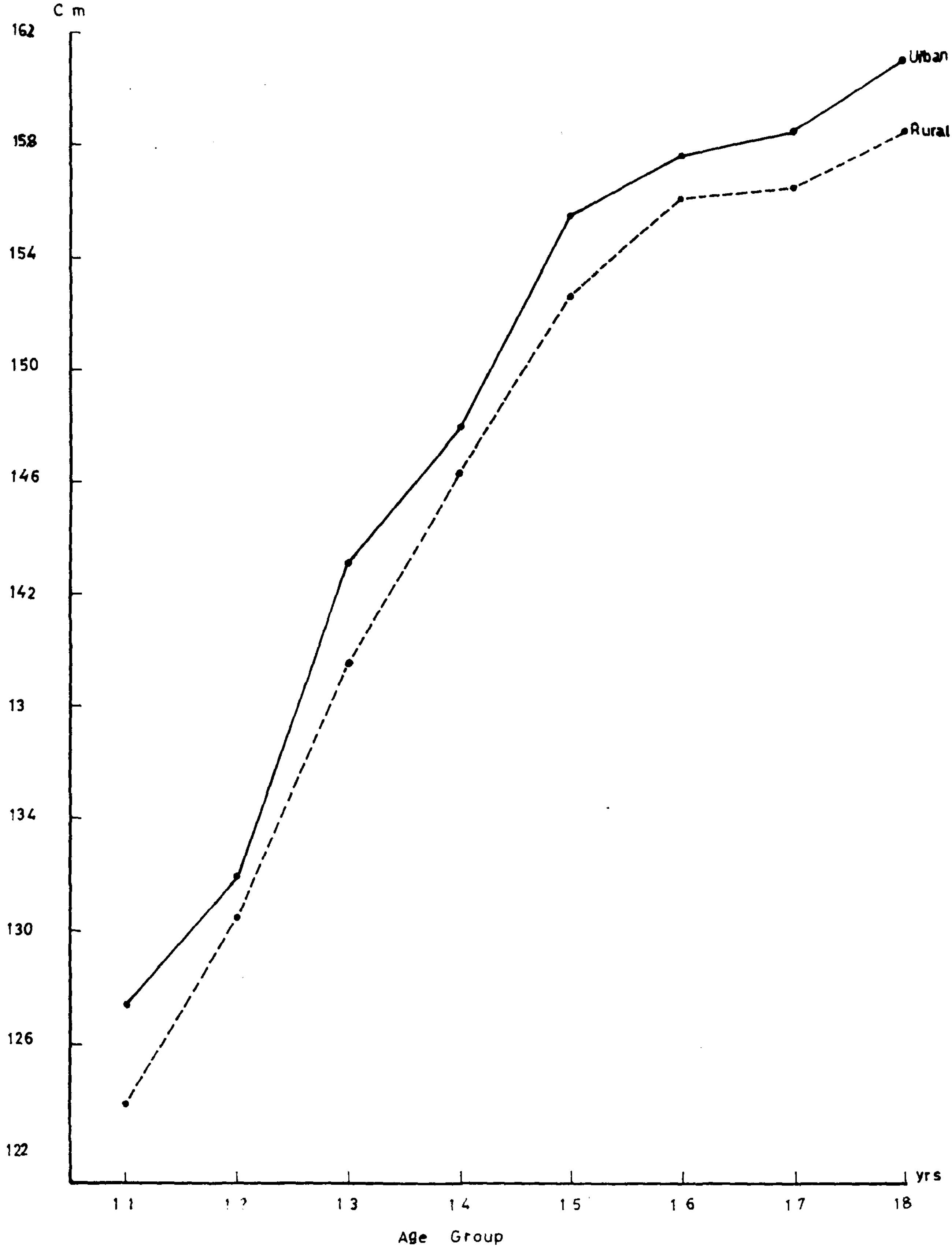
Age, Height, Weight and Height-Weight Ratio

The type and extent of analysis of somatotype data depends on the purpose of the study. According to Carter and Heath (1990) descriptive statistics and somatocharts (as already discussed) should be the minimum for any study, and 'to provide further information on each sample'

Table 10. Descriptive statistics for Age (years) in urban and rural Pnar boys.

Age Group	Urban				Rural			
	N	$\bar{X}$	± SD	CV	N	$\bar{X}$	± SD	CV
11	32	11.04	0.25	2.217	32	11.02	0.22	1.949
12	31	12.10	0.21	1.742	32	12.06	0.22	1.856
13	33	13.08	0.29	2.189	32	13.07	0.20	1.544
14	31	14.01	0.26	1.839	34	14.07	0.25	1.774
15	33	15.05	0.31	2.072	32	15.04	0.23	1.551
16	30	16.06	0.26	1.619	31	16.00	0.27	1.706
17	30	16.98	0.22	1.297	31	17.07	0.23	1.332
18	33	17.98	0.28	1.567	32	17.95	0.25	1.386

FIG.15 HEIGHT



descriptive statistics 'should be calculated routinely for age, height, weight and the HWR'. In view of this, the information on the above four variables in the urban and rural samples is being presented here.

Age: The descriptive statistics for age are presented in Table 10, for both urban and rural samples. It can be seen from the table that the mean age for all age groups lies almost at the completed years, i.e., 11, 12, 13 years; or in other words, at the central point of the range of decimal age considered, for example, 11 is at the centre between 10.500 and 11.499. Further the intra-sample variability for age groups is very small for all the age groups of the two samples, the value of coefficient of variation lying between 1.297 and 2.217 for various age groups of urban boys, and, between 1.332 and 1.949 for the rural boys.

Height (Table 11, Fig. 15): It is clear from the table and the figure that the urban boys are relatively taller than their rural counterparts at all the ages considered in the present study. However, in both these samples there is a sharp increase in mean height between 11 and 15 years of age, while a relatively lesser increase in mean height is observed from 15 to 18 years of age. In both urban and rural boys the greatest addition to mean height

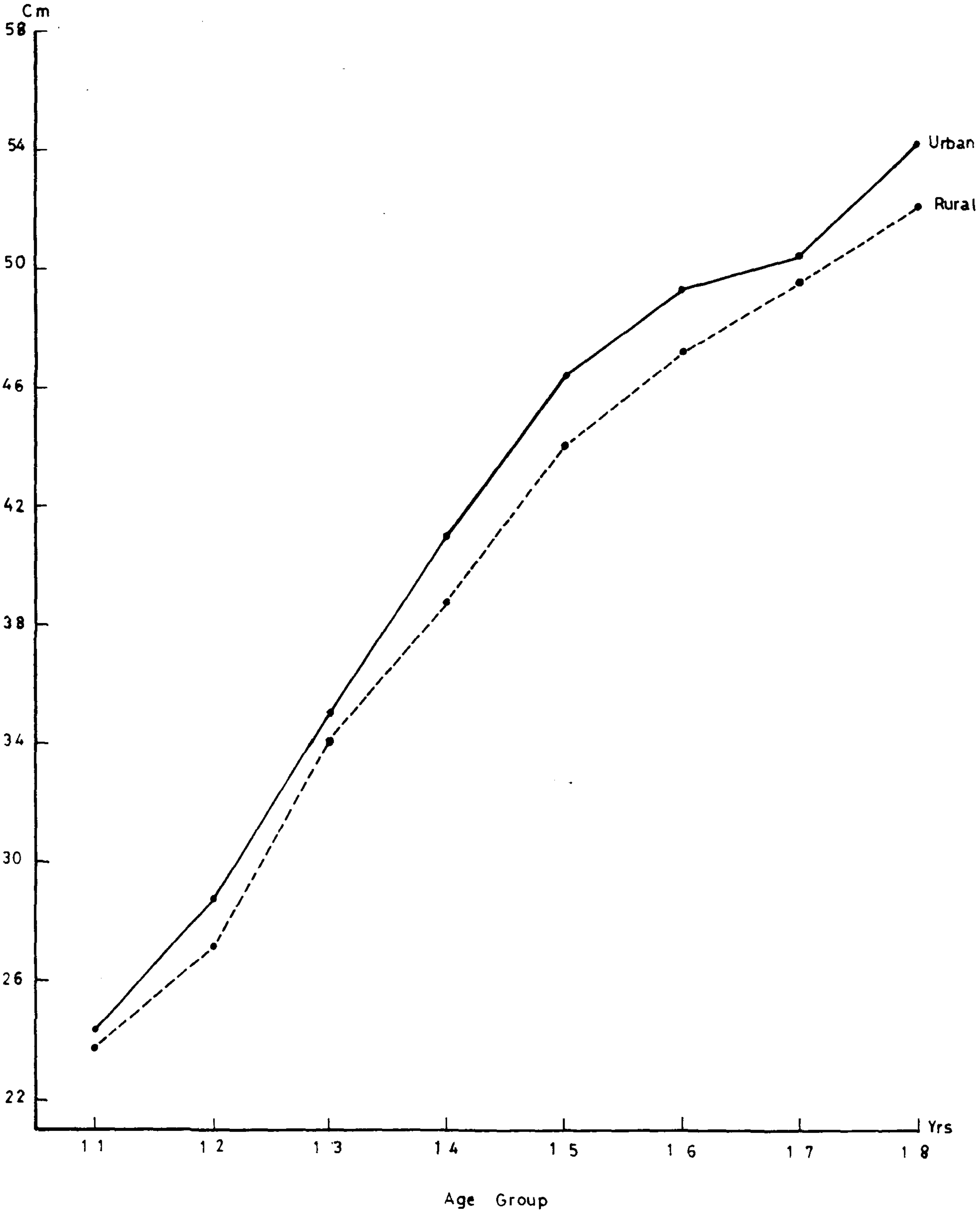
Table 11. Descriptive statistics for height (cm) in urban and rural Pnar boys.

Age Group	Urban			Rural		
	$\overline{X}$	± SD	CV	$\overline{X}$	± SD	CV
11 Yr	127.40	4.21	3.305	123.92	4.27	3.446
12 Yr	131.94	5.65	4.282	130.55	4.87	3.730
13 Yr	143.12	6.81	4.758	139.45	5.71	4.095
14 Yr	147.88	6.78	4.585	146.28	7.67	5.243
15 Yr	155.40	5.04	3.243	152.58	5.87	3.847
16 Yr	157.59	4.19	2.659	156.00	4.31	2.763
17 Yr	158.33	3.79	2.394	156.38	4.32	2.763
18 Yr	160.92	4.71	2.927	158.28	4.39	2.774

Table 12. Descriptive statistics for weight (kg) in urban and rural Pnar boys.

Age Group	Urban			Rural		
	$\overline{X}$	± SD	CV	$\overline{X}$	± SD	CV
11 Yr	24.38	2.39	9.803	23.78	1.96	8.242
12 Yr	28.87	4.08	14.132	27.13	3.18	11.721
13 Yr	35.03	5.37	15.901	34.13	4.16	12.189
14 Yr	41.07	5.52	13.441	38.86	5.76	14.938
15 Yr	46.36	4.41	9.513	44.16	5.51	12.477
16 Yr	49.33	4.68	9.487	47.16	3.34	7.082
17 Yr	50.40	4.32	8.571	49.55	5.16	10.414
18 Yr	54.21	4.24	7.821	52.03	4.53	8.687

FIG.16 WEIGHT



occurs from 12 to 13 years of age. From 11 to 18 years, the mean height of urban boys increases by 33.53 cm (or 26.31%), while in the rural boys this increase is slightly more, i.e., 34.36 cm (or 27.73%). It can be seen from the table that the intra-sample variability for height is not very large, the values for coefficient of variation ranging from 2.394 to 4.758 for age groups of urban boys, and 2.763 to 5.243 for age groups of rural boys.

Weight (Table 12, Fig. 16): The age group-wise changes in the mean weight of both urban and rural samples reveals almost a similar pattern as observed for height. The distance curves plotted for the urban as well as rural samples show a sharp increase in mean weight from 12 to 15 years, whereas, from 15 to 18 years this increase is relatively less. Once again the urban boys are ahead of their rural counterparts in possessing larger mean weight at all the age groups considered. As seen in the case of height, mean weight also show the greatest increase between 12 and 13 years of age in urban as well as rural sample. From 11 to 18 years the mean weight increases by almost 122% (29.83 kg) in urban boys and slightly less, i.e., 119% (28.25 kg) in rural boys. It can be seen from the table that age groups 12, 13, 14 of urban samples and 12, 13, 14, 15 of rural samples show relatively greater intra sample variability for weight.

Table 13. Descriptive statistics for Heigh-Weight Ratio (HWR) in urban and rural Pnar boys.

Age Group	Urban				Rural			
	N	$\bar{X}$	± SD	CV	N	$\bar{X}$	± SD	CV
11 Yr	32	44.03	0.85	1.933	32	43.12	0.93	2.152
12 Yr	31	43.13	1.50	3.474	32	43.45	1.25	2.864
13 Yr	33	43.88	1.18	2.690	32	43.05	1.28	2.971
14 Yr	31	43.83	1.33	3.028	34	43.41	1.19	2.735
15 Yr	33	42.84	1.02	2.389	32	43.28	1.50	3.469
16 Yr	30	43.04	1.48	3.440	31	43.21	1.04	2.414
17 Yr	30	42.88	1.44	3.350	31	43.00	1.25	2.899
18 Yr	33	42.63	1.02	2.384	32	42.45	0.98	2.311

Table 14. **Age-wise comparisons (t-values) for mean Height and Weight in urban and rural Pnar boys.**

Age groups compared	Height				Weight			
	Urban boys		Rural boys		Urban boys		Rural boys	
11-12 Yrs	-3.550	$p < 0.01$	-5.699	$p < 0.01$	-5.223	$p < 0.01$	-4.993	$p < 0.01$
12-13 Yrs	-7.052	$p < 0.01$	-6.632	$p < 0.01$	-5.105	$p < 0.01$	-7.222	$p < 0.01$
13-14 Yrs	-2.757	$p < 0.01$	-4.033	$p < 0.01$	-4.363	$p < 0.01$	-3.710	$p < 0.01$
14-15 Yrs	-4.931	$p < 0.01$	-3.703	$p < 0.01$	-4.175	$p < 0.01$	-3.769	$p < 0.01$
15-16 Yrs	-1.865	n.s.	-2.521	$p < 0.05$	-2.542	$p < 0.05$	-2.592	$p < 0.05$
16-17 Yrs	-0.717	n.s.	-0.327	n.s.	-0.920	n.s.	-2.140	$p < 0.05$
17-18 Yrs	-2.392	$p < 0.05$	-1.724	n.s.	-3.502	$p < 0.01$	-1.992	n.s.

Height-Weight Ratio: Age group-wise mean, standard deviation and coefficient of variation for HWR are presented in Table 13. The mean HWR of 11 year old urban boys is 44.03 and at 18 years of age the mean HWR value falls to 42.63. In the rural boys the mean HWR values are 43.12 and 42.45 at age 11 and 18 years respectively. As observed for height and weight, the intra-sample variability are low for height-weight ratio also. In the urban sample the value of coefficient of variation ranges between 1.933 and 3.474, while in the rural sample it varies between 2.152 and 3.469.

Age Changes in Height and Weight

Age-wise comparisons for mean height and weight in urban and rural boys are presented in Table 14. It is clear from the t-values and their statistical significance that mean height as well as weight in both urban and rural samples change significantly from age 11 to 12, 12 to 13, 13 to 14, and 14 to 15 years. While the urban boys do not show any statistically significant difference in their mean height from age 15 to 16, and 16 to 17 years, the mean height in rural sample differs significantly from age 15 to 16 years. Once again it is the urban sample which reveals statistically significant changes in mean height and weight from 17 to 18 years of age.

Table 15. Age-wise Urban-Rural comparisons (t-values) for mean Height and Weight of Pnar boys.

Age Group	Height		Weight	
11	3.231	$p < 0.01$	1.081	n.s.
12	1.028	n.s.	1.854	n.s.
13	2.295	$p < 0.05$	0.731	n.s.
14	0.879	n.s.	1.562	n.s.
15	2.043	$p < 0.05$	1.770	n.s.
16	1.133	n.s.	2.079	$p < 0.05$
17	1.609	n.s.	0.692	n.s.
18	2.302	$p < 0.05$	1.971	n.s.

Urban-Rual Comparison for Height and Weight

Table 15 presents age-wise comparisons for mean height and weight between urban and rural samples. The statistical differences do not reveal any consistent trend in the two samples. However, statistically significant differences in the mean height between urban and rural boys are observed at age 11, 13, 15 and 18 years. Mean weight of urban and rural samples appear to be almost similar at all ages considered, except at age 16 years where the t-value happens to be statistically significant.

CHAPTER VI

DISCUSSION

The present study was undertaken to report the somtotypes of Pnar boys of Meghalaya. One of the objectives of the study was to explore age changes in mean somatotypes of the boys as they grow from 11 to 18 years. The results presented in the previous chapter has shown that though urban as well as rural Pnar boys are ecto-mesomorphic at all ages considered in the study, however, some statistically significant age changes are observed for each component values among various age group comparisons in the two samples. The urban-rural somatotype comparison has shown that the two samples differ only at age 11 and 13 years (and that too only for endomorphy and ectomorphy) and at age 12 years for endomorphy alone. The percent overlap of somatotype distributions presented earlier has also shown a great commonality between urban and rural samples of this study. In view of the above it was thought proper to pool the two samples (urban and rural) according to age for further analysis, interpretation and comparison with other studies.

Somatotype Distribution of Pooled Sample

Mean Somatotypes: Table 16 presents various statis-

Table 16. Age-wise statistics for somatotypes of pooled (urban + rural) sample.

Age	N	Statistics	Somatotype			Two Dimensions Plot Coordinates		SDM	Three Dimensions
			Endomorphy	Mesomorphy	Ectomorphy	X	Y		SAM
11	64	Mean	1.47	3.85	3.32	1.85	2.89	2.01	1.11
		Variance	0.22	0.28	0.52	1.11	2.22	1.46	0.37
		SD	0.47	0.53	0.72	1.05	1.49	1.21	0.61
12	63	Mean	1.51	3.89	3.13	1.62	3.18	2.39	1.64
		Variance	0.18	0.42	1.00	2.67	66.48	2.34	1.12
		SD	0.42	0.65	1.00	1.63	8.15	1.53	1.06
13	65	Mean	1.49	3.86	3.25	1.76	2.98	4.58	1.51
		Variance	0.12	0.49	0.87	2.17	18.05	10.03	0.62
		SD	0.35	0.70	0.93	1.47	4.25	3.17	0.79
14	65	Mean	1.62	3.92	3.35	1.74	2.88	4.77	1.54
		Variance	0.13	0.50	0.85	2.37	44.82	33.21	0.53
		SD	0.36	0.71	0.92	1.54	6.69	5.76	0.73
15	65	Mean	1.92	4.09	2.95	1.02	3.31	5.04	1.56
		Variance	0.22	0.55	0.87	5.84	37.48	31.16	0.90
		SD	0.46	0.74	0.93	2.42	6.12	5.58	0.95
16	61	Mean	1.87	4.11	2.99	1.12	3.35	2.57	1.49
		Variance	0.26	0.56	0.83	10.01	43.68	2.66	0.85
		SD	0.51	0.75	0.91	3.16	6.61	1.63	0.92
17	61	Mean	2.02	4.23	2.72	0.71	3.76	2.60	1.57
		Variance	0.21	0.55	0.93	6.08	52.06	2.67	0.69
		SD	0.46	0.74	0.97	2.46	7.22	1.64	0.83
18	65	Mean	2.34	4.30	2.57	0.15	3.68	2.34	1.41
		Variance	0.87	0.42	0.53	20.60	3.21	2.77	0.71
		SD	0.93	0.65	0.73	4.54	1.79	1.66	0.84

FIG.17 AGE WISE SOMATOTYPE COMPONENT VARIATION IN PNAR BOYS

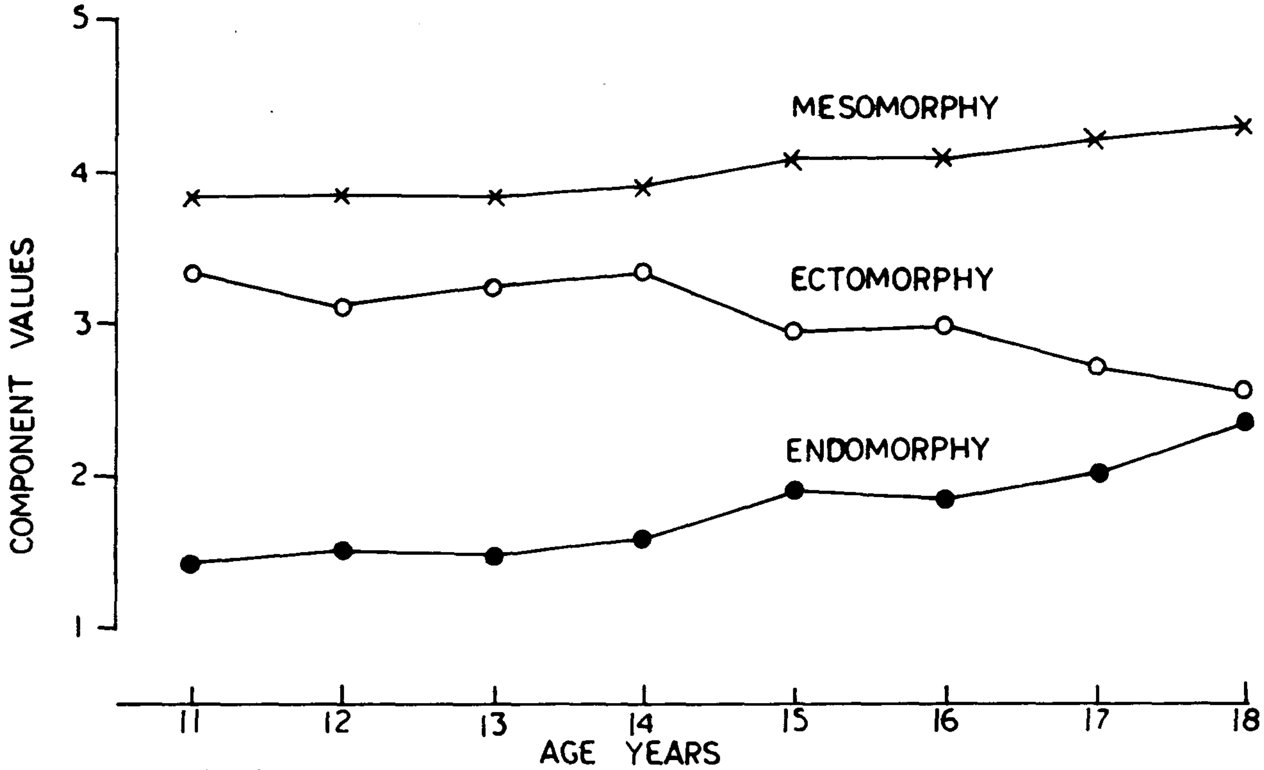
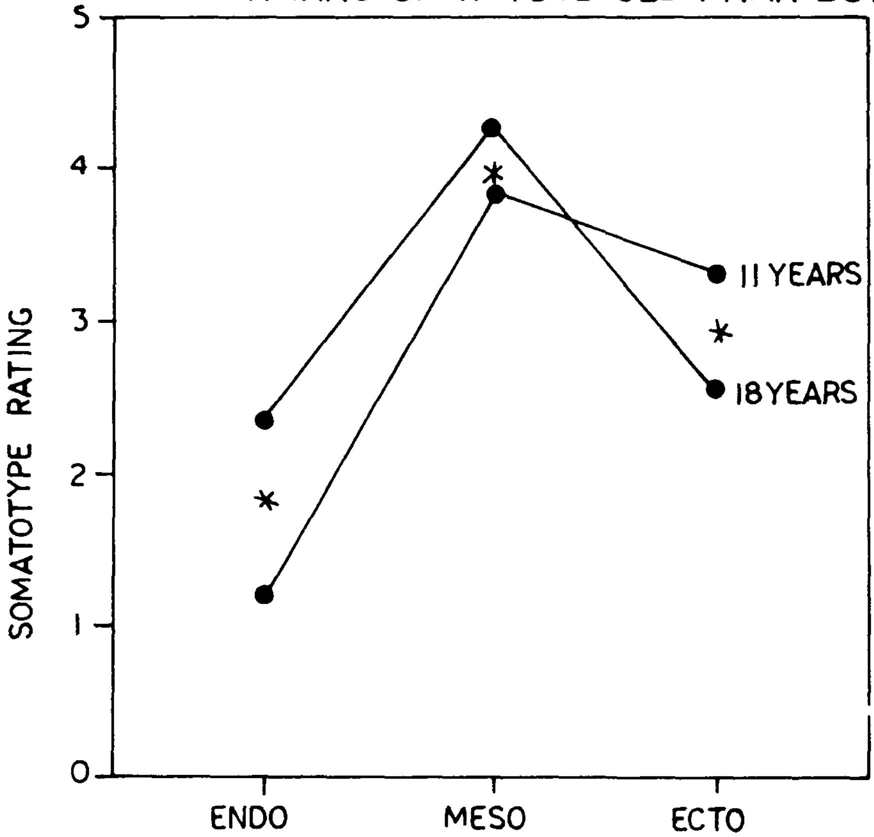


FIG 18 COMPOGRAM SHOWING AGE CHANGES IN MEAN COMPONENT RATING OF 11 TO 18 OLD PNAR BOYS (*P<0·05)



tics for somatotypes of pooled (urban + rural) sample of 509 Pnar boys ranging in age from 11 to 18 years. It is clear from the table that from age 11 through 18 years the Pnar boys remain ecto-mesomorphic. However, from the youngest to the oldest age group considered, the mean values of all the three components change gradually. That is, while mean values of endomorphy and mesomorphy increase, and that of ectomorphy decrease with growing age. Among the three components, mean values for mesomorphy dominate, while that of endomorphy remain lowest at all ages. On the whole, the Pnar boys' physique could be described as showing a high musculo-skeletal development with relatively least fat.

From 11 to 18 years of age, an overall increase of 0.87 units in endomorphy, 0.45 unit increase in mesomorphy, and 0.75 unit decrease in ectomorphy is seen in the mean component ratings. The values for somatotype dispersion means and somatotype attitudinal means (Table 16) indicate that the somatotypes at various ages considered do not differ in the dispersion about their means.

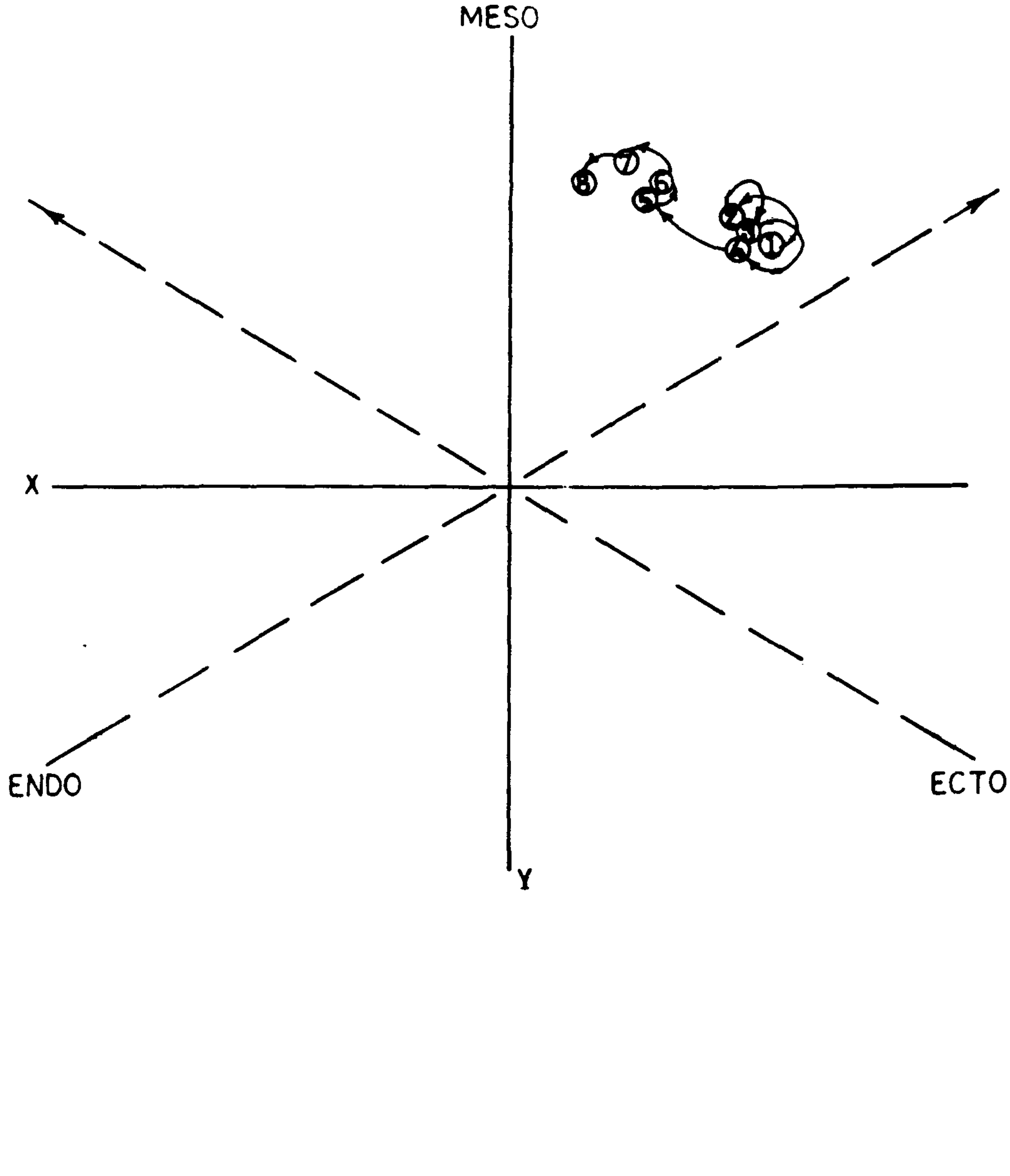
Fig. 17 presents age-wise component variation in the somatotypes of the pooled sample of Pnar boys. It is clear from the figure that though the Pnar boys of the present study are generally ecto-mesomorphic, they reveal age changes in the values of all the three components of their physique. The range of component ratings of the three components of 509 Pnar boys is 0.7 to 6.3 for endomorphy, 1.9 to 6.8 for mesomorphy, and 0.2 to 6.3 for ectomorphy. However, a majority of the subjects show values falling within the range of 1.0 - 2.0 for endomorphy, 3.0 - 5.0 for mesomorphy, and 2.0 - 4.0 for ectomorphy.

Somatotype Categories: The age-wise frequency and percentage of Pnar boys (pooled sample) falling into various somatotype categories is listed in Table 17. All 509 boys are found to be distributed among 8 out of the total of 13 somatotype categories. At age 11, 12, 13 and 14 years a majority of the boys fall under the Mesomorph-Ectomorph category. At age 15 and 16 most of the boys are almost equally distributed into two categories, i.e., Mesomorph-Ectomorph and Balanced mesomorph. However, at least 50% of the boys at age 17 as well as 18 years fall under the Balanced mesomorph category. Considering all the age groups together, a majority of somatotypes of the pooled sample of 509 Pnar boys fall under Mesomorph-Ectomorph (39.66%), followed by Balanced mesomorph (32.81%), Ectomorph mesomorph (13.56%), Mesomorph-ectomorph (7.46%), Endomorphic-mesomorph (3.73%), Balanced ectomorph (1.57%), Mesomorph-endomorph (0.98%), and Mesomorphic-endomorph (0.20%).

Table 17. Age-wise frequency and percentage of Pnar boys (pooled sample) in various somatotype categories.

Sl. No.	Somatotype Categories	AGE GROUP							
		11 year	12 year	13 year	14 year	15 year	16 year	17 year	18 year
		f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)	f (%)
1.	Balanced endomorph	-	-	-	-	-	-	-	-
2.	Mesomorphic endomorph	-	-	-	-	-	-	-	1(1.54)
3.	Mesomorph-endomorph	-	-	-	-	-	-	-	5(7.69)
4.	Endomorphic mesomorph	-	-	1(1.54)	-	4(6.15)	4(6.56)	5(8.20)	5(7.69)
5.	Balanced mesomorph	12(18.75)	17(26.98)	13(20.00)	15(23.08)	24(36.92)	22(36.07)	31(50.82)	33(50.77)
6.	Ectomorphic mesomorph	7(10.94)	13(20.63)	12(18.46)	10(15.38)	11(16.92)	5(8.20)	7(11.47)	4(6.15)
7.	Mesomorph-ectomorph	42(65.62)	26(41.27)	27(41.54)	32(49.23)	21(32.31)	25(40.98)	14(22.95)	15(23.08)
8.	Mesomorphic ectomorph	3(4.69)	7(11.11)	10(15.38)	7(10.77)	3(4.61)	4(6.56)	2(3.28)	2(3.08)
9.	Balanced ectomorph	-	-	2(3.08)	1(1.54)	2(3.08)	1(1.64)	2(3.28)	-
10.	Endomorphic ectomorph	-	-	-	-	-	-	-	-
11.	Endomorph-ectomorph	-	-	-	-	-	-	-	-
12.	Ectomorph endomorph	-	-	-	-	-	-	-	-
13.	Central	-	-	-	-	-	-	-	-

FIG. 19 GENERAL PATHWAY OF SOMATOTYPES OF PNAR BOYS FROM 11 YEARS TO 18 YEARS (NUMBER 1 TO 8)



Age Changes in Somatotypes

After pooling the urban and rural samples once again the data on mean somatotypes and somatotype categories is subjected to t-test and chi-square test in order to find out if there are any significant age changes. It is clear from the t-values presented in Table 18 that mean endomorphy component show statistically significant differences among boys between age 13 and 14, 14 and 15 and 17 and 18 years. While mesomorphy does not reveal any significant age changes between successive age group comparisons, mean ectomorphy shows statistically significant difference between 14 and 15 years old boys. The last row of Table 18 shows t-values between age 11 and 18 years for mean component ratings, and the same is also depicted in Figure 18. It is obvious from this analysis that the mean somatotypes of 18 year old are significantly different from the 11 year old Pnar boys.

The general pathway of somatotypes of Pnar boys (pooled sample) aged 11 to 18 years is presented in Figure 19. The figure shows mean somatoplots (No. 1 to 8; 1 = 11 years, 2 = 12 years and so on) plotted on a somatochart according to scale. It is clear from the figure that the mean somatotype of Pnar boys at all age groups considered lies in the ectomorphy-mesomorphy region above the upper axis of endomorphy, and to the east of upper axis of mesomorphy. It can also be observed from the figure that from 11 to 18 years there is a shift of mean somatotypes from near upper axis of endomorphy towards near upper axis of mesomorphy. In other words, the shift takes place in the North-West direction almost parallel to ectomorphy axis. It is interesting to note that on the one hand, mean somatotypes of age groups 11, 12, 13 and 14 years tend to cluster together while those of 15, 16, 17 and 18 years tend to form another cluster. It may be recalled here that among various age group comparisons (Tables 6 and 18) the greatest number of statistically significant differences in mean somatotypes are observed to occur between age 14 and 15 years.

Age changes in somatotype categories are also presented in Table 18. It can be seen from the X^2 values that none of the successive age group comparison is statistically significant. The distribution of somatotypes into various categories also fail to reveal statistically significant differences between boys aged 11 and 18 years.

Several cross-sectional and longitudinal studies across the world have tried to probe age changes in

Table 18. Age changes in components of mean somatotypes (t-values) and somatotype categories (X^2 values) of Pnar boys (pooled sample).

Age groups compared	Somatotype Component						Somatotype Categories		
	Endomorphy t-value		Mesomorphy t-value		Ectomorphy t-value		X^2	d.f.	Significance
11-12 Yrs	-0.500		-0.378		+1.218		2.622	3	n.s.
12-13 Yrs	+0.290		+0.252		-0.698		0.235	5	n.s.
13-14 Yrs	-2.067	$p < 0.05$	-0.480		-0.613		0.318	5	n.s.
14-15 Yrs	-4.132	$p < 0.05$	-1.328		+2.454	$p < 0.05$	1.816	5	n.s.
15-16 Yrs	+0.573		-0.149		-0.242		0.460	5	n.s.
16-17 Yrs	-1.695		-0.882		+1.579		1.738	5	n.s.
17-18 Yrs	-2.460	$p < 0.05$	-0.560		+0.968		0.349	7	n.s.
11-18 Yrs	-6.662	$p < 0.01$	-4.286	$p < 0.01$	+5.814	$p < 0.01$	9.544	6	n.s.

somatotypes. Singh (1978) and Singh and Sidhu (1980) studied the changes in somatotypes of Gaddi Rajput boys aged 4 to 20 years, and found significant age changes in different components, specially in younger age groups, i.e., below 12 years. The study of 13 to 15 year old school boys from Bangalore by Rangan (1982) does not show significant inter-age differences in somatotype components. Bhasin and Singh (1991) reported non-significant age changes in the somatotypes of 8 to 18 year old Gujjar and Tibetan boys of Jammu and Kashmir. Similarly, the data on somatotypes of the Bodh and Balti boys aged 8 to 18 years obtained from Ladakh in Jammu and Kashmir (Bhasin and Singh, 1992) fail to reveal any significant change 'corresponding to adolescent growth spurt'. A recent study by Handa et al. (1995) on somatotype changes in Jat Sikh boys of Chandigarh aged 13 to 17 years, though acknowledges 'change in somatotype components as age progresses', but does not report if this change is statistically significant.

In longitudinal studies on stability of somatotypes of American aged 9 to 12 and 12 to 17 years. Sinclair (1966, 1969) found significant changes in the 12 to 17 years group. Parizkova and Carter (1976) found substantial individual somatotype changes in a yearly-interval longitudinal study on 11 to 17 year old boys from Prague. In another study in Prague, Bok & Tlapakova (1982) did not find great changes in whole somatotypes of boys aged 15, 16 and 17 years. Claessens (1981) while reporting on the stability of anthropometric somatotypes of 13-18 year old Belgian boys found high correlations between years, but lower correlation for the five year interval. Other longitudinal studies that attempted to find out age changes in somatotypes include those by Zuk (1958), Clarke (1971), Morton (1967), Heath and Carter (1971), and Toteva (1986). On the whole, various longitudinal studies show that individual as well as group somatotypes change with age.

Many cross-sectional studies carried out on different populations have also tried to answer the question regarding somatotype permanence. Duquet et al. (1975) and Duquet (1980) while studying 6 to 13 year old Belgian boys and girls found that in both sexes endomorphy and ectomorphy increased while mesomorphy decreased by age. Szmodis (1977) obtained anthropometric somatotypes of Hungarian children aged 5 to 17 years. He observed that from age 5 to 13 years the boys tend towards higher ectomorphy, and from age 14 to 17 years slightly more toward balanced ectomorphy-mesomorphy. An extensive growth study including children from age 6 to 18 years, conducted in a small town in

Hungary by Eiben (1985) shows significant differences in somatotype distributions with age. He (Eiben, 1985) observed that from age 6 years the mean somatoplots for boys moved towards greater ectomorphy by the early teens, and towards greater mesomorphy by age 18 years. The cross-sectional study in Hälopainen et al. (1984) on 7 to 16 year old children from Central Finland reveals that at the outset the boys show a mean balanced mesomorphy, followed by a tendency towards increasing ectomorphy and finally balanced ecto-mesomorphy at 14 to 16 years. Hälopainen et al., (1984) also found significant differences between somatotype categories by age. Age changes in somatotypes have also been studied on children from Belgium (Clarys et al., 1970; Stepnicka, 1976 b, c), Hungary (Farmosi, 1982; Bodzsar, 1982), America (Slaughter et al., 1980; Carter, 1958), Venezuela (Perez et al., 1985), Cuba (Amador et al., 1983), Brazil (Guedes, 1983), and Nigeria (Toriola and Igbokwe, 1985).

The results of various cross-sectional and longitudinal studies mentioned above show that somatotypes of children are subject to changes during adolescence. Some studies have also shown that the somatotypes of some children are fairly stable over some period of their growth. The present study also reveals stability of physique in Pnar boys from the period 11 to 13 years and 15 to 17 years, while significant changes are found in some components between age 13-14, 14-15 and 17-18. The overall 7-year interval age changes (from 11 to 18) in all the components of somatotype are highly significant. However, no significant changes in somatotype categories by age are observed among the present study. Generally speaking, the data given by various studies cited above show that after age 6 the boys tend to decrease in mesomorphy and increase slightly in ectomorphy into mid-adolescence, and thereafter, a reversal toward ecto-mesomorphy, balanced mesomorphy or endo-mesomorphy occurs. The results of the present study also agree in that towards late-adolescence the mean somatotypes of boys are toward ecto-mesomorphy, but the Pnar boys remain ecto-mesomorphic throughout adolescence though the mean values for mesomorphy and ectomorphy decrease while that for endomorphy increase from 11 to 18 years. Such a trend is expected since during adolescence, with increased muscle mass and complete ossification, mesomorphy increases and ectomorphy decreases. While acknowledging that many children change somatotypes and some children having relatively stable somatotypes, Carter and Heath (1990) feel that "with relatively unchanging patterns of diet and exercise the more ectomorphic somatotypes are the most stable."

Population Similarities/Differences

In order to evaluate population similarities/differences, one of the objectives of the present study was to compare the present findings with other such studies. Therefore, the somatotypes of Pnar boys (pooled sample) are compared with boys of comparable ages from other populations. The other populations compared are divided into two groups, one, populations within India, and two, populations outside India.

Populations within India

A majority of the studies carried out within the country report somatotypes on populations of North India. Some of these are caste populations while a few are tribe populations. Most of these studies have followed the Heath-Carter method of somatotyping. Different studies have presented findings on different age groups. However, out of a total of thirteen studies which are being compared five studies present mean somatotypes at age groups similar to the present study (i.e., 11 to 18 years), while eight studies report findings on lesser number of age groups but falling within the age range of 11 to 18 years.

Table 19 presents age-wise comparison of mean somatotypes of Pnar boys with other studies on Indian

Table: 19 AGE-WISE COMPARISIONS OF MEAN SOMATOTYPES OF PNAR BOYS (POOLED SAMPLE) WITH OTHER STUDIES OF INDIAN POPULATION

Age group	1 Present Study			2 Bhasin&Singh (91)			3 Bhasin&Singh (91)			4 Bhasin&Singh (92)			5 Bhasin&Singh (92)			6 Bhasin&Singh (80)			7 Kansal (81)		
Years	Pnar Boys			Tibetan (J.K.)			Gujjars (J.K.)			Bodhs of Ladakh (J.K.)			Baltis of Ladakh (J.K.)			Gaddi Rajput (H.P.)			Jat-Sikh (Punjab)		
	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto
11.0	1.5	3.9	3.3	2.0	3.8	3.9	1.9	3.1	5.0	1.6	3.4	3.9	1.3	3.1	3.9	1.6	3.3	4.1	-	-	-
12.0	1.5	3.9	3.1	2.1	3.5	4.1	1.5	2.9	5.4	1.5	3.3	4.4	1.3	3.1	4.2	1.4	3.1	4.8	1.7	3.1	5.3
13.0	1.5	3.9	3.3	1.9	3.2	4.5	1.3	3.1	5.2	1.4	3.4	4.2	1.2	3.0	4.4	1.5	3.0	4.7	-	-	-
14.0	1.6	3.9	3.4	1.9	3.8	3.9	1.9	3.5	4.6	1.5	3.2	4.4	1.3	2.8	4.8	1.6	3.1	4.8	1.7	3.1	5.3
15.0	1.9	4.1	3.0	1.9	3.7	3.8	1.6	2.8	5.3	1.2	3.1	4.6	1.2	2.8	4.8	1.7	3.2	4.6	-	-	-
16.0	1.9	4.1	3.0	1.9	3.6	4.1	1.5	2.9	5.0	1.7	3.3	4.0	1.3	2.7	4.8	1.6	3.3	4.5	1.8	2.9	5.2
17.0	2.0	4.2	2.7	1.9	3.5	3.9	1.7	3.1	5.0	1.9	3.6	4.9	1.6	3.0	4.3	1.7	3.1	4.5	-	-	-
18.0	2.3	4.3	2.6	1.7	3.4	4.1	1.8	3.1	4.9	1.6	3.5	3.9	1.6	3.7	4.5	1.8	3.4	4.1	2.1	2.9	4.8

Contd...

8 Kansal (81)			9 Rangan (82)			10 Handa *et al* (95)			11 Singh&Singh (91)			12 Singh&Singh (91)			13 Singh&Bhasin (90)			14 Sethi&Sidhu (92)		
Bania (Punjab)			(Bangalore)			Jat-Sikh (Chandigarh)			Brahmin (Chandigarh)			Rajput (Chamba)			Dogra Brahmin (J.K.)			Punjabi (Patiala)		
Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.5	3.1	4.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	3.4	2.6	4.9	3.1	3.0	4.1	2.4	3.1	4.6	2.4	2.0	4.2	1.5	2.9	5.7	1.9	2.9	3.9
2.0	2.9	5.2	3.2	2.6	5.0	3.7	2.7	4.5	2.1	2.8	4.7	2.2	2.7	4.9	1.6	2.7	5.5	1.8	2.9	4.4
-	-	-	3.2	6.4	4.8	3.9	2.9	4.1	2.2	3.1	4.3	2.4	3.5	3.4	1.7	2.8	5.2	2.3	2.8	3.9
2.1	2.9	5.0	-	-	-	3.6	2.5	4.2	2.2	2.4	4.8	2.0	2.9	4.3	1.6	2.5	5.5	2.2	2.4	4.4
-	-	-	-	-	-	3.6	2.4	4.2	2.7	2.9	4.1	2.2	2.7	4.5	1.6	2.6	5.4	2.5	2.6	3.8
2.7	3.0	4.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.5	2.7	3.6

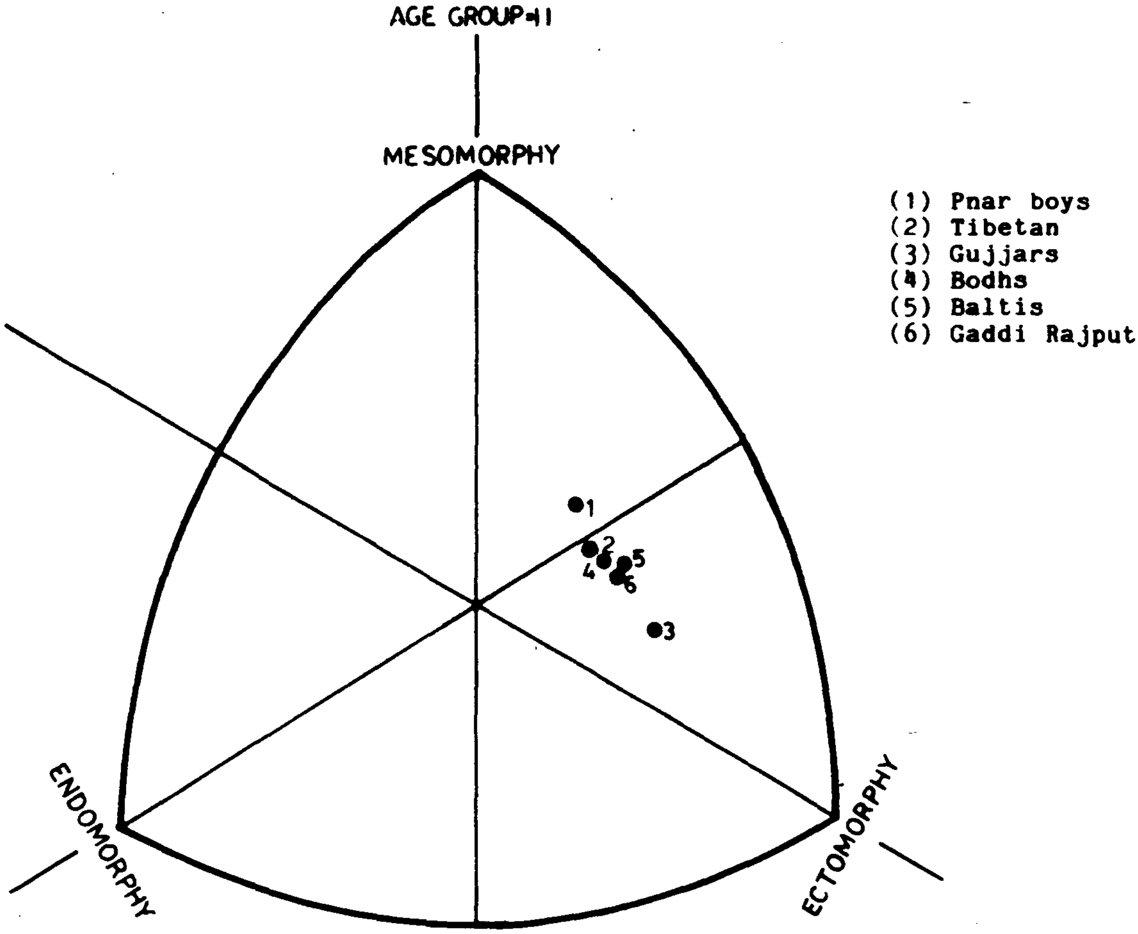


Fig. 20. Comparison of mean somatotypes of Pnar boys with other studies on Indian populations.

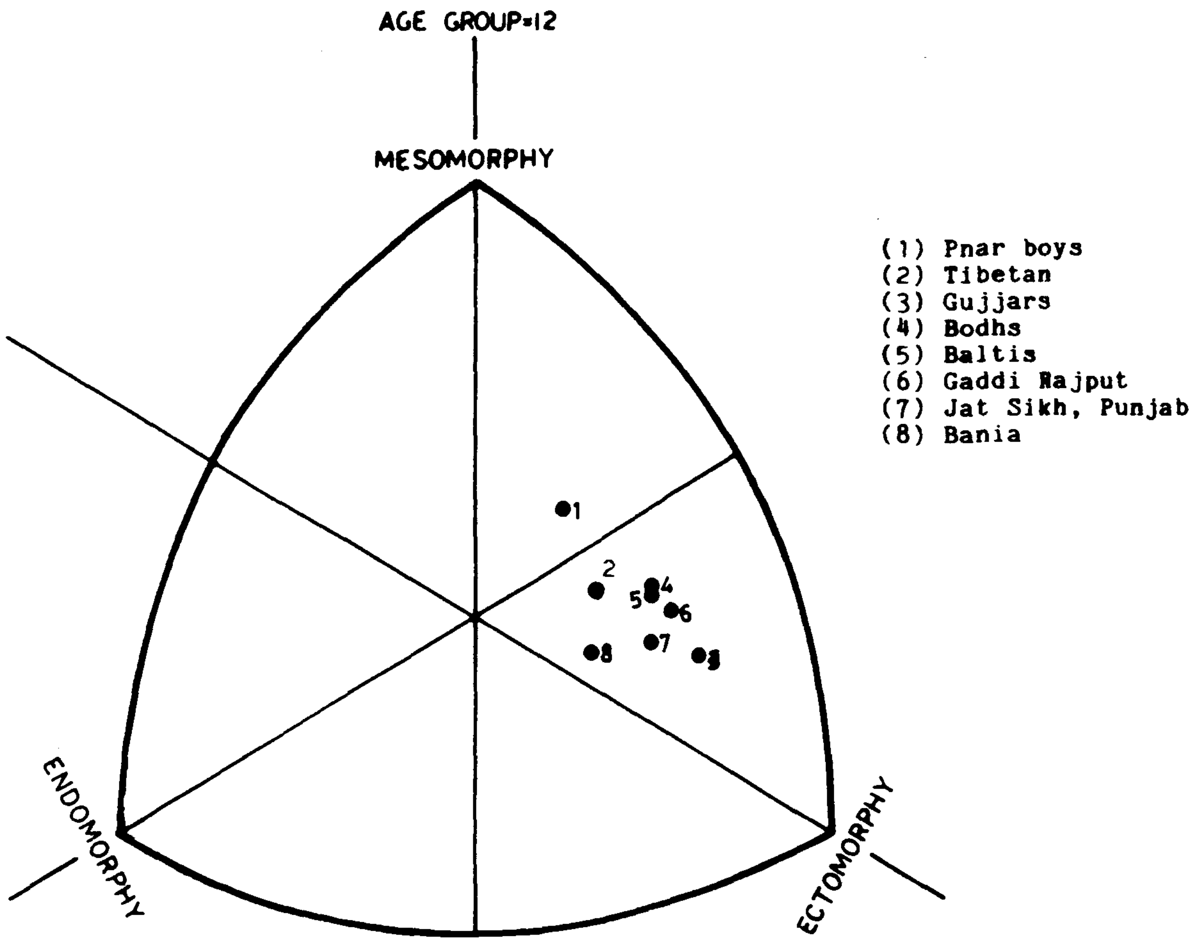


Fig. 21. Comparison of mean somatotypes of Pnar boys with other studies on Indian populations.

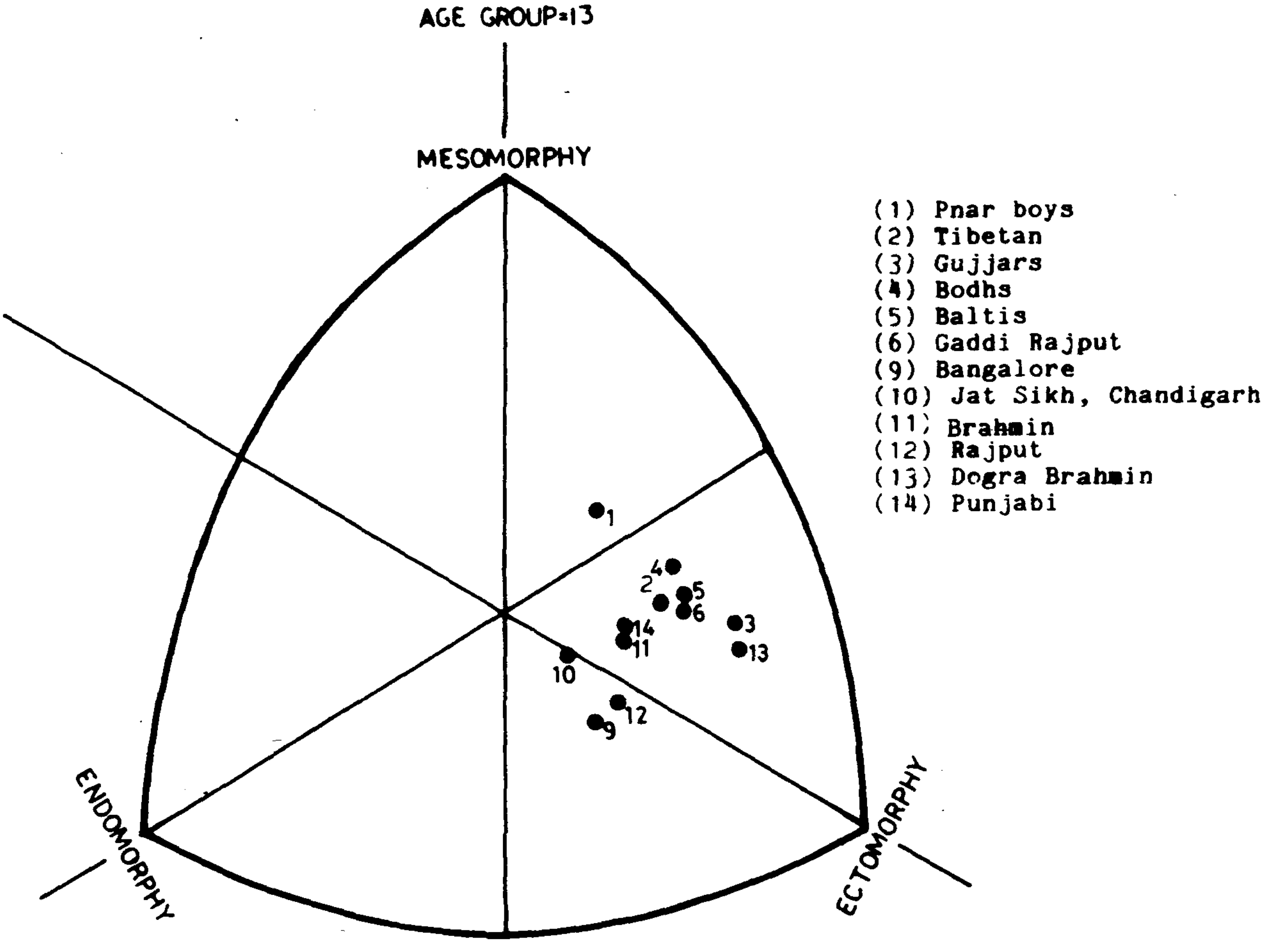


Fig. 22. Comparison of mean somatotypes of Pnar boys with other studies on Indian populations.

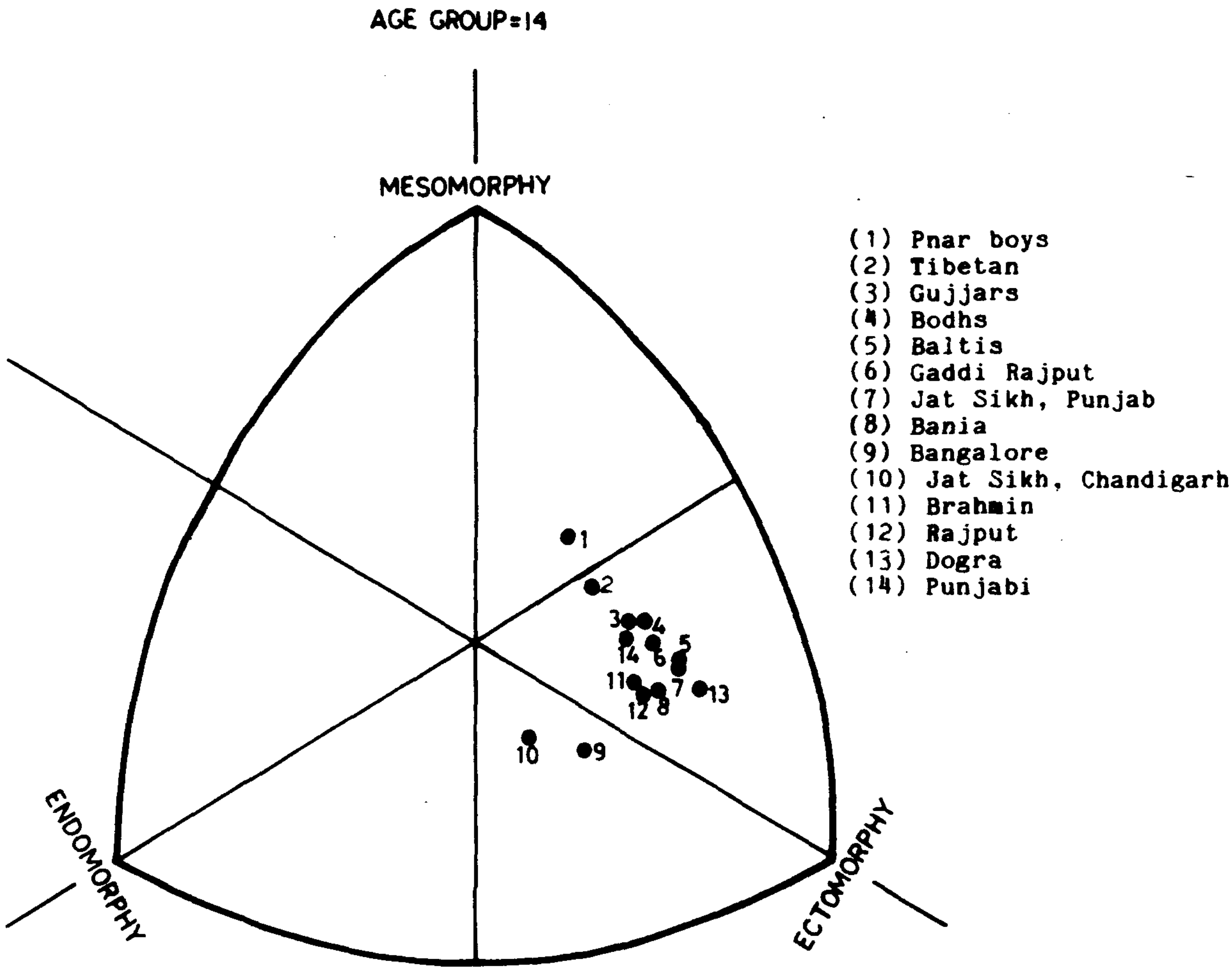


Fig. 23. Comparison of mean somatotypes of Pnar boys with other studies on Indian populations.

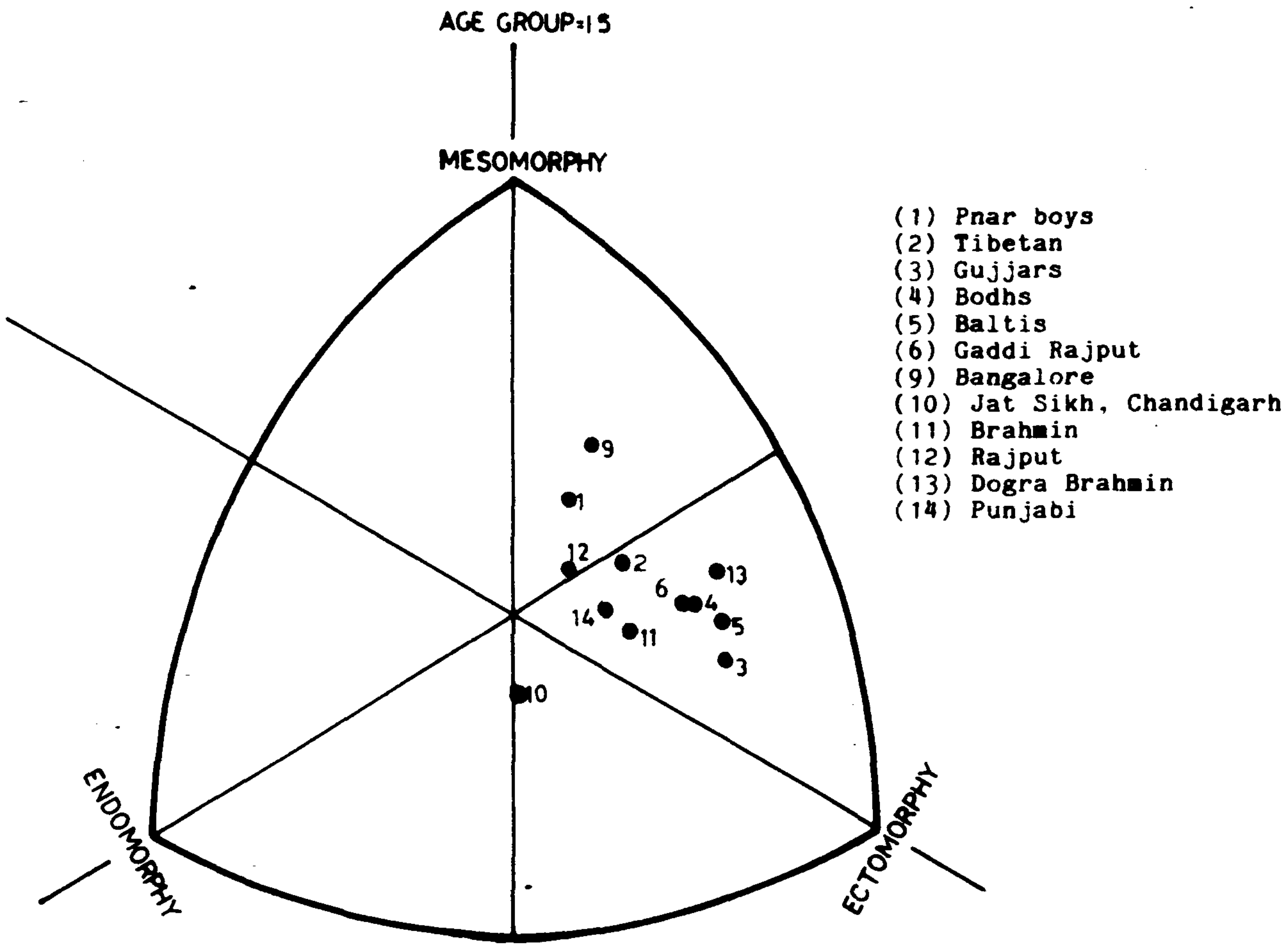


Fig. 24. Comparison of mean somatotypes of Pnar boys with other studies on Indian populations.

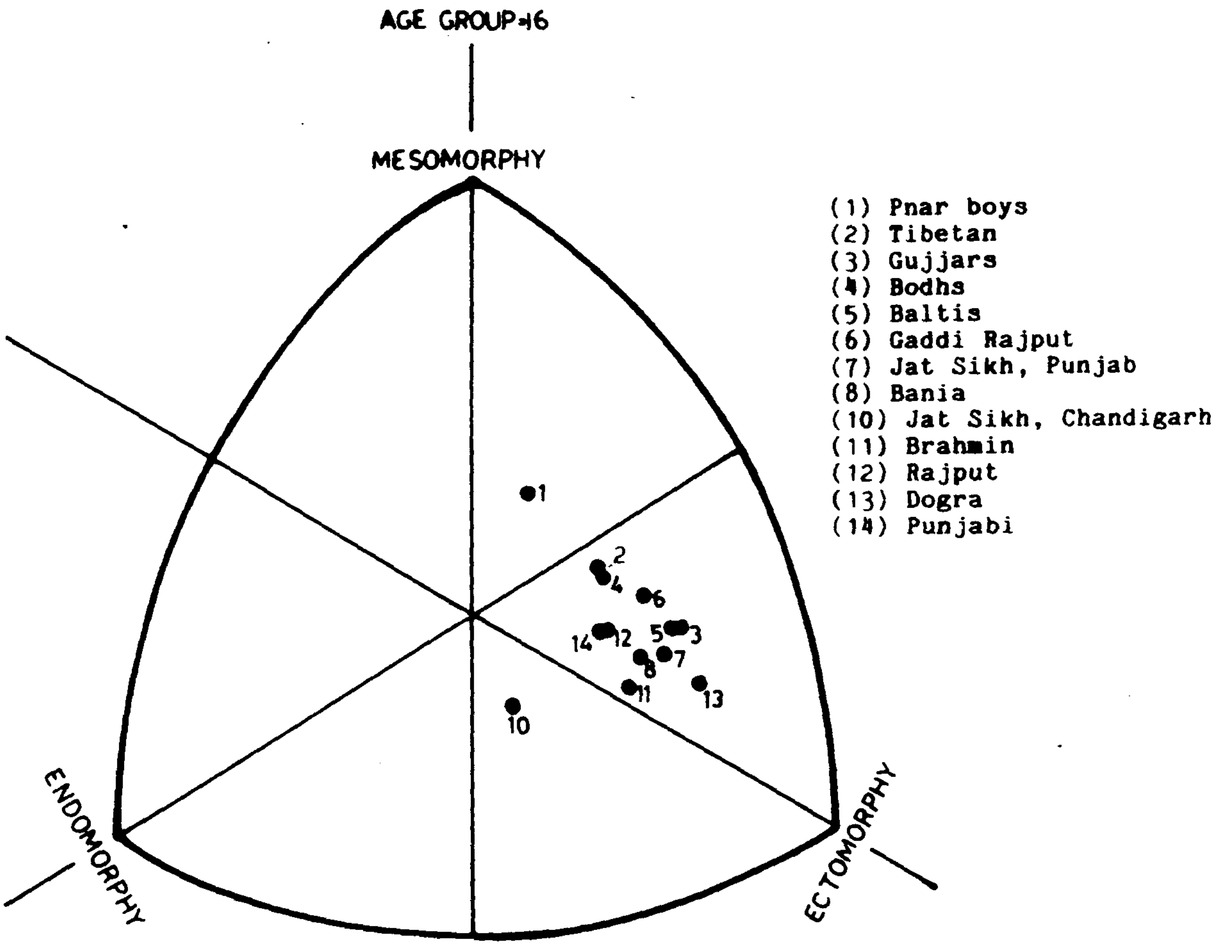


Fig. 25. Comparison of mean somatotypes of Pnar boys with other studies on Indian populations.

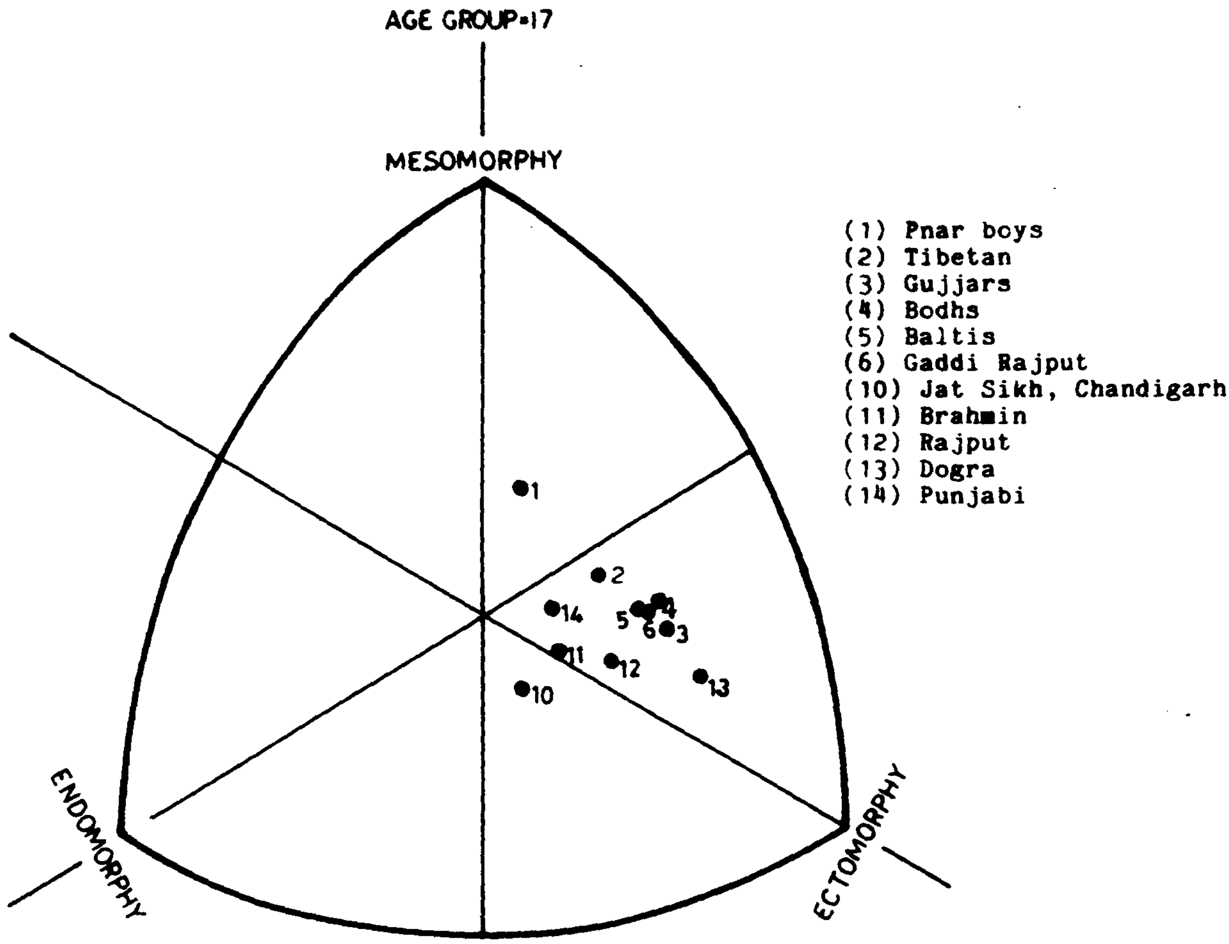


Fig. 26. Comparison of mean somatotypes of Pnar boys with other studies on Indian populations.

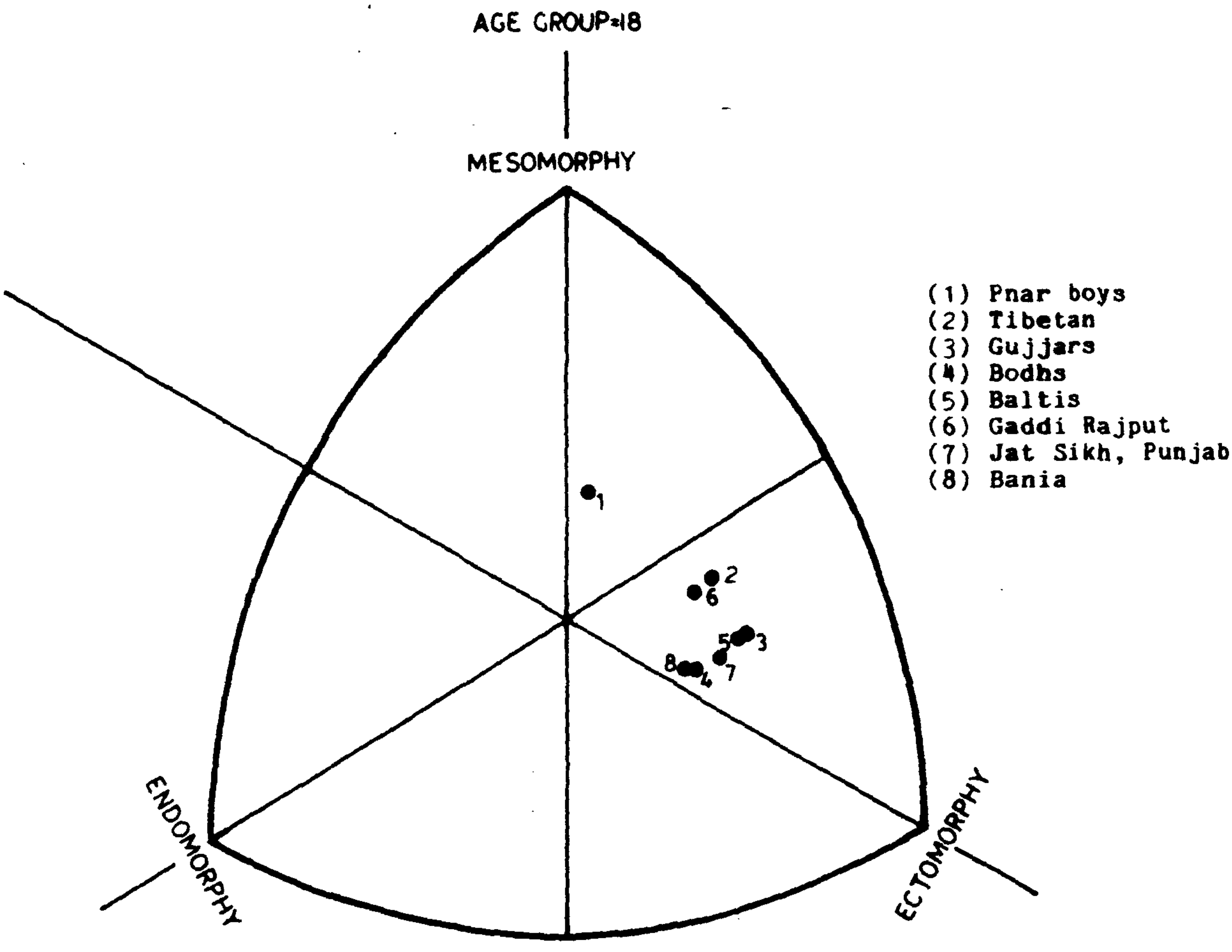


Fig. 27. Comparison of mean somatotypes of Pnar boys with other studies on Indian populations.

populations. These studies are based on cross-sectional samples of Gujjar and Tibetan boys of Jammu and Leh District of Jammu & Kashmir (Bhasin and Singh, 1991), Bodhs and Baltis boys of Ladakh, Jammu & Kashmir (Bhasin and Singh, 1992), Gaddi Rajput boys of Chamba District of Himachal Pradesh (Singh and Sidhu, 1980), Jat Sikh and Bania from Punjab (Kansal, 1981), boys from Bangalore, Karnataka (Rangan, 1982), Jat Sikh boys from Chandigarh (Handa et al., 1995), Brahmin and Rajput boys of Chamba district of Himachal Pradesh (Singh & Singh, 1991), Dogra Brahmin boys of Jammu and Kashmir (Singh and Bhasin, 1990), and Punjabi boys of Patiala, Punjab (Sethi and Sidhu, 1992).

Fig. 20 to 27 depict mean somatoplots of age groups 11 to 18 years respectively, for the present study as compared to other studies on Indian populations. At age 11, among the populations compared, Pnar boys are highest on mesomorphy, lowest on ectomorphy, and very low on endomorphy. Boys of present study are closest to Bodh of Ladakh and Gaddi Rajput of Himachal Pradesh in endomorphy, to Tibetan in mesomorphy, and to Tibetan, Bodh and Balti in ectomorphy. The mean somatoplots (Fig. 20) show that the somatotype of all other populations lie in the ecto-mesomorphic region below the upper axis of endomorphy, however, the mean for Pnar boys is placed above the upper axis of endomorphy. It can be seen that the somatotype of 11 year old Pnar boys is closer to Tibetan, Bodh, Balti and Gaddi Rajput. The comparisons at age 12 reveals similar picture as that observed at age 11 years. The data at 12 years is also compared with the Jat-Sikh and Bania communities of Punjab. The mean somatoplots for these two samples are found to lie far away from the Pnar boys (Fig. 21).

Figures 22 and 23 present mean somatoplot comparisons at age 13 and 14 years, respectively. For these two ages data on some more studies are available. A perusal of the two figures reveal that the comparative picture remains almost the same as seen for age groups 11 and 12 years, i.e., the placement of mean somatoplots of Pnar boys is in between the upper axis of endomorphy and mesomorphy, those of all other populations lie below the endomorphy axis in South-east direction. The mean somatotypes of 13 and 14 year old boys of present study are once again found to be closer to Tibetan, Bodh, Balti, Gujjar, and Gaddi Rajput boys. Only at age 14, interestingly, the mean somatotype of Punjabi boys from Patiala is also found to lie nearer to the Pnar boys.

At age 15 years the mean somatoplots for Bangalore boys and Rajput (Chamba) boys (Fig. 24) are found to be placed in the same region as that for Pnar boys, i.e., in the ecto-mesomorphic region, and in between the upper halves of endomorphy and mesomorphy axis. The comparative position of mean somatotypes of all other populations viz-a-viz the present study remains almost similar to that observed at earlier ages. At 16 and 17 years of age the somatotypes of many other populations show a substantial change in component ratings, but the mean ratings for Pnar boys remain unchanged (Figs. 25 and 26). By the age of 18 years the mean somatoplot for boys of present study move closer to the upper axis of mesomorphy, while those of other populations remain below the endomorphy axis in the south-west direction (Fig. 27).

Parizkova and Carter (1976) and Walker (1978) have reported change in component dominance during adolescence. In the somatotype comparisons presented above almost all the population groups, including the Pnar boys of the present study, do not reveal any change in component dominance during the adolescent period. Tanner (1970) had reported that there is not much change in somatotype ratings during the course of growth. Almost all studies (Table 19) show some change in the component ratings as the children grow. Considering only those studies (Nos. 1 to 6, Table 19) reporting somatotypes from 11 to 18 years of age, it is found that maximum overall change in component ratings occur among Pnar boys of the present study. From age 11 to 18, endomorphy increases by 0.8 units, mesomorphy increases by 0.4 units, while ectomorphy decreases by 0.7 units. Similarly, a substantial change in component ratings is found among Tibetan and Balti boys, while the Gujjar, Bodh and Gaddi Rajput boys show minimum change in the ratings of the three components from age 11 to 18 years. Data on other population samples (Table 19) also show such changes in component ratings.

Carter (1975) divided somatochart into various sectors. According to sector division, at age 11 the Pnar boys are placed in mesomorph-ectomorph sector along with Tibetan, Bodh and Baltis of Jammu and Kashmir, and Gaddi Rajput of Himachal Pradesh (Fig. 20), but the somatoplot for Gujjar boys lies in meso-ectomorph sector placed far away from the somatoplot of boys of the present study. With increasing age the somatoplot for Pnar boys show a trend to move closer to the upper axis of mesomorphy (Fig. 20 to 27), and by 18 years of age it comes to be placed in the balanced mesomorph sector.

From the comparisons presented above it becomes clear that though at younger ages the somatotype of Pnar boys may have some similarity to the somatotypes of some other populations, but by the age of 18 years the Pnar boys show a somatotype (balanced mesomorph) which is quite different from that of the other populations compared (others being, mesomorph-ectomorph, or mesomorphic ectomorph, or balanced ectomorph).

Populations Outside India

The findings of the present study are compared with the results of ten different studies from outside India, to evaluate population differences/similarities. Only those studies have been considered here which report somatotypes of boys falling within the age range (i.e., 11 to 18 years) of the present study. The populations included here for the purpose of comparison are, Hungarian boys (Farmosi, 1982), boys from a small town called Kormend in western Hungary (Eiben, 1985), African boys belonging to Ile-Ife, Nigeria (Toriola and Igbokwe, 1985), a mixed longitudinal study on Manus boys from Papua New Guinea (Heath and Carter, 1971), boys from Central Finland (Halopainen et al., 1984), boys of Medford Growth Study - a mixed longitudinal and cross-sectional study, Oregon, U.S.A. (Clarke, 1971), Belgian boys (Duquet, 1980), boys from Bohemia & Morabia (Stepnicka, 1976), a longitudinal study of Belgian boys (Claessens, 1981), and Czechoslovakian boys from Prague (Bok and Tlapakova, 1982).

Table: 20 AGE-WISE COMPARISIONS OF MEAN SOMATOTYPES OF PNAR BOYS (POOLED SAMPLE) WITH OTHER STUDIES ON POPULATION OUTSIDE INDIA

Age group	1 Present Study			2 Farmosi (82)			3 Eiben (85)			4 Toriola&Igbekwe (85)			5 Heath -Carter(71)			6 Halopainen *et al*. (84)			7 Clarke (71)		
Years	Pnar Boys			Hungary			Kormend (Hungary)			Ile-Ife (Nigeria)			Manus (Papua New Guinea)			Central Finland			Medford Oregon (USA)		
	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto
11.0	1.5	3.9	3.3	2.6	4.3	3.8	2.5	3.6	3.9	2.8	3.7	2.7	1.6	5.1	2.3	3.4	4.2	3.0	3.4	4.2	3.2
12.0	1.5	3.9	3.1	2.8	4.5	3.5	2.1	3.7	2.9	2.7	3.8	2.6	1.7	5.0	2.8	3.4	3.8	3.4	3.5	4.1	3.2
13.0	1.5	3.9	3.3	3.0	4.4	3.6	2.2	3.5	4.2	2.7	3.9	2.5	1.8	5.2	2.6	3.0	3.8	3.6	3.5	4.0	3.2
14.0	1.6	3.9	3.4	3.1	4.3	3.7	2.1	3.9	3.9	2.9	4.0	2.3	1.6	4.8	3.1	2.7	3.6	3.9	3.3	4.1	3.4
15.0	1.9	4.1	3.0	3.0	4.1	3.8	2.0	3.6	3.9	2.9	4.4	2.4	2.0	4.6	3.1	2.5	3.4	4.0	3.3	4.1	3.5
16.0	1.9	4.1	3.0	3.2	4.6	3.2	2.1	3.8	3.6	3.3	4.9	2.2	1.5	5.5	3.0	2.9	3.8	3.8	3.4	4.2	3.4
17.0	2.0	4.2	2.7	3.4	5.0	2.6	2.2	3.7	3.5	3.7	4.9	2.3	2.6	6.2	2.0	-	-	-	-	-	-
18.0	2.3	4.3	2.6	3.4	5.4	2.8	2.0	3.6	3.5	3.8	5.0	2.4	-	-	-	-	-	-	-	-	-

Contd...

8 Duquet (80)			9 Stepnicka (76)			10 Claessens (81)			11 Bok & Thapakova (81)		
Belgium			Behemia & Moravia			Belgium			Prague (Czechoslovakia)		
Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto
2.1	3.5	3.7	-	-	-	-	-	-	-	-	-
2.2	3.4	3.7	2.5	4.2	3.9	-	-	-	-	-	-
2.3	3.5	3.6	-	-	-	2.2	4.1	3.6	-	-	-
-	-	-	2.1	4.3	3.9	2.3	4.1	3.7	-	-	-
-	-	-	-	-	-	2.6	3.8	3.7	2.3	4.3	3.4
-	-	-	-	-	-	2.7	4.1	3.8	2.2	4.2	3.5
-	-	-	-	-	-	2.6	4.0	3.6	1.8	4.6	3.4
-	-	-	-	-	-	2.6	3.9	3.4	-	-	-

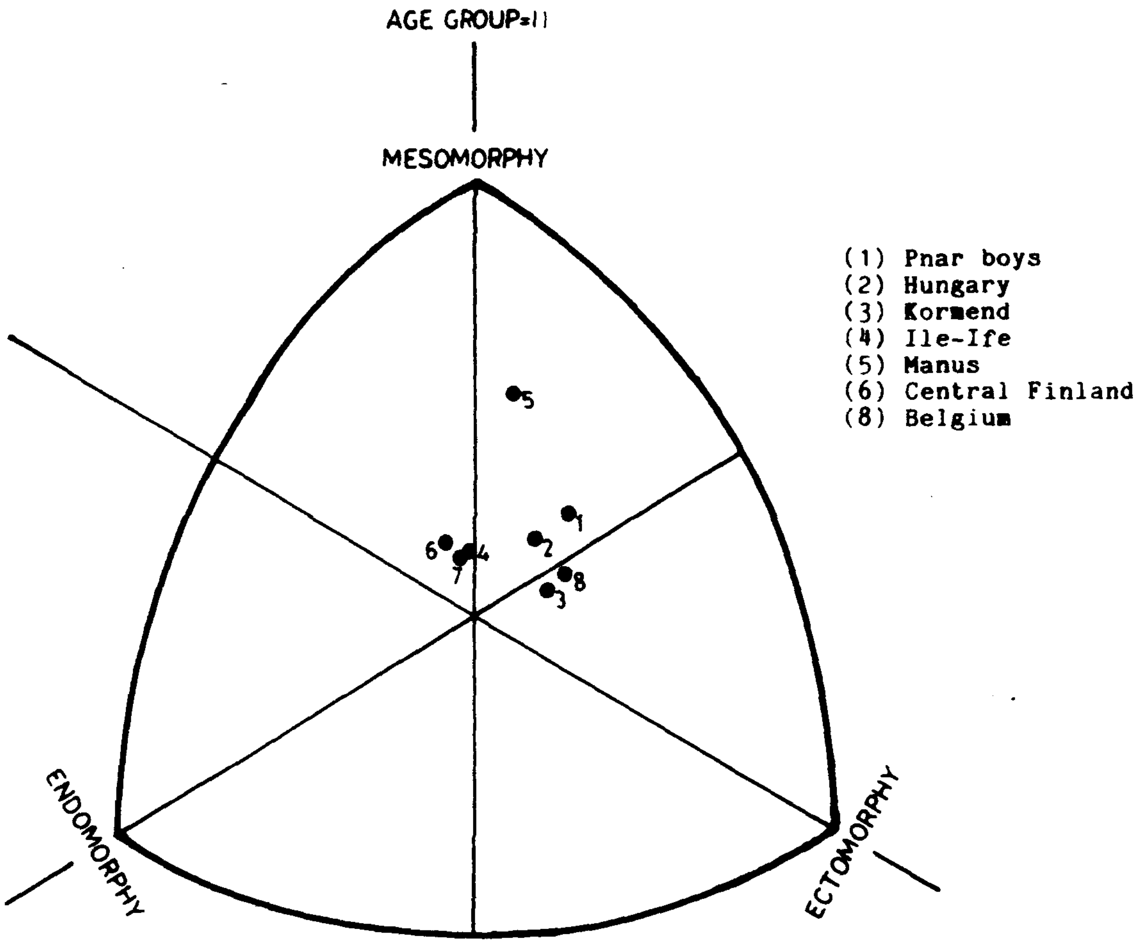


Fig. 28. Comparison of mean somatotypes of Pnar boys with other studies on populations outside India.

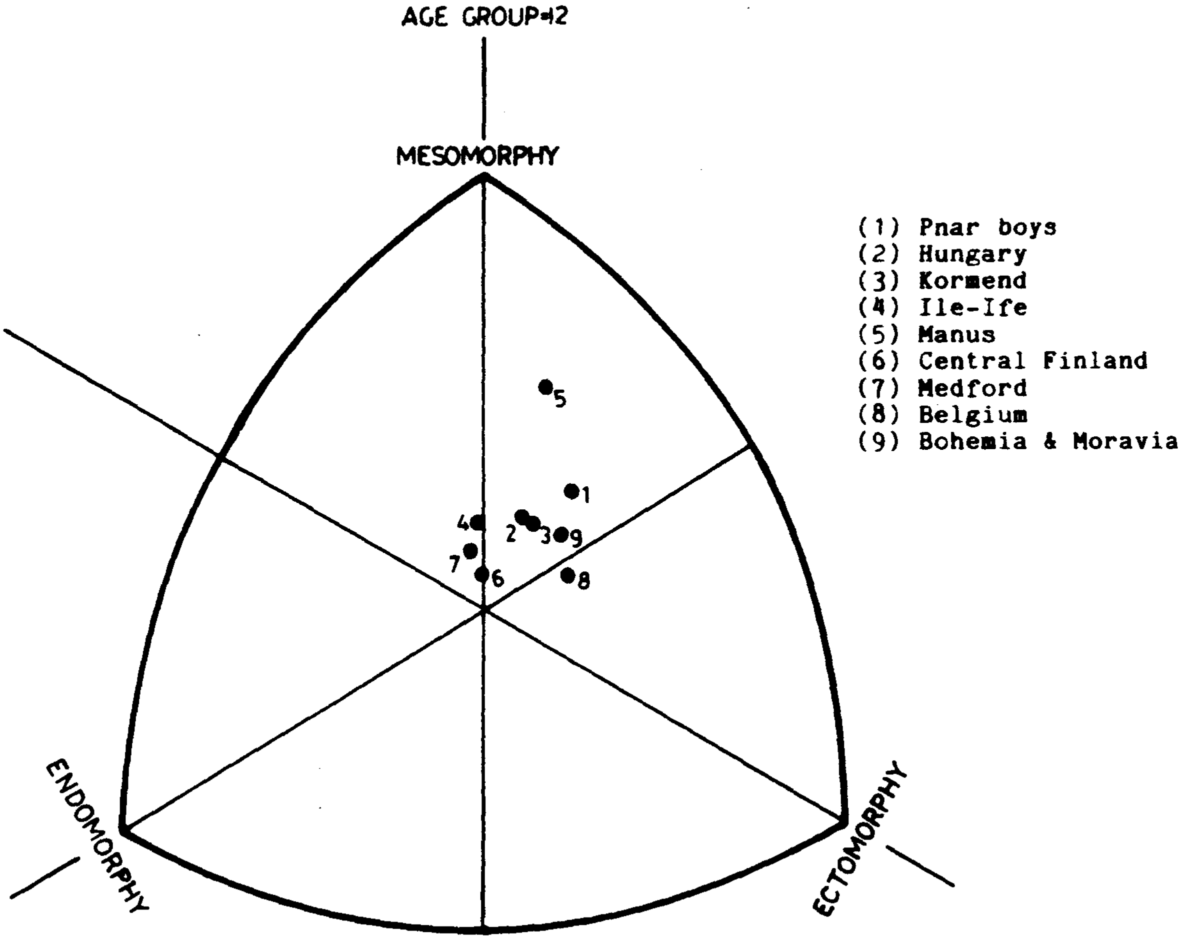


Fig. 29. Comparison of mean somatotypes of Pnar boys with other studies on populations outside India.

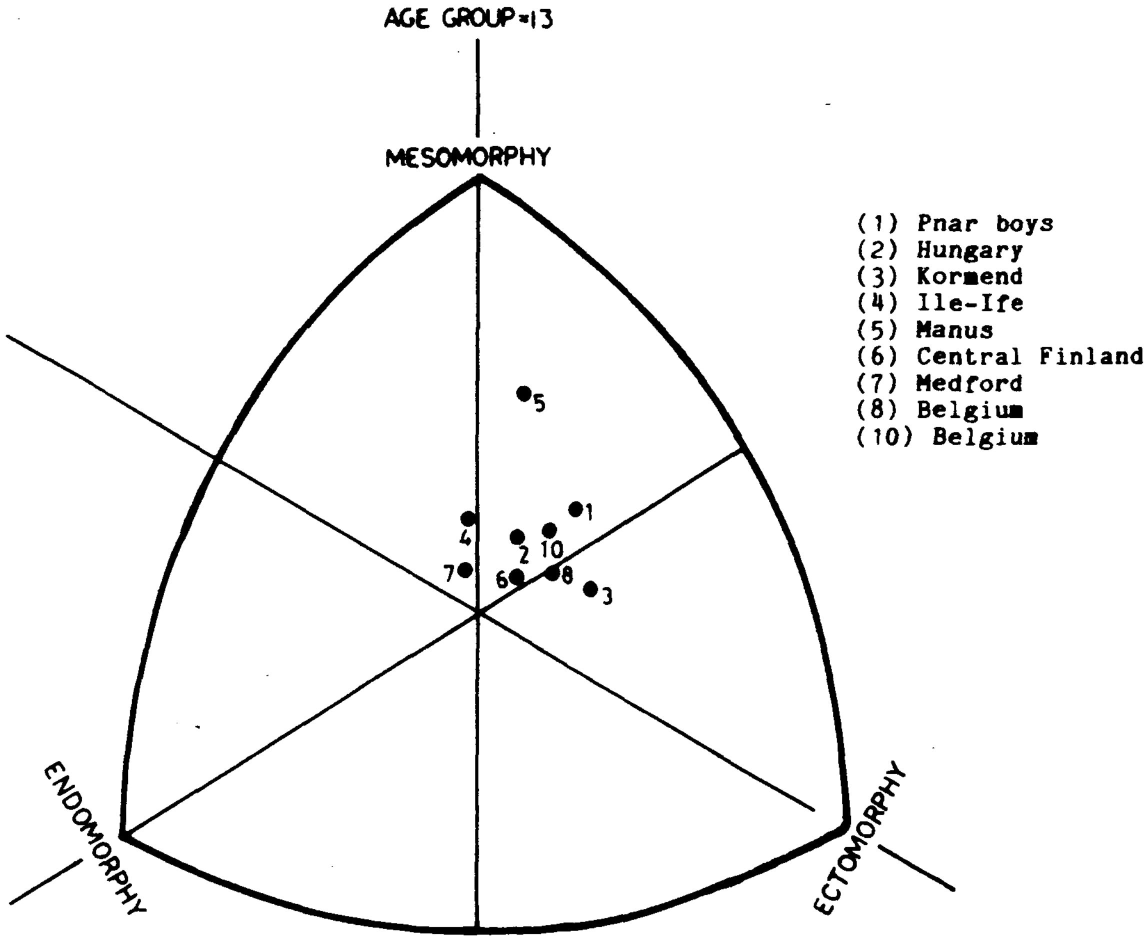


Fig. 30. Comparison of mean somatotypes of Pnar boys with other studies on populations outside India.

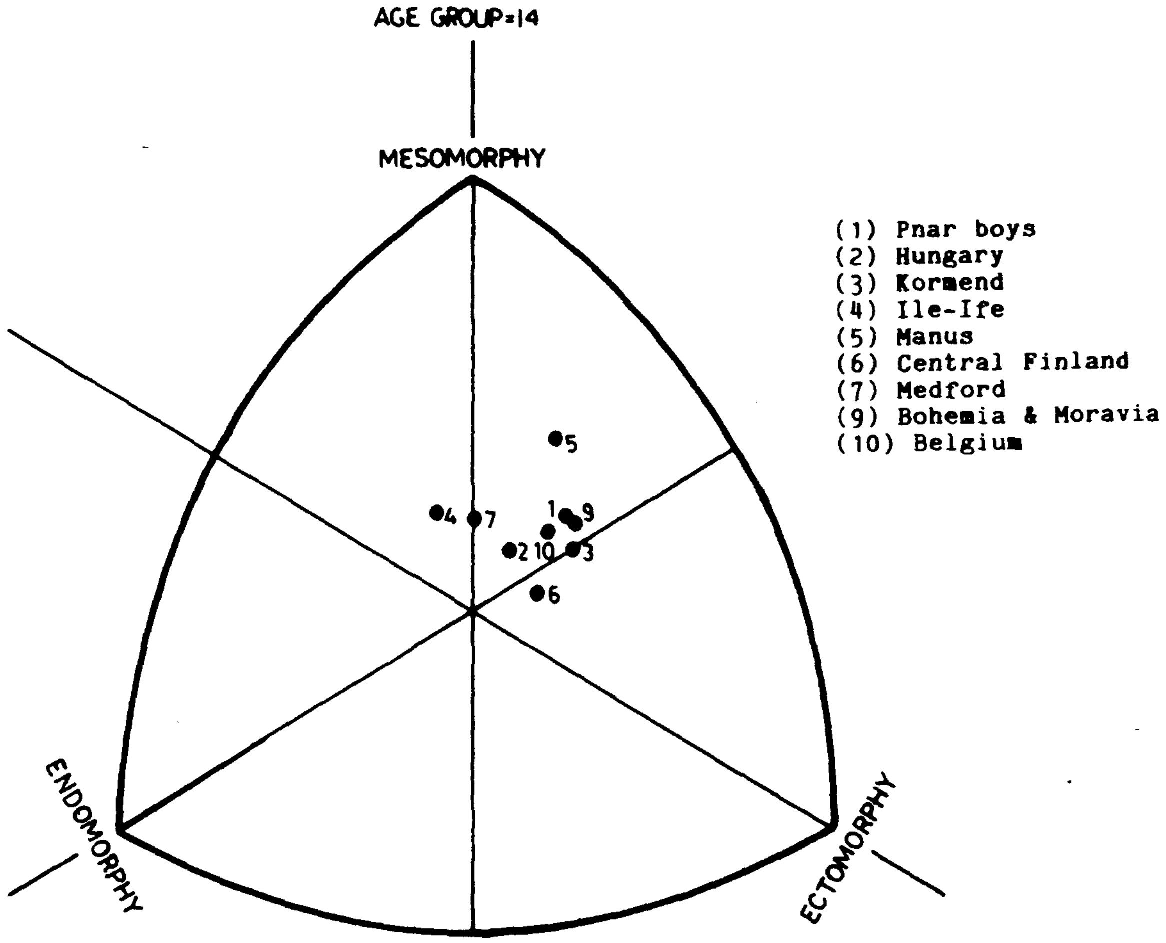


Fig. 31. Comparison of mean somatotypes of Pnar boys with other studies on populations outside India.

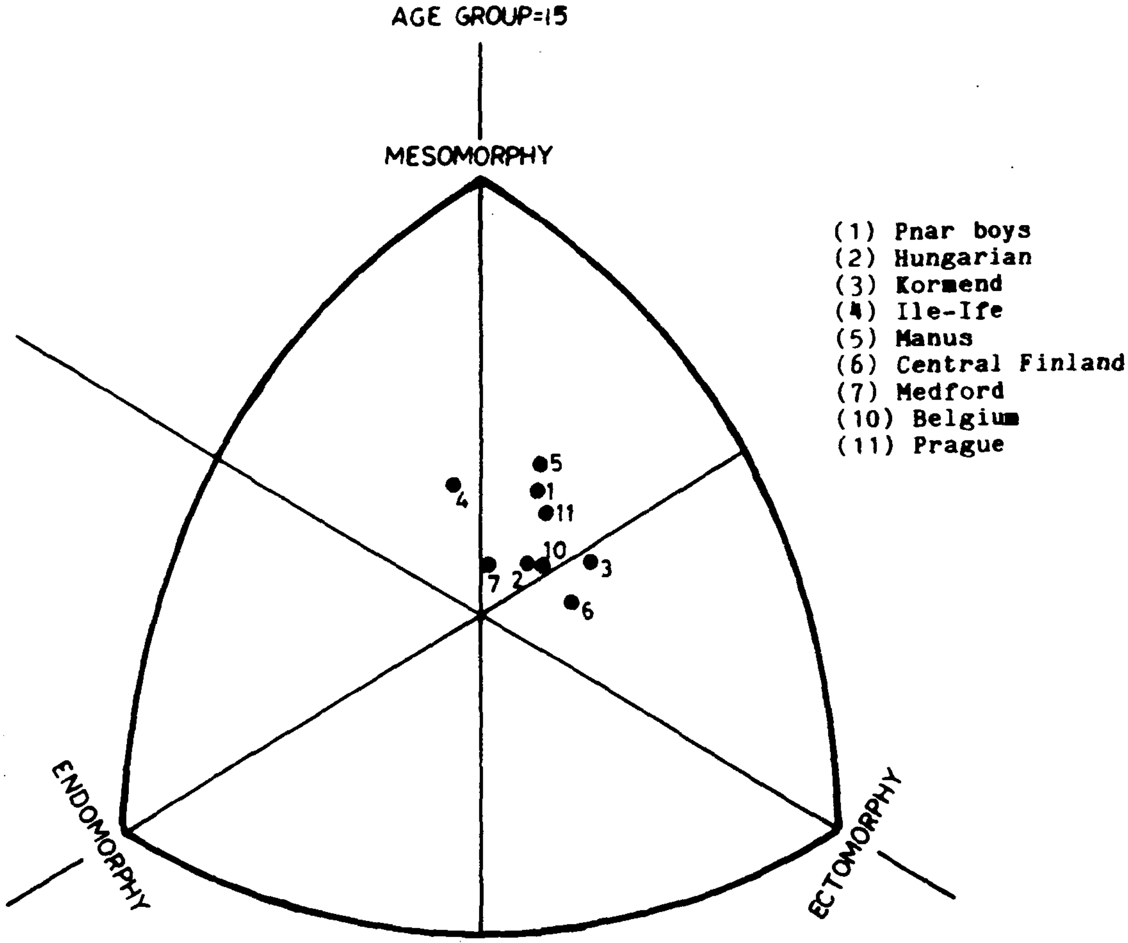


Fig. 32. Comparison of mean somatotypes of Pnar boys with other studies on populations outside India.

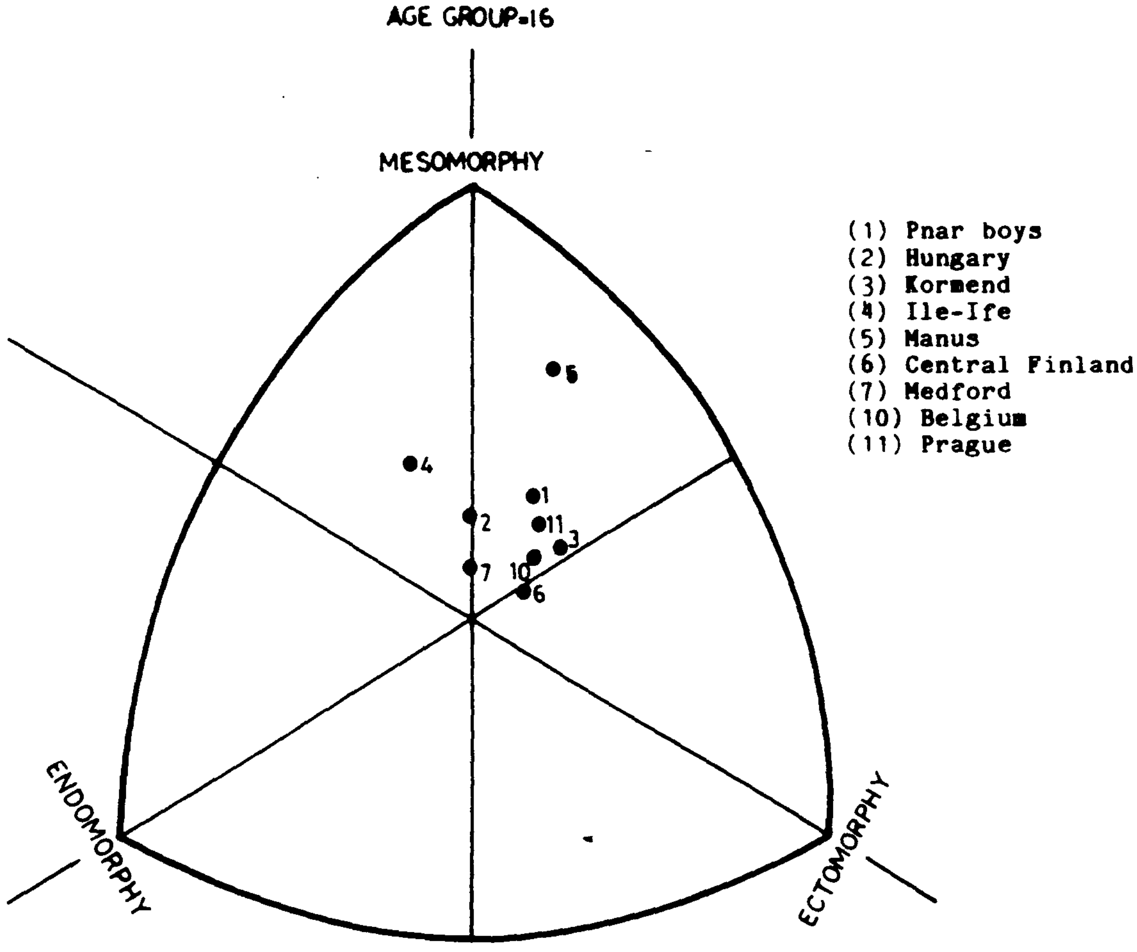


Fig. 33. Comparison of mean somatotypes of Pnar boys with other studies on populations outside India.

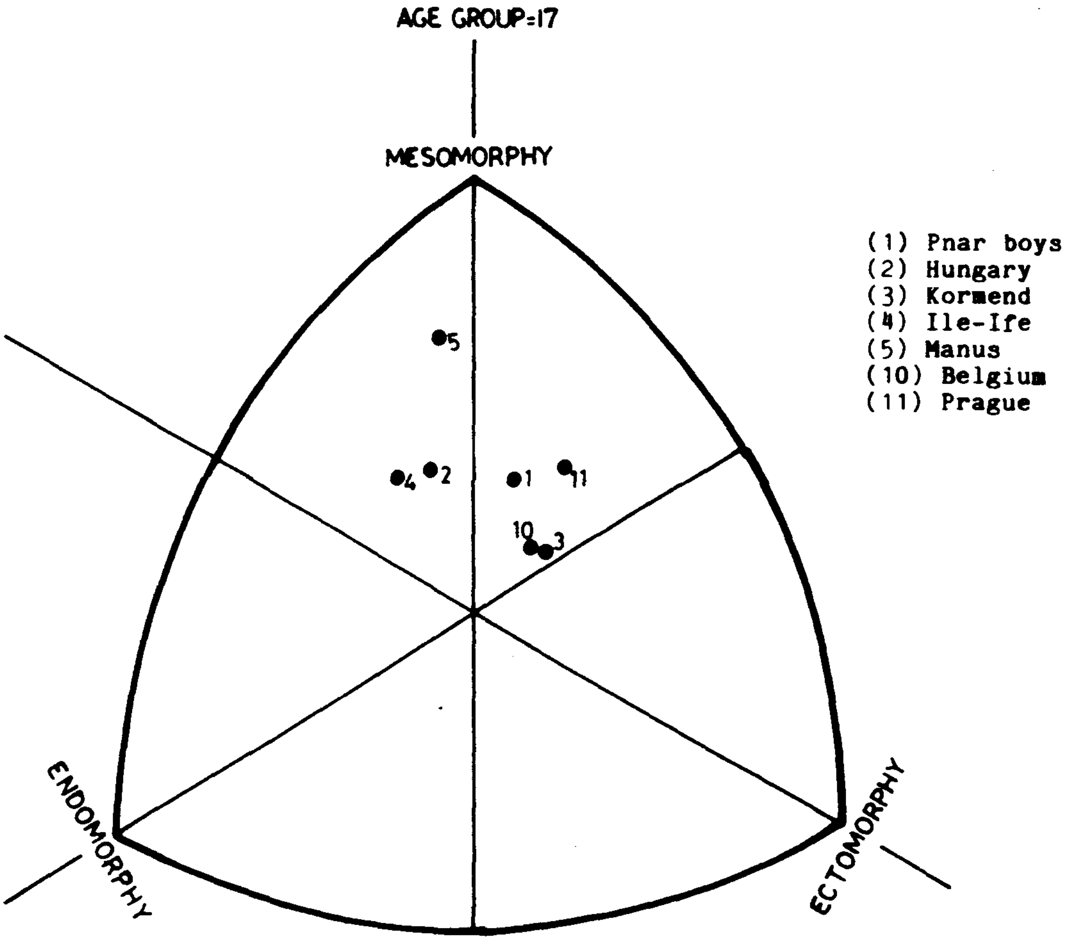


Fig. 34. Comparison of mean somatotypes of Pnar boys with other studies on populations outside India.

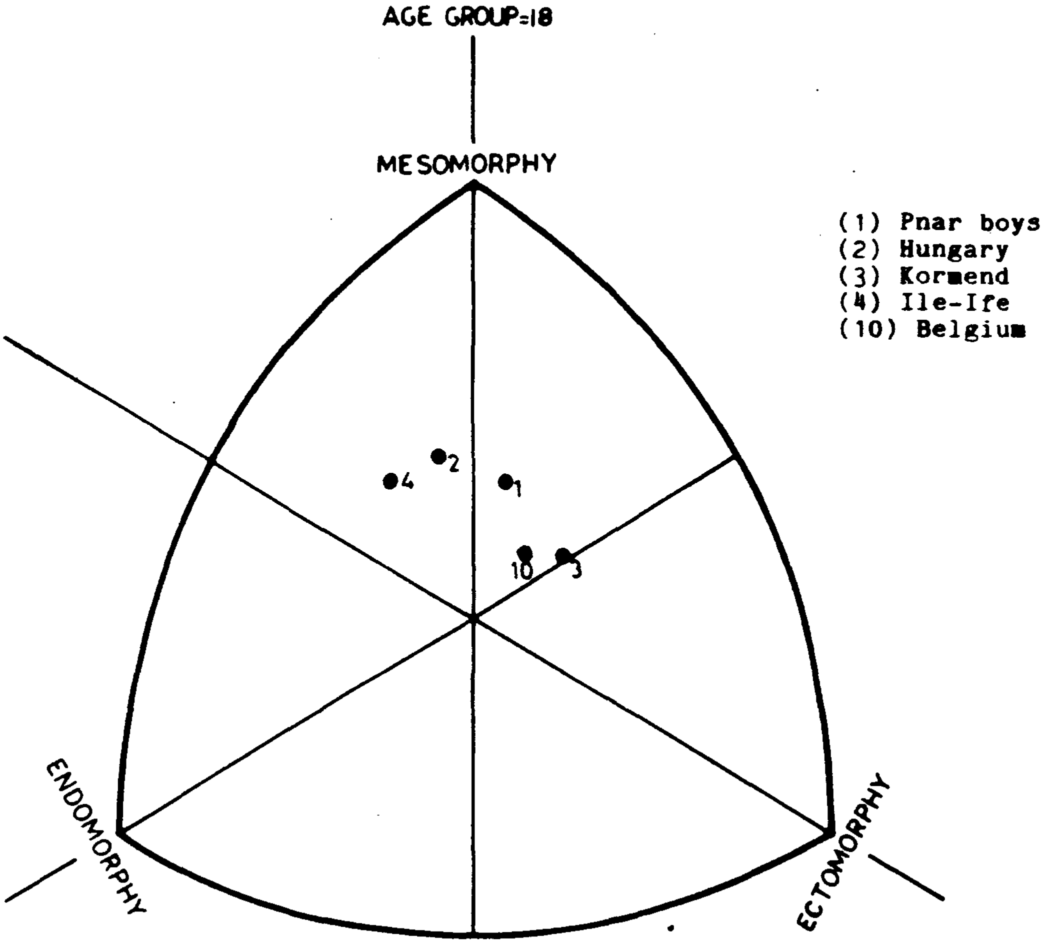


Fig. 35. Comparison of mean somatotypes of Pnar boys with other studies on populations outside India.

Table 20 presents age-wise comparison of mean somatotypes of Pnar boys with the mean somatotypes of different populations outside India. The values of mean somatotypes are also plotted on somatocharts according to age groups, as given in Fig. 28 to 35. At age 11, among the populations compared, the Pnar boys of present study are lowest on endomorphy, and are nearer to Manus boys at least for this component, while for mesomorphy and ectomorphy components they show similarity with Ile-Ife and Medford boys, respectively. However, taking the whole somatotype at age 11 the Pnar boys appear close to Hungarian boys (see somatoplot Nos. 1 and 2, Fig. 28). At 12 years of age the mean somatoplots of boys from Hungary, Kormend and Behemia & Moravia lie very close to that of the Pnar boys (Fig. 29), all being placed just above the upper half of endomorphy axis.

Figure 30 shows that the mean somatoplot at age 13 for Belgium boys followed by Hungarian boys is placed nearest to Pnar boys. It is interesting to note that the mean somatoplot for 14 year old boys from Behemia & Moravia lies just next to the Pnar boys, while those of Belgium, Kormend and Hungarian boys are also placed close to the Pnar boys (Fig. 31). The Czechoslovakian boys at age 15 and 16, and Manus boys at age 15 only reveal mean somatoplots lying very close to the Pnar boys (Figs. 32 and 33). Figures 34 and 35 present mean somatoplot comparisons at age 17 and 18 years, respectively. It can be seen that the mean somatoplot for none of the populations compared lie very close to the Pnar boys of present study.

Regarding change in component dominance during the growth period almost all the population samples including the present study do not show any change in component dominance with increasing age (Table 20), the only exception being Kormend (Eiben, 1985) and Central Finland (Halopainen <u>et al</u>., 1984) boys. Among the Kormend boys ectomorphy dominates at age 11, 13 and 15, while mesomorphy dominates at age 12, 16 and 18 years, and both ectomorphy and mesomorphy components remain equal at 14 years of age. On the other hand, among the boys from Central Finland mesomorphy dominates from age 11 to 13, whereafter a change is observed and ectomorphy dominates at age 14 and 15 years, while at 16 years both the components show equal values. All studies (Table 20) show some change in the component ratings as the children grow. Considering only those studies (Nos. 1 to 4, Table 20) reporting somatotypes from 11 to 18 years, it is found that the maximum overall change in component ratings occur among the Hungarian boys followed by Ile-Ife, Pnar, and Kormend boys. In most studies including the present study the value for endomorphy and mesomorphy components show an increasing trend while for the ectomorphy component shows a decreasing trend with increasing age.

According to sector division of somatochart, at age 11 the Pnar boys are placed in mesomorph-ectomorph sector along with boys from Hungary, Kormend and Belgium (Fig. 28). From 11 to 18 years (Figs. 28 to 35) the relative position of mean somatoplot for Kormend boys does not change, but the mean somatoplots for Pnar, Hungarian and Ile-Ife boys reveal a shifting trend in the north-west direction parallel to and above the ectomorphy axis. A similar trend of shift, but in south-east direction, is also observed in mean somatoplots of boys from Central Finland between age 11 to 16 years. The mean somatoplots for Manus boys (11 to 17 years) and Medford boys (11 to 16 years) do not show much shift with increasing age. At age 18 the Hungarian boys (Farmosi, 1982) along with Pnar boys of present study are observed to be balanced mesomorph (Fig. 35), while Kormend and Belgium boys remain mesomorph-ectomorph, and Ile-Ife boys become endomorphic-mesomorph.

The somatotype of Pnar boys at different ages have been compared with populations outside India. For this purpose only three studies (Table 20) were available which reported mean somatotypes from age 11 to 18 years, while other studies did not include all the eight age groups that are considered in the present study. On the basis of comparisons presented above, it may be said that most studies, including the present study, do not reveal a change in somatotype component dominance during adolescence. However, a change in relative values of the three components is observed in all studies. Considering only those studies that provide mean somatotypes for all age groups from 11 to 18 years, it is found that Hungarian boys (Farmosi, 1982) show similarities in mean somatotypes with the Pnar boys. At age 11 both Pnar and Hungarian boys are categorized as mesomorph-ectomorph, and by the age of 18 years once again both the samples (Pnar and Hungary) show similarity in mean somatotypes falling under the balanced mesomorph category. It may not be possible to explain the similarity of somatotypes between Hungarian boys and Pnar boys. But, it needs to be mentioned that the Hungarian subjects studied by Farmosi (1982) were training for competitions in various sports, while the subjects of the present study were not participating in any formal sports or physical education activity, other than the habitual daily physical activity.

Comparison of Somatotype of Pnar boys with Sportsmen

The characteristics of physique viz-a-viz success in sports have always interested scientists in particular and public in general. A number of studies have been carried out on this aspect in the last 100 years. Tittel and Wutscherk (1972) have cited about one hundred such studies. In the last 24 years there have been at least one hundred more such studies. Generally speaking, these studies provide evidence that somatotype and success in sport and physical performance are positively related; the somatotypes for successful young sportspersons are similar to those of their adult counterparts; and that diet, growth, and training can change somatotypes.

Earlier the present author had undertaken a study on the somatotypes of football players of Meghalaya (Dkhar, 1991), which provided interest and encouragement to undertake the present study. Among the formal sports 'Foot-ball' the most popular sport of the people of Meghalaya. The other popular sport is 'archery' which is played in its own traditional customary way, different from the modern form. One of the reasons for conducting the present study was to search and train such children who later on grown as adult would possess the type of physique which is suited for football or any other sport. Therefore, the somatotypes

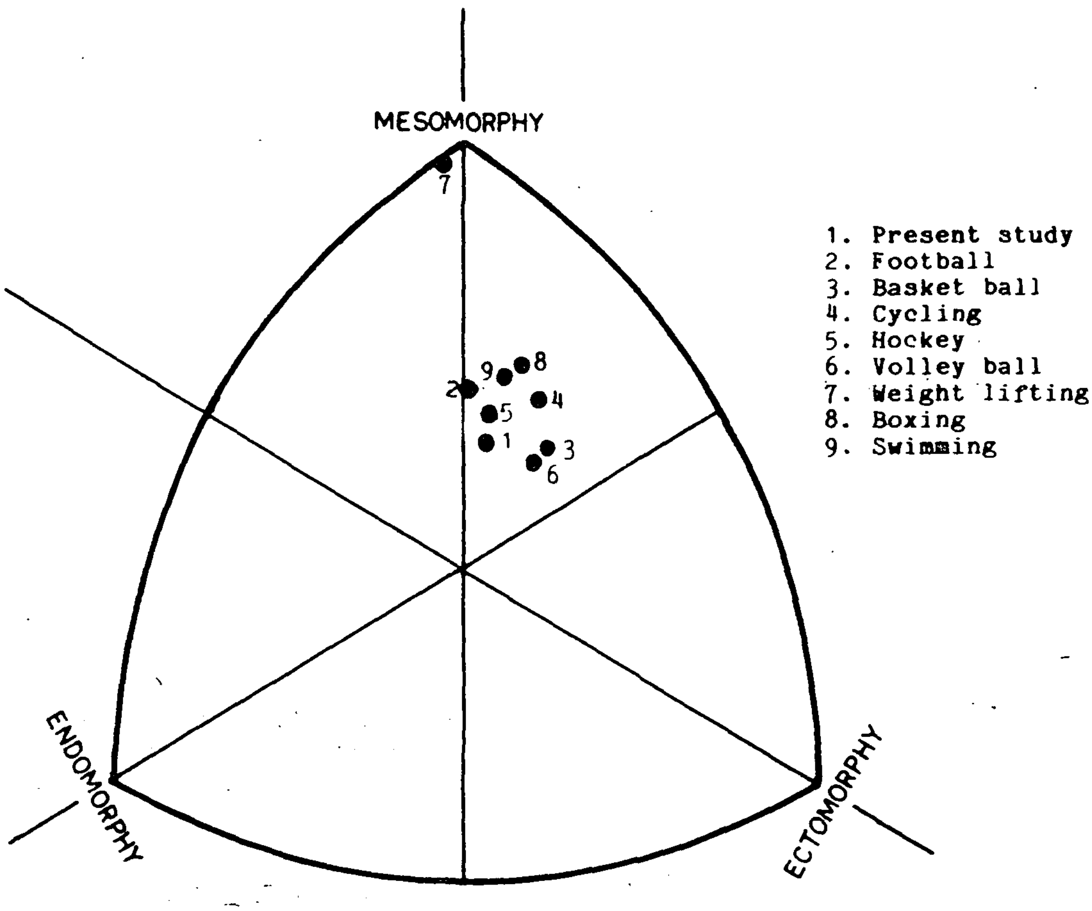


Fig. 37. Mean somatotype of Pnar boys as compared to International level sportsmen.

of Pnar boys of present study are being compared with some other studies reporting data on sportsmen involved in different sports. For this purpose two groups are made, that is, State and National level sportsmen, and International level sportsmen. Since most of the State, National or International level sportsmen had mean age above 19 years, the somatotypes of only 18 year old Pnar boys are taken into consideration for comparisons.

Table 21 presents sample size, mean age and mean somatotypes of 18 year old Pnar boys of present study and other State/National level sportsmen for different sports. The mean somatoplots for all the studies listed in Table 21 are plotted in Fig. 36. It is clear that in most sports the players reveal a dominant mesomorphy component in their somatotypes. The only exception are Volleyball players (Sodhi & Sidhu, 1984) in whom ectomorphy is dominant, and swimmers (Sodhi, 1985) which show equal values for mean ectomorphy and mesomorphy. Among the three components of physique, mesomorphy dominates in Pnar boys not only at age 18, but also at all younger ages considered in the present study. It can be seen from the mean somatoplots in Fig. 36 that the Pnar boys along with Football players of Meghalaya (Dkhar, 1991), Basketball players (Sodhi, 1980; Sodhi & Sidhu, 1984), Cyclists (Sodhi & Sidhu, 1984) and Boxers

Table 21. **Mean somatotype of Pnar boys as compared to State and National level sportsmen.**

	N	Mean age	Mean Somatotype
1. Present study (Pnar boys, age 18 only).	65	18.0	2.3-4.3-2.6
2. Football - Meghalaya State Team (Dkhar, 1991)	16	25.7	1.3-5.7-1.9
3. Basketball - India, National (Sodhi, 1980; Sodhi & Sidhu, 1984)	12	-	3.0-3.7-3.5
4. Cycling - India (Sodhi & Sidhu, 1984)	15	25.1	2.4-3.8-3.2
5. Hockey - India, Jat-Sikh (Sidhu & Wadhan, 1975)	25	21.6	3.5-4.0-3.0
6. Volleyball - India, National (Sodhi & Sidhu, 1984)	14	-	2.5-3.1-4.2
7. Weight lifting - India (Sodhi & Sidhu, 1984)	33	-	3.0-5.0-1.9
8. Boxing - India (Sodhi, 1985)	-	-	3.1-4.0-2.7
9. Swimming - India (Sodhi, 1985)	-	-	1.6-3.5-3.5

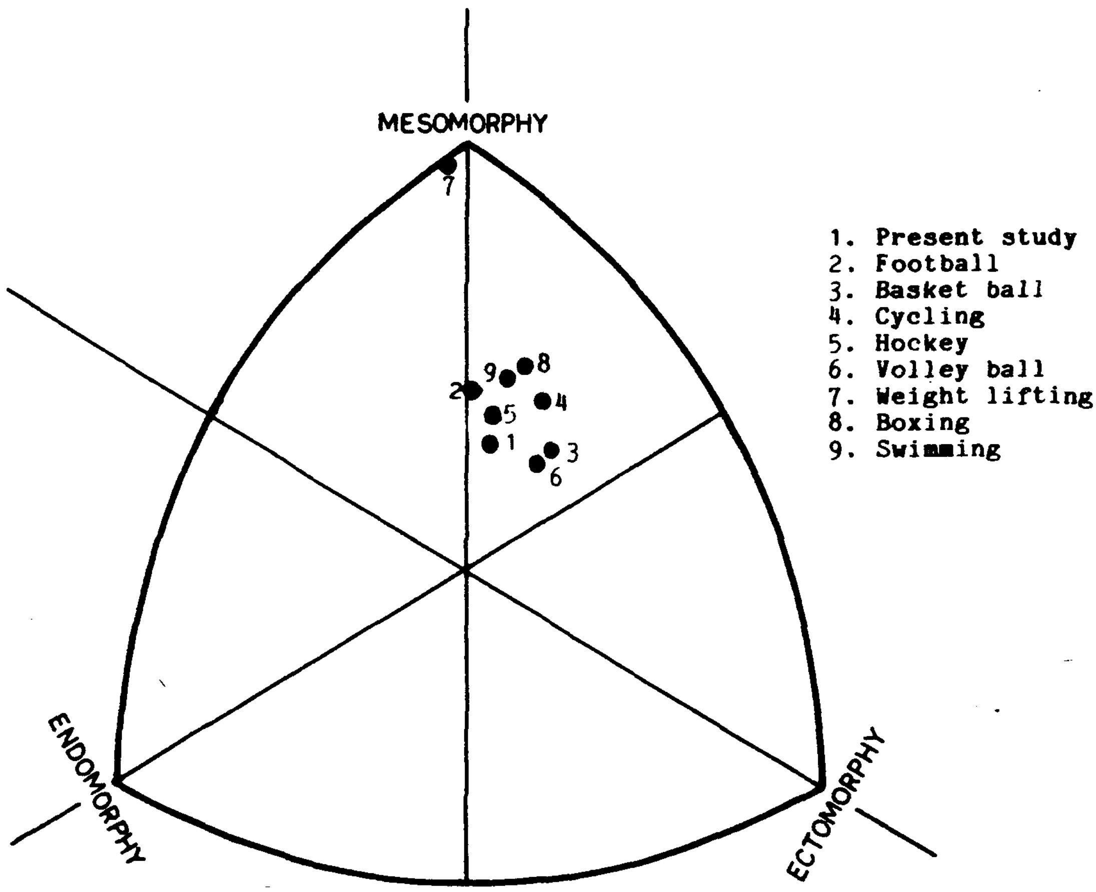


Fig. 37. Mean somatotype of Pnar boys as compared to International level sportsmen.

(Sodhi, 1985) are all placed in the balanced mesomorphy category. The swimmers (Sodhi & Sidhu, 1984) mesomorphic ectomorph, weight lifters (Sodhi & Sidhu, 1984) endomorphic mesomorph, while the Hockey players (Sidhu & Wadhan, 1975) are placed in central category of somatotypes.

Mean somatoplots, for 18 years old Pnar boys of present study, and other International level sportsmen of various sports are drawn in Fig. 37. Table 22 gives sample size, mean age and mean somatotypes for all the somatoplots *drawn in Fig.* 37. *It can be seen from* Table 37 *that in* all nine studies mesomorphy dominates among the three components, while endomorphy is at the lowest. Only among the olympic weight lifters (Carter, 1984) mean ectomorphy (instead of endomorphy) reveals lowest value. Fig. 37 shows that hockey players (Carter et al., 1981), Football players (Matsudo, 1986), Swimmers (Carter et al., 1982), weight lifters (Carter, 1984), and the Pnar boys fall into the balanced mesomorph category; while players of other sports are placed in ectomorphic mesomorph or mesomorph ectomorph category.

Carter & Heath (1990) have concluded that "in most sports top level athletes are more mesomorphic and less endomorphic than non-athlete reference groups." The sample of Pnar boys of present study (which is a non-athlete

Table 22. Mean somatotype of Pnar boys as compared to International level sportsmen.

	N	Mean age	Mean Somatotype
1. Present study (Pnar boys, age 18 only)	65	18.0	2.3-4.3-2.6
2. Football - Brazil, professional (Matsudo, 1986)	25	25.0	2.2-4.8-2.3
3. Basketball - Mexico city olympics (De Garay *et al*., 1974)	63	24.0	2.0-4.3-3.5
4. Cycling - Montreal Olympics, 1976 (Carter *et al*, 1982)	18	23.0	1.7-4.8-3.1
5. Hockey - Montreal Olympics, 1976 (Carter *et al*, 1981)	47	25.6	2.3-4.6-2.7
6. Volleyball - USA Olympics, 1983 (Carter & Heath, 1990)	13	25.8	2.3-4.4-3.4
7. Weight lifting - Olympics, 1960-76, < 60 kg (Carter, 1984)	16	-	1.4-6.9-1.0
8. Boxing - Montreal Olympics, 1976 Carter *et al*., 1982)	22	23.9	1.7-5.1-2.7
9. Swimming - Montreal Olympics, 1976 (Carter *et al*, 1982)	33	19.3	2.1-5.1-2.8

sample) like many other sportsmen (Tables 21 and 22) are observed to be of more mesomorphic and less endomorphic somatotype. Different sports activity may require different physique characteristics for excellent performance, but it is also well known that some sports may have similar somatotype distribution. That is why perhaps we find mean somatoplots of Pnar boys and athletes of certain other sports (Fig. 36 and 37) lying very close to each other, and in the same category, i.e., balanced mesomorph. Other reasons, apart from sample size and mean age, could be race/ethnicity differences in somatotypes at same or different levels of competition. The boys of present study belong to one tribe - the Pnar, of Meghalaya, and therefore represent a more homogeneous sample.

One of the aims of present study was to make some suggestions in the light of findings of the present study. In an earlier study by the present author (Dkhar, 1991) it was suggested that one of the major applications of somatotyping is to explore age changes in the physique. How the physique of a child is transformed into that of an adult? It was also suggested that extensive somatotype survey should be conducted among children of Meghalaya, which might help in spotting and training such children who later on grown as adult would possess the type of physique which may best suit for a kind of sport. Shape and size are two determinants of success in a particular sport since performance is determined by interaction of these variables with physiological capacities, psychological status, technique skill and socio-economic factors.

As discussed in earlier chapters various cross-sectional and longitudinal studies reflect extensive somatotype variations suggesting differences mainly due to genetics, sex, nutrition, physical activity, and age. The range of childhood somatotypes is more limited than that of adults. Longitudinal studies have also shown that children's somatotypes change in a generally consistent pattern. In general the somatotypes of boys aged 2 to 6 years progress from endo-mesomorphy towards balanced mesomorphy; "thereafter, the boys tend to decrease in mesomorphy and increase slightly in ectomorphy in mid-adolesence, when there is dramatic reversal toward ecto-mesomorphy, balanced mesomorphy or endo-mesomorphy" (Carter & Heath, 1990). Various studies have also shown that somatotypes of some children are subject to significant changes while those of others are quite stable over a long period of growth.

The findings of the present study reveal that on the whole Pnar boys remain ecto-mesomorphic throughout 11 to 18 years of age, though average values of all the three components register age changes. Among the three components mesomorphy dominates, while endomorphy is at the lowest. In other words, the physique of Pnar boys may be described as showing a high musculo-skeletal development with relatively less fat. From the youngest to the oldest age group considered in the present study, somatotypes of Pnar boys show a tendency to move away from upper axis of endomorphy towards upper axis of mesomorphy. Mean somatotypes of age groups 11, 12, 13, 14 years tend to cluster together, while those of age 15, 16, 17, 18 form another cluster nearer to upper axis of mesmomorphy. Considering the total sample of 509 Pnar boys, a majority (72%) fall in two categories, i.e., mesomorph-ectomorph and balancéd mesomorph. Comparisons with various populations show that in terms of somatochart categories somatotypes of Pnar boys are more stable, while samples of some other populations reveal significant changes over same period of growth.

The relative stability of somatotype of Pnar boys during adolescence may be attributed to a relatively constant dietary pattern and unchanging pattern of daily physical activity. The daily food of the Pnar consists of rice, which they usually consume twice or thrice a day with either pork or beef or dry fish, or potatoes. This diet is occassionally supplemented with fresh fish or chicken, pumpkin and cucumber, seasonal leafy vegetables and fruits, and certain other forest food products. Consumption of tea (without milk), chewing (betel leaf with slaked lime) is quite frequent. Smoking tobacco is common among males including adolescent children. On the other hand, the Pnar people who are mainly engaged in agricultural and related activities, are acknowledged to be very hard working people. Most Pnar children attend school, but yet they perform a good amount of physical activity daily by working in the fields, carrying water, and doing other sundry jobs.

Carter & Heath (1990) state that in a majority of sports the best performers are more mesomorphic and less endomorphic as compared to non-athlete groups. The sample of Pnar boys of the present study, though a non-athlete group, also show that the boys are more mesomorphic and less endomorphic. This is why, perhaps, somatotype data of Pnar boys shows proximity to mean somatotypes of sportsmen of different games at various levels of competition. In other words, it may be said that the physique characteristics of boys of the present study is suitable to many a kind of sports. Since, mean somatotypes of Pnar boys aged

11 through 18 years fall between upper axis of mesomorphy and endomorphy where the means for sportsmen of most Olympic games are also located, and also since the present sample does not reveal changes in component dominance, it may be suggested that coaches can select Pnar boys at any age from 11 years onwards and guide them to appropriate sports. Arnot & Gaines (1984) say that somatotyping is useful for grossly describing the structural requirements for various sports. The general hypothesis is that (Tanner, 1964) without the required physique an athlete is unlikely to reach a high level of success. Literature on studies of school age athletes show that their somatotype distributions resemble those of mature and successful athletes. The guidance of coaches is crucial in helping young athletes to discover their aptitudes for particular sports. With the somatotypes of successful athletes as model, the objective is to predict the most likely mature somatotypes and to estimate the influence of nutrition and training in modifying the somatotype for optimal performance in the chosen sport (Carter & Heath, 1990).

CHAPTER VII

SUMMARY

The present study describes somatotype patterns of 509 Pnar boys ranging in age from 11 to 18 years. Data for the present study has been collected from 8 schools located in rural area and 2 schools from urban area of the Jaintia Hills District of Meghalaya. Anthropometric measurements on each subject followed the techniques described by Weiner & Lourie (1981). The data were entered into the Heath-Carter Somatotype Rating Proforma (Heath & Carter, 1967; Carter, 1975), and the somatotype analysis was performed according to the methods given by Carter _et al_. (1983) and Carter & Heath (1990). Findings of the present are summarized as follow:

Urban Pnar boys are ecto-mesomorphic from age 11 to 18, and therefore show high musculo-skeletal development with relatively less fat in their physique. From 11 to 18 years the urban boys show a change in mean values of all the components of somatotype, but mesomorphy remains highest and endomorphy lowest at all ages. Somatotypes of majority or urban subjects fall within the range of 1.0 to 2.0 for endomorphy, 3.0 to 5.0 for mesomorphy, and 2.0 to 4.0 for ectomorphy. At all ages mean somatoplots for urban boys are placed between upper mesomorphy and upper endomorphy axes. Out of the 13 generalized categories of somatotypes, the sample for urban boys is distributed into 6 categories.

Rural Pnar boys, like their urban counterparts, are also ecto-mesomorphic from age 11 to 18 years, and hence show relatively greater musculo-skeletal development in their body. Though at all ages mesomorphy dominates over other two components, a gradual change in mean values of the three components is observed from 11 to 18 years among the rural boys. Most boys of rural sample show somatotypes within the range of 1.0 to 2.0, 3.0 to 5.0, 2.0 to 4.0, for endomorphy, mesomorphy, ectomorphy, respectively. Mean somatoplots for age groups 11 to 17 years are located between upper mesomorphy and upper endomorphy axes, while that for age 18 lies on the upper mesomorphy axis. According to component dominance, the total sample of rural boys is distributed into 8 somatotype categories.

Age changes in mean values for different components of somatotypes are found between some of the successive age group comparisons for urban as well as rural boys. Considering a 7 year interval from age 11 to 18 statistically significant age changes are observed in all components of physique in the two samples. The distribution of somatotypes into categories does not reveal statistically significant age changes in both urban and rural boys.

Urban-rural somatotype differences assume statistical significance for one or the other component only at age 11, 12, 13, while mean somatotypes of both samples are almost similar from age 14 upto 18 years. Overall distribution of somatotypes into various categories is also more or less similar between urban and rural samples. Almost all distributions of the two samples are more or less circular in shape and are lying above the ectomorphy axis in ecto-mesomorphy region. Somatoplot distributions reveal an overlap of a minimum 53.12% (age 11) and maximum 85.29% (age 14) between the urban and rural samples. The area of overlap shows a tendency to shift from upper axis of endomorphy towards upper axis of mesomorphy.

In order to provide further information descriptive statistics for age, height, weight and HWR is presented. Mean age for all age groups lies almost at completed years in both urban and rural samples. Age group-wise mean height and weight reveal almost a similar picture in the two samples, i.e., urban boys being relatively taller and heavier than their rural counterparts, greatest increase in height as well as weight occurring between 12 and 13 years' age. Mean HWR value ranges between 42.63 to 44.03 in urban sample, and between 42.45 to 43.12 in rural sample, for various age groups considered. All four anthropometric parameters show very low intra-sample variability at different age groups of both urban and rural samples.

On the whole, since urban-rural differences in somatotype are not great, the two samples are pooled. Mean somatotypes of pooled sample of 509 Pnar boys show that from age 11 through 18 years they remain ecto-mesomorphic. Among the three components mean values for mesomorphy dominates and that of endomorphy remains lowest at all ages. Somatotypes at different ages do not differ in dispersion about their means. From 11 to 18 years an overall increase of 0.87 units in endomorphy, 0.45 unit increase in mesomorphy, and 0.75 unit decrease in ectomorphy ratings is observed. Somatotypes of pooled sample are distributed among 8 out of a total of 13 categories.

Mean mesomorphy does not show any significant age changes between successive age group comparisons, while statistically significant change is observed only in a few age group comparisons for endomorphy and ectomorphy. However, mean somatotypes of 11 year old are significantly different from the 18 year old boys. The mean somatotype of Pnar boys at all age groups lies in ectomorphy-mesomorphy region, above the upper axis of endomorphy. General pathway of mean somatoplots from age 11 to 18 years indicate a shift from near upper axis of endomorphy towards near upper axis of mesomorphy, i.e., the shift takes place in the north-west direction parallel to ectomorphy axis. Mean somatoplots of age group 11, 12, 13 and 14 years tend to form one cluster, while those of age 15, 16, 17, 18 show a tendency to form another cluster.

Various studies across the world have discussed regarding age changes in somatotypes or somatotype stability, and have shown that somatotypes of children are subject to significant changes during adolescence, while some studies have also shown that somatotypes of some children are fairly stable over some periods of growth. Generally speaking, the present study reveals a fair stability of somatotypes in Pnar boys from the period 11 to 13 years and 15 to 18 years, while significant changes are seen between 13 and 15 years. Findings of present study are in agreement with other studies in that towards late adolescence the mean somatotypes of boys are toward ecto-mesomorphy; the only difference being that Pnar boys are ecto-mesomorphic even during early adolescence.

Comparisons with other Indian populations indicate that though at younger ages the somatotypes of Pnar boys may have some similarity with some other populations, but by the age of 18 years Pnar boys show a somatotype (balanced mesomorph) different from that reported on other populations (mesomorph-ectomorph, or mesomorphic-ectomorph, or balanced ectomorph). Comparisons with populations outside India the sample on Hungarian boys show similarities in mean somatotypes with the Pnar boys of present study.

Somatotypes of eighteen year old Pnar boys are compared with data on State, National and International level sportsmen, and it is found that somatotype of Pnar boys closely resemble those of athletes of various sports. It is known that in most sports top level athletes are more mesomorphic and less endomorphic (which is the case in Pnar boys) than the non-athlete reference groups (the present sample of Pnar boys is a 'non-athlete' group!).

LITERATURE CITED

Amador, M., Rodriquez, C. and Gonzales, M.E. (1983). Somatotyping as a tool for nutritional assessment in preschool children. Anthropologiai Kozlemenyek, 27, 109-118.

Anderson, L.P. (1985). Somatotype and Skinfolds of Down's syndrome adolescents. M.A. Thesis, San Diego State University.

Arnot, R.B. and Gaines, C.L. (1984). Sport Selection. New York: Viking Press.

Bareh, H. (1967). The History and Culture of the Khasi People. Spectrum Publication, Gauhati.

Bareh, H. (1979). Sources of the History of the Khasis and Jaintias, In S.P. Sen (ed.), Sources of the History of India, Vol. II, Indian Historical Studies, Calcutta.

Bailey, D.A., Carter, J.E.L. and Mirwald, R.L. (1982). Somatotype of Canadian Men and Women. Human Biology. 54: 813-828.

Behnke, A.R. (1961). Quantitative Assessment of Body Build. Journal of Applied Physiology, 16:960-968.

Bell, W. (1973). Distribution of Skinfolds and Differences in Body Proportions in Young Adult Rugby Players. Journal of Sports Medicine and Physical Fitness, 13:69.

Berger, R.A. (1973). Test of Motor Ability for College Men. Research Quarterly. 25:253-260.

Berry, J.N. and Deshmukh, P.Y. (1963). Physique of Male College Students in Nagpur. Indian Journal of Medical Research. 51:313-326.

Berry, J.N. and Deshmukh, P.Y. (1964). Somatotypes of Male College Students in Nagpur, India. Human Biology. 36:157-176.

Beunen, G., Glaessens, A., Ostyn, M., Renson, R. and Simon, J. (1987). Somatotype as related to age at peak velocity and to peak velocity in height, weight and strength in boys. Human Biology. 59(4):641-655.

Bhasin, M.K. and Singh, L.P. (1991). Somatotype changes during adolescence in Gujjars and Tibetan of Jammu and Kashmir, India. Journal of Human Ecology. 2:81-84.

Bhasin, M.K. and Singh, L.P. (1992). A study of Anthropometric Somatotype in two high altitude population - Bodhs and Baltis of Ladakh, Jammu and Kashmir, India. Journal of Human Ecology. 3(1):35-38.

Bodzsar, E.B. (1982). The indices of the physique and the socio-economic factors based on a growth study in Bakony girl. Anthropologiai Kozlemenyek. 26:129-134

Bok, V. and Tlapakova, E. (1982). New Ways of Somatotyping and their application. Acta Universitatis Carolinae (Gymnica), 18:5-19.

Bouchard, C., Dermirzian, A. and Malina, R.M. (1980). Heritability estimates of Somatotype components based upon familial data. Human Heredity. 30:112-118.

Bransby, E.R. (1945a). Med. Offr. 73:149-151. In: Application Areas of Anthropology 1. (Ed.) A. Mahajan and S. Nath (1992). Reliance Publishing House, New Delhi.

Bransby, E.R. (1945b). Med. Offr. 74:95. In: Application Areas of Anthropology 1. (Ed.) A. Mahajan and S. Nath (1992). Publishing House, New Delhi.

Buday, J. and Eiben, O.G. (1982). Somatotype of adult Down's patients. Anthropologiai Kozlemenyek. 26:71-77.

Bullen, A.K. (1952). Some problems in the practical application of Somatotyping. Florida Anthropologists. 5:17-20.

Bullen, A.K. and Hardy, H.L. (1946). Analysis of body build photography of 175 college women. Am. J. Phys. Anthrop., 4:37-65.

Carter, J.E.L. (1958). An analysis of somatotypes of boys aged twelve to seventeen years. M.A. Thesis, State University, Iowa, Iowa City.

Carter, J.E.L. (1966). The Somatotypes of Swimmers. Swimming Technique. 3:76-79.

Carter, J.E.L. (1968). Somatotypes of College football players. Research Quarterly. 39:466-481.

Carter, J.E.L. (1970). Somatotypes of Athletes a review. Human Biology, 42:539-569.

Carter, J.E.L. (1975). The Heath-Carter Somatotype Method. San Diego State University Syllabus Service, San Diego.

Carter, J.E.L. (1980). The Heath-Carter Somatotype Method. San Diego State University Syllabus Service, Third Edition.

Carter, J.E.L. (1984). Somatotypes of Olympic athletes from 1948 to 1976. In: Physical Structure of Olympic Athletes. Part II. Kinanthropometry of Olympic Athletes. Ed. J.E.L. Carter, pp. 80-109. Basel: Karger.

Carter, J.E.L. (1981). Somatotypes of female athletes. In: J. Berms, M. Hebbelinck and A. Venerando (eds.), The Female Athlete, Basel, Karger.

Carter, J.E.L. and Heath, B.H. (1990). Somatotyping Development and Applications. Cambridge: Cambridge University Press.

Carter, J.E.L. and Succec, A.A. (1966). Somatotype of Collegiate and Olympic distrance runners. U.S. Track Coaches. Assoc. Quarterly Review. 36-42.

Carter, J.E.L., Rendle, M.L. and Gayton, P.H. (1981). Size and Somatotype of Olympic male field Hockey players. New Zealand Journal of Sports Medicine. 9: 8-13.

Carter, J.E.L., Aubry, S.P. and Sleet, D.A. (1982). Somatotypes of Montreal Olympic athletes. In: Physical Structure of Olympic Athletes. Part I. The Montreal Olympic Games Anthropological Project, ed. J.E.L. Carter, pp. 53-80. Basek Karger.

Carter, J.E.L., Ross, W.D., Duquet, W. and Aubry, S.P. (1983). Advances in somatotype methodology and analysis. Yearbook of Physical Anthropology. 26:193-213.

Census of India, 1971. Series 13, Meghalaya General Population Tables, Part II - A. Published by the Controller of Publications, Delhi.

Census of India, 1991. Meghalaya Provisional Population Totals, Series 16, Paper I. Tapan Senapati, Director of Census Operations, Meghalaya.

Chatterji, S.K. (1974). Kirata-Jamakrti. The Asiatic Society, Calcutta (Reprint).

Chovanova, E., Bergman, P. and Stukovsky, R. (1981). The share of heredity on forming a somatotype. Sbornik VR UV CSTV, 'Telesna Kultura V Zivote dietata. Sport (Bratislava), 12:218-221.

Chovanova, E., Bergman, P. and Stukovsky, R. (1982). Genetic aspects of somatotypes in twins. Modern Man Anthrop. (Brno.), 22:5-12.

Claessens, A. (1981). Stability of the body structure and of the somatotype. Follow up study on Belgian boys aged 13 to 18 years. Ph.D. Dissertation, Katholieke Universiteit Leuven, Belgium.

Clarke, H.H. (1971). Physical and Motor Tests in the Medford Boys Growth Study. Englewood Cliffs, N.J: Prentice-Hall.

Clarys, J.P., Borms, J. and Hebbelinck, M. (1970). Somatotypologie by Kinderen uit het lager onderwijs (Somatotypology of children from primary education). Belgisch Archief Van Sociale Geneeskemde en Hygiene. 6: 427-440.

Conrad, K. (1963). Der Konstitutionstypus. Z. Aufl. Berlin: Springer.

Cureton, T.K. (1947). Physical Fitness, Appraised and Guidance. London: Kimpton.

Damon, A. (1965). Delineation of the body build variables associated with cardiovascular diseases. Annals of the New York Academy of Sciences. 126:711-727.

Damon, A. (1970). Constitutional medicine. In: Ovon Mering and L. Kasdan (eds.), Anthropology and the Behavioral and Health Sciences. Pittsburgh: Univ. of Pittsburgh Press, pp. 179-195.

Damon, A. and McFarland, R.A. (1955). The physique of bus and truck drivers, with a review of occupational anthropology. Am. J. Phys. Anthrop. 13:711-42.

Damon, A., Bleibtreu, K., Elliot, O. and Giles, E. (1962). Predicting somatotype from body measurements. Am. J. Phys. Anthrop., 20:461-474.

Das, B.M. (1978). Variation in Physical Characteristics in the Khasi Population of North-East India. The Bulletin of the Department of Anthropology. Vol. 7-8.

De Garay, A.L., Levine, L. and Carter, J.E.L. (1974). Genetic and Anthropological Study of Olympic Athletes. New York: Academic Press.

D.I.P.R. (1991). Meghalaya Land and People. Published by D.I.P.R., Government of Meghalaya.

Dkhar, J.W. (1991). Somatotypes of Football Players of Meghlaya. M. Phil Thesis (Unpublished), Department of Anthropology, North-Eastern Hill University, Shillong.

Dkhar, J.W. and Pathak, R.K. (1996). Somatotypes of the Khasi and the Jaintia men of Meghalaya. (Unpublished paper), Department of Anthropology, NEHU, Shillong.

Dupertuis, C.w. and Emanuel, I. (1956). A Statistical Comparison of the Body Typing Methods of Hooton and Sheldon. U.S. Air Force, Wright Air Development Center, WACD Technical Report 56-366, (Astia Document AD 97205).

Duquet, W. (1980). Studie Van de toepasbaarheid Van de Heath & Carter Somatotype methods op Kinderen Van 6 tot 13 jaar (Applicability of the Heath-Carter Somatotype Method from 6 to 13 year old children). Ph.D. dissertation, Vrije Universiteit Brussel, Belgium.

Duquet, W., Hebbelinck, M. and Borms, J. (1975). Somatotype distributions of primary school boys and girls. In: Proceedings of the 18th International Council on Health, Physical Education and Recreation, ed. D. Schmull, pp. 326-334. Zeist, The Netherlands: The Jan Luiting Foundation.

Eiben, O.G. (1985). The Kormend Growth Study, Somatotypes. In: Physique and Body Composition. Vol. 16, ed. O.G. Eiben, pp. 37-52. Budapest: Humanbiologia Budapestinensis.

Eiben, O.G., Bosze, P., Laszlo, J. and Gaal, M. (1985). Somatotype of patients with streak gonad syndrome. In: Physique and Body Composition, Vol. 16, ed. O.G. Eiben, pp. 53-64. Budapest: Humanbiologia Budapestinensis.

Farmosi, I. (1982). Results of Constitutional and Motor Examination of Male Athletes. Glasnik Anthropoloskog Drustva Jugoslavije. 19:35-51.

Fitt, A.B. (1941). Cf. Chopra, S.R.K. (1982). In: Application Areas of Anthropology 1. (Ed.), A. Mahajan and S. Nath (1992). Reliance Publishing House, New Delhi.

Fisher, R. (1975). Grandmothers and granddaughters: A descriptive and comparative study of selected measurements. Ph.D. Thesis. University of Southern California, Los Angeles.

Fredman, M. (1972). Somatotypes in a group of Tamil diabetics. South African Medical Journal, 46:1836-1837.

Fredman, M. (1974). Body constitution and blood glucose and serum insulin levels in a group of Tamil Indians. In: The Regulation of the Adipose Tissue Mass. Ed. J. Vague and J. Boyer, pp. 194-197. Amsterdam: Exerpta Medica.

Gait, E. (1967). A History of Assam. Thacker Spink and Company, Calcutta (Reprint).

Garn, S.M. (1952). Am. J. Phys. Anthrop., 10:169-192. In: Application Areas of Anthropology 1, (Ed.), A. Mahajan and S. Nath (1992). Reliance Publishing House, New Delhi.

Greenbe, G.A. (1986). The relationship of somatotype and isokinetic strength measures to lower extremity injuries in female athletes. In: Kinanthropometry III, ed. T. Reilly, J. Watkins and J. Borms, pp. 191-196. London: Spon.

Greulich, W.W. (1957). Am. J. of Phys. Anthrop., 15:489. In: Application Areas of Anthropology I, (Ed.), A. Mahajan and S. Nath, (1992). Reliance Publishing House, New Delhi.

Grewal, R. and Sidhu, L.S. (1984). Effect of training on subcutaneous and lean tissue of top class female volleyball players. Hung. Rev. Sports Medicine, 25: 57-74.

Guedes, D.P. (1983). Estudos antropometricos entre escolares. Reviste Brazileire de Educao Fisica & Desportos, Out/Mar, 12-17.

Gyenis, G. (1985). Body composition and socio-economic factors in male university students in Hungary. In: Physique and Body Composition, Vol. 16, ed., O.G. Eiben, pp. 65-70. Budapest: Humanbiologia Budapestinensis.

Haddon, A.C. (1925). Races of Man. Macmillan.

Handa, N., Karir, B.S. and Kaul, S. (1995). Somatotype changes during adolescence in Jat Sikh boys of Chandigarh. Journal of the Indian Anthropological Society. Vol. 30(1):85-88.

Haley, J.S. (1974). The somatotypes of fifteen-year-old male basketball players, distance runners and sprinters. M.A. Thesis. San Diego State University.

Heath, B.H. (1963). Need for modification of Somatotype Method. Am. J. Phys. Anthrop., 21:227.

Heath, B.H. and Carter, J.E.L. (1966). A Comparison of Somatotype Methods. Am. J. Phys. Anthrop., 24:87-99.

Heath, B.H. and Carter, J.E.L. (1967). A modified somatotype method. Am. J. Phys. Anthrop., 25:57-74.

Heath, B.H. and Carter, J.E.L. (1971). Growth and Somatotype patterns of Manus children, Territory of Papua and New Guinea: Application of a modified somatotype method to the study of growth pattern. Am. J. Phys. Anthrop., 19:173-184.

Hebbelinck, M., Duquet, W. and Ross, W.D. (1973). A practical outline for the Heath-Carter Somatotyping method applied to children. In: Pediatric Work Physiology Proceedings, 4th International Symposium, 71-84. Wingate Institute, Israel.

Hebbelinck, M., Ross, W.D., Carter, J.E.L. and Borm, J. (1990). Anthropometric characteristics of female Olympic rowers. Canadian Journal of Applied Sport Sciences, 5:255-262.

Hellerstein, H.K., Friedman, E., Brdar, P.J., Weiss, M. and Dupertuis, C.W. (1969). A comparison of the personality of adult subjects with rheumatic heart disease and with arteriosclerotic heart disease. In: Rehabilitation of Non-Coronary Heart Disease, ed. H. Denolin, pp. 220-282. Symposium by the Council of Rehabilitation of the International Society of Cardiology, Hohenried.

Hirata, Kin Itsu. (1966). Physique and age of Tokyo Olympic Champion. Journal of Sports Medicine and Physical Fitness, 6:207-222.

Halopainen, S., Lumiaho-Hakkinen, P. and Telama, R. (1984). Level and rate of development of motor fitness, motor abilities and skills by somatotype. Scandinavian Journal of Sports Sciences, 6(2):67-75.

Holtker, G.I. (1949). Act. Med. Scand., 142:367. In: Application Areas of Anthropology 1, (ed.) A. Mahajan and S. Nath (1992). Reliance Publishing House, New Delhi.

Hooton, E.A. (1951). Handbook of Body Types in the United States Army. Cambridge, Mass: Harvard University Department of Anthropology.

Hunt, E.E. Jr. (1981). The Old Physical Anthropology. Am. J. Phys. Anthrop., 56:339-346.

Hulse, F.S. (1981). Habits, habitats and heredity: a brief history of studies in human plasticity. Am. J. Phys. Anthrop., 10:55-67.

Imlay, F.A. (1966). The physiques of college baseball players in San Diego, California. M.A. Thesis. San Diego State College.

Julian, D.G. (1970). Cardiology. Baillure Tindall and Cassell, London.

Kahlar, R. (1987). A study of Anthropometric measurements of Punjabi females of 17 to 20 years in Chandigarh. M.Sc. Thesis. Unpublished. Panjab University, Chandigarh.

Kansal, D.K., Verma, S.K. and Sidhu, L.S. (1980). Anthropometric characteristics of Indian University Zonal Champion football players. Journal of Sports Medicine and Physical Fitness. 20:275-284.

Kansal, D.K. (1981). A study of age changes in physique and body composition in males of two communities of Punjab. Ph.D. Thesis. Punjabi University, Patiala.

Kansal, D.K., Verma, S.K., Sidhu, L.S. and Sohal, M.S. (1983). Physique of hockey, Kabaddi, Basket ball and Volley ball players. Journal of Sports Medicine and Physical Fitness, 23:194-200.

Kaul, S.S., Karir, B.S. and Monika. (1994). Parent-daughter somatotype similarities among the Punjabi adolescent girls in Chandigarh. Auxology'94 Human Biol. Budapest, 25:415-418.

Kaul, S.S., Karir, B.S. and Handa, N. (1996). Somatotype variations in India. In: Human Biology - Global Developments, eds. L.S. Sidhu and S.P. Singh, pp. 61-82. U.S.G. Publishers and Distributors, Ludhiana.

Kroll, W. (1954). An Anthropometric study of some big ten varsity wrestlers. Res. Quart., 25:307.

Kovar, R. (1977). Somatotype of twins. Acta Universitatis Carolinae, Gymnica, 13(2):49-59.

Lasker, G.W. (1947). The effects of partial starvation on somatotype: an analysis of material from the Minnesota experiment. Am. J. Phys. Anthrop., 5:323-341.

Lasker, G.W. (1960). Am. J. Phys. Anthrop., 18:257-261. In: Application Areas of Anthropology 1. (ed.) A. Mahajan and S. Nath (1992). Reliance Publishing House, New Delhi.

Lewis, S. (1966). The physique of New Zealand basketball players. N.Z.J. Phys. Education, 39:25-36.

Lindegard, B. (1953). Variations in human body build. Acta. Psychiatr. Neurol. (Suppl.), 88:1-63.

Macy, I.G. and Kelly, H.J. (1960). In: Handbook of Research Methods in Child Development, (ed.) P.H. Mussen, University of California.

Mahajan, A. and Nath, S. (1992). Application Areas of Anthropology 1. Reliance Publishing House, New Delhi.

Malhotra, M. (1987). A study of anthropometric somatotypes of 14 to 18 year old Punjabi Sikh females. Unpublished M.Sc. Project Report. Panjab University, Chandigarh.

Mall, T. (1989). Talent Search for Sports. Indian Journal of Sports Sciences, 1(2):1-2, L.N.C.P.E. Gwalior.

Matsudo, V.K.R. (1986). Effects of soccer training on adolescents and adults physical fitness characteristics (In Portuguese). In: Celafiscs-Des Anos de Contribuicao as Ciencias do Esporte, pp. 298-304. Laboratorio de Aptidao Fisica de Sao Caetano do Sul, SP, Brasil.

McLure, C.C. (1967). The physiques of professional and amateur women golfers. M.A. Thesis. San Diego State College.

Medekova, H. and Havlicek, I. (1982). Genetic contingency of Variability of somatic traits in parents and children. Modern Man Anthropos (Brno), 22:13-19.

Meredith, H.V. (1957). The Concept of Development, (ed.) Haris, Minneapolis.

Mitchell, H.S. (1962). J. Am. Diet. Assn., 40:52. In: Application Areas of Anthropology 1, (ed.) A. Mahajan and S. Nath (1992). Reliance Publishing House, New Delhi.

Morris, P.C. (1960). A comparative study of physical measures of women athletes and unselected college women. Ph.D. Thesis, Temple University.

Morton, A.R. (1967). Comparison of Sheldon's trunk-index and anthroposcopic methods of somatotyping and their relationships to the maturity, structure and motor ability of the same boys, nine through sixteen years of age. Ed.D. Thesis. University of Oregon, Eugene (Microcord PE1032).

Munroe, R.A., Clarke, H.H. and Heath, B.H. (1969). A somatotype method for young boys. Am. J. Phys. Anthrop. 30:195-201.

Nehru, V. (1985). Somatotypes of young adult North Indian girls. M.Sc. Project Report. Unpublished. Panjab University, Chandigarh.

Osborne, R.H. and De George, F.V. (1959). Genetic Basic of Morphological Variation: An Evaluation and Application of the Twin Study Method. Harvard University Press, Cambridge, Mass.

Ostyn, M., Simons, J., Beunen, G., Renson, R. and Van Gerven, D. (1980). Somatic and Motor Development of Belgian Secondary School Boys. Leuven: Leuven University Press.

Pakem, B. (1979). Sources of the Early History of the Jaintias. In: Sources of the History of India, Vol. 11, (ed.), S.P. Sen, Institute of Historical Studies, Calcutta.

Parnell, R.w. (1954). Somatotyping by physical anthropometry. Am. J. Phys. Anthrop., 12:209-239.

Parnell, R.W. (1957). Physique and mental breakdown in young adults. British Medical Journal, 1:1485-90.

Parnell, R.W. (1958). Behaviour and Physique. London. Edward Arnold.

Parizkova, J. and Carter, J.E.L. (1976). Influence of physical activity on stability of somatotypes in boys. Am. J. Phys. Anthrop., 44:327-340.

Parizkova, J., Adamec, A., Berdychova, J., Cermak, J., Horna, J. and Teply, Z. (1984). Growth, Fitness and Nutrition in Preschool Children. Prague: Charles University.

Perez, B. Castillo, T.L. and Brief, F.K. (1985). Caracteristicas Somatotipicas asociadas conla edad sexo en un grupo de escalres Venezolanos. Caracas: Instituto de Investigaciones Economicas y Sociales. FACES Universidad Central de Venezuela.

Petersen, G. (1967). Atlas for Somatotyping Children. Assen. The Netherlands: Royal Vangorcum and Springfield, Illinois: C.C. Thomas.

Pollitzer, W.S. (1981). The development of genetics and population studies. Am. J. Phys. Anthrop., 56:483-489.

Pugh, L.G.C.E. and Others (1960). A physiological study of channel swimming. Clinical Science, 19:257-273.

Rangan, S.C.B. (1982). Validity of age, socio-economic belonging and dietary type as somatotype determinants in boys of Secondary Schools. Ph.D. Thesis. Bangalore University, Bangalore, India.

Reynolds, E.L. and Sontag, L.W. (1944). J. Pediat., 24:524-535. In: Application Areas of Anthropology 1, (ed.) A. Mahajan and S. Nath (1992). Reliance Publishing House, New Delhi.

Richard, O.W. and Kavanagh, A.J. (1945). In: Essay on Growth and Form, Presented to D. Arcy Thompson, Oxford.

Roberts, D.F. (1953). Am. J. Phys. Anthrop., 11:533. In: Application Areas of Anthropology 1, (ed.), A. Mahajan and S. Nath (1992). Reliance Publishing House, New Delhi.

Roberts, D.F. and Bainbridge, D.R. (1963). Nilotic physique. Am. J. Phys. Anthrop., 21:341-370.

Roy, S.K. (1990). The Concept and Method of Anthropometric Somatotype with an example from Oraon tea garden labourers of Jalpaiguri District, West Bengal. Journal of the Indian Anthropological Society, Vol. 25, No. 2:129-140.

Rymbai, R.T. (1979). History of the Khasi and Jaintias in the Pre-British Period. In: Sources of the History of India, Vol. 11, (ed.) S.P. Sen, Institute of Historical Studies, Calcutta.

Seltzer, C.C. and Mayer, J. (1969). Body build (somatotype) distinctiveness in obese women. Journal of the American Diabetic Association, 189(9):677-684.

Sethi, H.K. and Sidhu, L.S. (1992). Somatotypes of Sports boys from 13 to 18 years. Indian Journal of Sport Science and Physical Education, 4(1):38-41.

Sharma, S.S. and Shukla, B.R.K. (1981). A comparative study of somatological variation among athletes. Indian Journal of Physical Anthropology and Human Genetics 7(3):189-194.

Sharma, S.S. and Shukla, B.R.K. (1982). Kinanthropometry of soccer players with respect to their field positions. International Congress Sports Sciences, NIS, Patiala, Abst. 33-34.

Sharma, S.S. and Shukla, B.R.K. (1985). Kinanthropometry of Indian Junior Football Players. Proceedings, 72nd Indian Science Congress, Part IV, p. 68.

Sharma, S.S. and Shukla, B.R.K. (1988). Somatic Constitution of Athletes in India. Journal of Sports Medicine and Physical Fitness. 28:194-199.

Sharma, S.S. and Shukla, B.R.K. (1989). A comparative study of Indian/Pakistani hockey players on some selected physical and physiological variables. Paavo Nurmi Congress, University of Turku, Finland.

Sharma, S.S., Shukla, B.R.K. and Singh, K. (1984). Kinanthropometry of Indian Junior Athletes. 1984 Olympic Scientific Congress, Oregon (USA).

Sheldon, W.H., Stevens, S.S. and Tucker, W.B. (1940). The Varieties of Human Physique. New York: Harper and Brothers.

Sheldon, W.H. (with the collaboration of S.S. Stevens) (1942). The Varieties of Temperament. New York: Harper and Brothers.

Sheldon, W.H. (with the collaboration of E.E. Hartl and E. McDermott) (1949). Varieties of Delinquent Youth. New York: Harper and Brothers.

Sheldon, W.H., Dupertuis, C.W. and McDermott, E. (1954). Atlas of Men. New York: Harper Brothers.

Shelley, M.E. 91960). Maturity, structure, strength, motor ability and intelligence test profiles of outstanding elementary school and junior high school athletes. Master's Thesis. University of Oregon.

Sidhu, L.S. and Kausal, D.K. (1974). Comparative study of body composition of Jat Sikhs and Banias of Punjab (India). Zeitschrift fur Morphologie and Anthropologie, 65:276-284.

Sidhu, L.S. and Singh, S.P. (1975). A study of somatotype distribution of sportsmen specialising in different events. Sports Medicine, 4:13-19.

Sidhu, L.S. and Wadhan, S.P.S. (1975). A study of somatotype distribution of sportsmen specializing in different events. Sports Medicine, 4:13-19.

Sidhu, L.S., Grewal, R. and Verma, S.K. (1984). Positional differences in physique and body composition among top level Indian women hockey players. Journal of Sports Medicine and Physical Fitness, 24:331-342.

Sidhu, L.S., Singh, J., Chugh, O.P. and Sohal, M.S. (1989). Physique and body composition of Indian national police players of team games. Indian Journal of Sports Sciences and Physical Education, 1(2):29-34.

Sidhu, S., Herm, K.P. and Sodhi, H.S. (1989). Somatotype of State level women participants in hockey, basketball, volleyball and athletics using Cornad Method. Indian Journal of Sports Sciences and Physical Education, 1(2):41-50.

Sinclair, G.D. (1966). Stability of physique types of boys nine through twelve years of age. M.Sc. Thesis, University of Oregon, Eugene.

Sinclair, G.D. (1969). Stability of somatotype components of boys aged twelve through seventeen years and their relationship to selected physical and motor factor. Ph.D. Thesis, University of Oregon, Eugene.

Singal, P. and Sidhu, L.S. (1984). Age changes and comparison of somatotypes during 20 to 80 years in Jat-Sikh and Bania females of Punjab (India). Anthropologia Anzeigor., 42:281-289.

Singal, P. and Kaur, S. (1993). Physique and body composition of urban and rural Jat Sikh girls of Punjabi. Indian Journal of Sport Sciences and Physical Education, 5(1):47-49.

Singh, S.P. (1978). Growth patterns from 4 to 20 years of male Rajput Gaddis-a Himalayan Tribe. Ph.D. Thesis. Punjabi University, Patiala.

Singh, S.P. and Sidhu, L.S. (1980). Changes in somatotypes during 4 to 20 years in Gaddi Rajput boys. Zeitschrift Fur Morphologie und Anthropologie. 71:285-293.

Singh, S.P. and Malhotra, P. (1989). Kinanthropometry. Lunar Publications, Patiala, India.

Singh, L.P. and Singh, S.P. (1991). Physical growth and anthropometric somatotype of Rajput and Brahmin boys of Chamba District, Himachal Pradesh. Journal of Human Ecology, 2(2):121-126.

Singh, S.P., Sidhu, L.S. and Malhotra, P. (1985). Body morphology of high altitude Spitians of North West Himalayas. Unpublished paper, Human Biology, Punjabi University, Patial, India.

Singh, S.P., Sidhu, L.S. and Malhotra, P. (1987). Somatotypes of some categories of Sportsmen. Sports Sciences. 55-65.

Skibinska, A. and Sklad, M. (1979). Genelyczene uwarunkonia somatotype Sheldona (Genetic Conditioning of the Sheldonian somatotype). Wychowania Fizyczne Sport. 2:3-12.

Slaughter, M.H., Lohman, T.G. and Misner, J.E. (1977). Relationship of somatotype and body composition to physical performance in 7-12 year old boys. Research Quarterly. 48:159-168.

Slaughter, M.H., Lohman, T.G. and Misner, J.E. (1980). Association of somatotype and body composition to physical performance in 7-12 year old girls. Journal of Sports Medicine and Physical Fitness, 20 (2):189-198.

Sodhi, H.S. (1976). The physique and body composition of Indian athletes and sportsmen of selected physical activity. Ph.D. Thesis. Punjabi University, Patiala.

Sodhi, H.S. (1980). A study of morphology and body composition of Indian basketball players. The Journal of Sports Medicine and Physical Fitness, 20(4):413-422.

Sodhi, H.S. (1985). International Workshop on Talent Scoutingfor Future Top Class Athletes. IOC/ICSSPE Project. Special Lecture, London.

Sodhi, H.S. (1991). Sports Anthropometry (A Kinanthropometric Approach). Anova Pulbications, Mahali.

Sodhi, H.S. and Sidhu, L.S. (1984). Physique and Selection of Sportsmen: A Kinanthropometric Study. Patiala: Punjab Publishing House.

Spain, D.M., Nathan, D.J. and Gellis, M. (1963). Weight, Body type, and the prevalence of coronary atherosclerotic heart disease in males. American Journal of Medicine and Sciences, 245:63-68.

Sports Authority of India (1990). Protocol for Application of Battery Tests for Identification of Talent for National Sports Talent Contest Scheme. Jawaharlal Nehru Stadium.

Stepnicka, J. (1976b). Somatotypes of Behemian and Moravian Youth. Acta Facultatis Medical Universitatis Brunensis, 57:233-242.

Stepnicka, J. (1976c). Somatotype, body posture, motor level and motor activity of youth. Acta Universitatis Carolinae, Gymnica, 12:81-93.

Stepnicka, J. (1977). Somatotypes of Czeckoslovak athletes. In: Eiben, G. (ed.), Growth and Development: Physique Symp. Biol. Hung., Akedemiai Kaido, Budapest, 20:357-364.

Szmodis, I. (1977). Physique and growth estimated by Conrad's and Heath-Carter's somatocharts in athletic children. In: Growth and Development Physique, ed. O. Eiben, pp. 407-415. Budapest: Akedemiai Kiado (Hungarian Academy of Sciences).

Talwar, I., Kaul, S., Karir, B.S. and Kaur, T. (1994). Socio-economic differences in somatotypes of Punjabi adolescent girls. Indian Journal of Sports Sciences and Physical Education, 6(2):103-111.

Tanner, J.M. (1956). Physique, character and disease. A contemporary appraisal. Lancet, 271:635-637.

Tanner, J.M. (1962). Growth at Adolescence. Oxford, Blackwell.

Tanner, J.M. (1964). The Physique of the Olympic Athlete. London: George Allen and Unwin.

Tanner, J.M. and Whitehouse, R.H. (1982). Atlas of Children Growth. New York: Academic Press.

Tanner, J.M. (1953). Growth and Constitution. In: Alkroeber (ed.), Anthropology Today. Chicago: University of Chicago Press, 750-770.

Tittel, K. and Wutscherk, H. (1972). Sportanthropometrie. Leipzig: Johann Ambrosius Barth.

Toriola, A.L. and Igbokwe, N.U. (1985). Relationship between perceived physique and somatotype characteristics of 10 to 18 year old boys and girls. Perceptual and Motor Skill, 60, 878.

Toteva, M. (1986). Somatotype characteristics of children at primary school age. In: Kinanthropometry III, ed. T. Reilly, J. Walkins and J. Borms, pp. 58-62. London: Spon.

Tucker, W.B. and Lessa, W.A. (1940). Man: a constitutional investigation. Q. Rev. Biol., 15:411-455.

Viola, G. (1932). La Constituzione Individuale. Bologna L. Cappelli.

Walker, R.N. (1978). Pre-school physique and late adolescent somatotype. Annal of Human Biology. 5:113-129.

Weiner, J.S. and Lourie, A. J. (1981). Practical Human Biology. London: Academic Press.

Whitacre, J. and Grimes, E.T. (1959). Child Development, 30:177.

Weiley, R.C. (1963). Single year and longitudinal comparisons of maturity, physique, structural strength and motor characteristics of twelve participants. Doctoral dissertation, University of Oregon, Oregon.

Wilson, D.C. and Sutherland, I. (1950). Brit. Med. J. 1:1267. In: Application Areas of Anthropology 1, (ed.), A. Mahajan and S. Nath (1992). Relia ce Publishing House, New Delhi.

Wilson, D.C. and Sutherland, I. (1953). Brit. Med. J. 2:607. In: Application Areas of Anthropology 1, (ed), A. Mahajan and S. Nath (1992). Reliance Publishing House, New Delhi.

Zimba, D.T. (1989). Geography of Meghalaya. 4th Ed. Published by P. Zimba, Printed at New Milani Press, Siliguri.

Zuk, G.H. (1958). The plasticity of physique from early adolescence through adulthood. Journal of Genetic Psychological. 92:205-219.
