41164

National Library of Canada | Bibliothèque nationale du Canada | **CANADIAN THESES ON MICROFICHE** | ***THÈSES CANADIENNES SUR MICROFICHE***

NAME OF AUTHOR/*NOM DE L'AUTEUR* Nancy Olive May WHITTINGHAM.

TITLE OF THESIS/*TITRE DE LA THÈSE* Anthropometric Prototypes of Girls and Boys Age 6-18 Years Exemplified by Structure Analysis of sub-12 year old Figure Skaters.

UNIVERSITY/*UNIVERSITÉ* Simon Fraser

DEGREE FOR WHICH THESIS WAS PRESENTED/ *GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE* M.Sc. (Kinesiology)

YEAR THIS DEGREE CONFERRED/*ANNÉE D'OBTENTION DE CE GRADE* 1978.

NAME OF SUPERVISOR/*NOM DU DIRECTEUR DE THÈSE* Dr. W.D. Ross.

Permission is hereby granted to the NATIONAL LIBRARY OF CANADA to microfilm this thesis and to lend or sell copies of the film.

The author reserves other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without the author's written permission.

L'autorisation est, par la présente, accordée à la BIBLIOTHÈQUE NATIONALE DU CANADA de microfilmer cette thèse et de prêter ou de vendre des exemplaires du film.

L'auteur se réserve les autres droits de publication; ni la thèse ni de longs extraits de celle-ci ne doivent être imprimés ou autrement reproduits sans l'autorisation écrite de l'auteur.

DATED/*DATÉ* August 24th, 1978 SIGNED/*SIGNÉ*

PERMANENT ADDRESS/*RÉSIDENCE FIXE* [redacted]

NL-91 (3-74)

National Library of Canada
Cataloguing Branch
Canadian Theses Division
Ottawa, Canada
K1A 0N4

Bibliothèque nationale du Canada
Direction du catalogage
Division des thèses canadiennes

NOTICE

The quality of this microfiche is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us a poor photocopy.

Previously copyrighted materials (journal articles, published tests, etc.) are not filmed.

Reproduction in full or in part of this film is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30. Please read the authorization forms which accompany this thesis.

THIS DISSERTATION
HAS BEEN MICROFILMED
EXACTLY AS RECEIVED

AVIS

La qualité de cette microfiche dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de mauvaise qualité.

Les documents qui font déjà l'objet d'un droit d'auteur (articles de revue, examens publiés, etc.) ne sont pas microfilmés.

La reproduction, même partielle, de ce microfilm est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30. Veuillez prendre connaissance des formules d'autorisation qui accompagnent cette thèse.

LA THÈSE A ÉTÉ
MICROFILMÉE TELLE QUE
NOUS L'AVONS REÇUE

NL-339 (3/77)

ANTHROPOMETRIC PROTOTYPES FOR BOYS AND GIRLS AGED 6 TO 18, EXEMPLIFIED BY STRUCTURE ANALYSIS OF SUB-12 YEAR OLD FIGURE SKATERS.

by

Nancy Olive May Whittingham

A.U.A. Physical Education, University of Adelaide,
Australia. 1957
B.Sc. Honours, Physiology, University of Adelaide,
Australia. 1972
Diploma in Teaching, Secondary Education. Teachers College
Adelaide, Australia. 1969

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE (KINESIOLOGY)
in the Department
of
Kinesiology

Simon Fraser University

August 1978

APPROVAL

Name: Nancy Olive May Whittingham

Degree: Master of Science (Kinesiology)

Title of Thesis: Anthropometric Prototypes for Children Aged 6 to 18, Exemplified by Structure Analysis of Sub-12 Year Old Figure Skaters.

Examining Committee:

Chairman: A.E. Chapman.

William D. Ross
Senior Supervisor

John Dickinson

Margaret Savage

Bruce Howe
External Examiner

University of Victoria

Date Approved: August 21, 1978

PARTIAL COPYRIGHT LICENSE

Title of Thesis/Dissertation:

Anthropometric Prototypes for Boys and Girls Aged 6 to 18, Exemplified by Structure Analysis of Sub-12 Year Old Figure Skaters

Author:

(signature)

Nancy Whittingham

(name)

August 24th, 1978

(date)

ABSTRACT

The physical appraisal and guidance of children and youth requires peer group reference material. Application of anthropometry in Canadian industrial, medical, educational and governmental pursuits and the supporting research ventures has been frustrated by the unavailability of comprehensive normative data.

The purpose of this study was to assemble prototypical data by means of 34 anthropometric items measured by trained anthropometrists using a standarized protocol. Data were collected on 446 girls and 477 boys aged 6 to 18 years who were students attending three selected schools in the Coquitlam municipality of Vancouver, British Columbia, which had average or better than average physical education and activity programs.

The assembled data were used to develop 26 age-sex prototypes described in terms of means, standard deviations and percentiles. The complete data are available in hard copy addendum volumes.

Mean height and weight values from the COGRO study were found to approximate similar studies reported from the U.S.A. (1977), Switzerland, (1971), Norway, (1975), and Czechoslovakia, (1976). However Indian data (1971) were dissimilar in that children at the same age as COGRO children, were smaller and lighter. COGRO data were similar to anthropometric data reported in essentially a population survey of 60,000 Manitoba school children in 1970.

The use of these prototypes as a standard reference for comparative studies was considered on the basis of national and international anthropometric similarities.

The applicability of the assembled data was shown in comparing outstanding sub-12 years old girl figure skaters with an appropriate age-sex prototype. From the analysis of raw data, skaters were identified as being smaller in 18 out of 20 selected variables. The determination of proportionality values for 13 anthropometric variables detected specific proportionality differences between the skaters and the prototype. The skaters exhibited significantly low skinfold thicknesses, proportionately large feet, and proportionately shorter lower arms. These particular features were suggested as being specific to figure skaters and were discussed in terms of training and possible delayed maturation phenomena.

The prototypes described and exemplified in this thesis were proposed as a new analytical tool for health professions and human biologists who require comprehensive anthropometric information on children and youth.

In Memory

of

ELIZABETH

ACKNOWLEDGEMENTS

In a study of such magnitude, there must of necessity be a large number of people, without whom the work could never have been undertaken.

The data was largely assembled by unpaid kinanthropometrists, who were at times sceptical that the task was even possible, and whose only compensation was the pride in their accomplishment, a t-shirt and an honorarium in the form of symposium and anthropometric certification course fees from funds provided by the National Research Council Canada in an operational grant for kinanthropometric research awarded to Dr. William D. Ross. So to Alison Rapp, Don Drinkwater, Roger Miller, Bill Ross and Richard Ward I say 'Thank you, and congratulations on a job well done.'

George Longstaff, Superintendent of Physical Education for the Coquitlam School Board, the Principals, staff and students, were always most cooperative and gave succour to our sometimes flagging spirits.

The 42 students who served as recorders and assistants were invaluable, and making frequent visits to distant schools between their classes, were rewarded with a t-shirt and the learning experience afforded them by COGRO.

I am deeply indebted to Marlene Hancock not only for her help in the preparation of this thesis but also for her acceptance of me into her family at a time when I doubted that I could complete the course.

Thanks also to Debbie Quercetti for her labour at the computer terminal and a special thanks to Don Drinkwater for his wizardry with the computer programmes and his immaculate data collection system.

I am indebted to Ms. Savage and Dr. Dickinson for their help and guidance in the preparation of this thesis.

Finally thanks to Dr. Ross, for his unswerving optimism which drew together the COGRO unit and provided the impetus and infectious enthusiasm needed for the completion of the project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

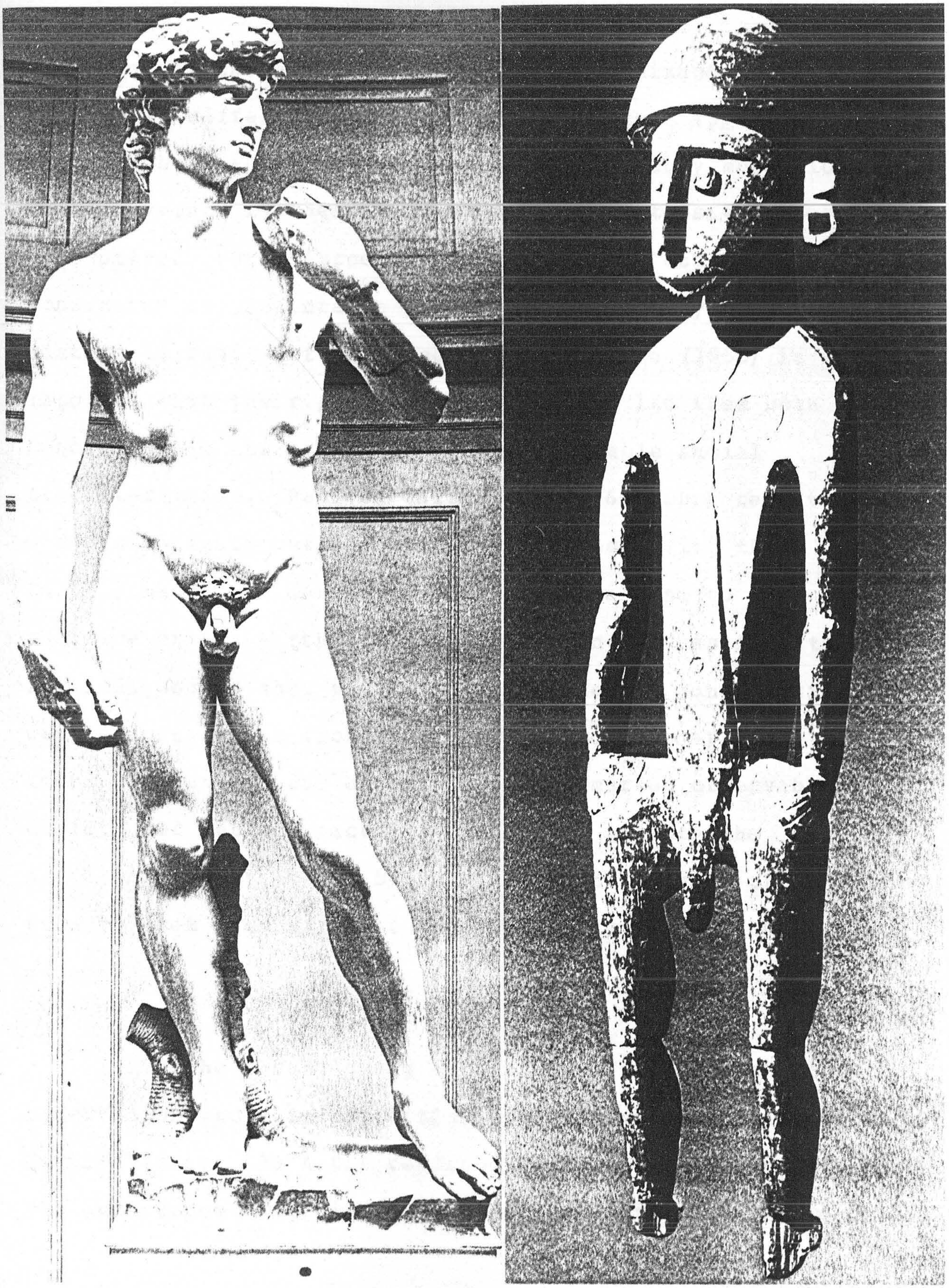
I INTRODUCTION

Since human beings pass from child to adult only once, the anthropometrist has only limited opportunities to measure individuals as they grow. It is important that the growth phenomenon be constantly monitored to detect changes both detrimental and advantageous, which might be reflective of alterations to the environment which influence this process.

When we observe the art forms of primitive man, the anthropometrist wonders at the differences between the form he knows man to have now, and the form in which he was depicted in the artistry of primitive man. Has physical man changed? Has man's perception of himself changed? While we can identify ourselves with Michelangelo's David, it is more difficult to identify with the figure depicted in the New Guinean art form in Figure 1.

Man's interest in his own form started from the very beginning of civilization with pictorial records of man in his natural environment. The cave drawings however, gave little suggestion of individual differences.

Figure 1:Michelangelo's 'David' (Condivi, A., 1976)
and a Primitive art human form (Newton, D., 1967).



Many of the earliest writers were cognizant of individual differences, in body form and this appreciation may have been an initiating factor in the study morphology. While comments by these writers were not extensive, they were perceptive. Both Hippocrates and Aristotle could be considered as pioneers in physical anthropology. From the historical review of anthropology by Slotkin (1965) it was reported that their personal observations led them both to conclude that there were indeed identifiable racial characteristics. Paul of Tarsus (circa 60 A.D.) reported a basic similarity between all men since believing that God,"...made from one, every nation of mankind to live on all the face of the earth..."(Acts 17:26) and it was from this biblical source that the classical belief of monogenesis (the development of man from a single genetic source), took its roots. However, many authors reported marked observable differences between races and this gave rise to the protagonist polygenetic belief, where the origins of man were seen to stem from a number of genetically identifiable groups.

While the Church clung to its belief in monogenesis, observation was more supportive of polygenesis. Isidorus of Seville (circa 630 A.D.) reported racial differences in that "In accordance with diversity of climate, the appearance of men and their colour and bodily size vary...". These types of observations may be seen as the basis of an interest in the comparison of man, the birth of anthropometry and its development into a descriptive, analytical and predictive science.

The fifteenth and sixteen centuries were the era of commercial capitalism and at this time, which included the Renaissance, the breakdown of the theological point of view permitted human dissections and the drawing of man. At the same time the journeys of explorers led to the discovery of different racial groups and forced a re-examination of the origins and similarities of man. It was during this period that Vesalius, described as the founder of modern anatomy, placed physical anthropology on a precise basis. During initial studies in comparative anatomy, he noticed the relationship between the shape of the skull and race, although the suggested cause for skull shape differences now seems somewhat naive. He proposed:

> The Germans, indeed, have a very flattened occiput and a broad head, because the boys always lie on their backs in the cradle ... more oblong heads are reserved to the Belgians ... because their mothers permit their little boys to sleep turned over in their beds, and as much as possible on their sides.

At the same time Montaigne was reporting the existence of racial differences and Bodin was attempting to classify mankind on the basis of climate.

Anthropology did not make the advances in the seventeenth century which were typical in so many of the other sciences, as it was still somewhat restricted by the views on man's heritage in the Old Testament. Noteable during this period was William Pretty who identified mean values of an anthropometric measure and racial differences, as well as generation differences when he wrote;

> ...since wee know that there are men of 7 foot high & others but four foote, that is to say, the one a foote and a half above, & the other a foot and a halfe below the middle stature of mankind which I take to bee 5 foot & a half. I say there may bee Races and generations of such Men, whereof wee know the individualls; as wee see vast differences in the Magnitude of severall other Animalls which bear the same name,...

In this same period Bernier presented a classification of the races, and described the Lapps as '...little stunted creatures with thick legs, large shoulders, short neck, and a face elongated immensely; very ugly and partaking much of a bear." While the observations were descriptive, it was not surprising that the choice of words were considered by some to be derogatory and indeed, the history of modern anthropometry has sometimes been damaged by cries of 'racist' and 'racism'.

In the eighteenth century Linnaeus made an important contribution to physical anthropology in examining the causes of racial differences where he directed his questions to environmental factors such as nutrition, climate, habitual exercise and freedom from disease. This was perhaps the first attempt to identify those factors which modify growth. While he mentioned breast feeding, warmth and the avalability of food as being factors which might influence growth, he did not argue strongly in favour for or against modifiability of of body form due to these factors.

At around the same time Blumenbach among others proposed climate, diet, mode of life, hybrid generation and hereditary peculiarities as the factors which explained the morphological differences to be found in man. These factors were in part supported by Goldsmith. In this same period, Long did little toward the emancipation of the Negro when he attempted to show that the Negro did not belong to the same species as the other races of man. This may have been an attempt to justify the slavery in Jamaica which he was describing.

The nineteeth century was marked by a demand for uniformity and precision in scientific investigation. This could be described as the century of the systematizers. Many investigators were responsible for the invention of instruments and the standardization of procedures for anthropometrical measurement. Shortly after this movement towards descriptive consistency, Meyer, Quetelet and Galton realized the importance of applying statistical methods to anthropological measurements.

Quetelet may be considered as the father of physical anthropology. A mathematitian, astronomer, statistician and sociologist, his great contribution to anthropometry, was the application of statistical methods to the study of human beings. He also pioneered "many of our conventions in cross-sectional sampling and analysis."(Ross et al.,1978).

The value of this historical review from Slotkin, gives us valuable information as to the men and the methods which contributed to the development of physical anthropology.

Commencing as subjective observation, through the contributions of philosophers, inventors, mathematicians and historians, physical anthropology had developed into an objective science with systematized methods and statistical procedures but having to that point, limited applicability.

The twentieth century has seen a growing interest in anthropometry. The coining of the word 'kinanthropometry' is some indication that much of this interest has resulted from studies of physical performance and physical activity. Today there is a tremendous diversity of scientific areas which are being examined from an anthropometrical point of view. There has been a need for greater systematization and standardization of techniques as reflected by the initiation of an international certification course on anthropometric methodology. The rigidity required by this approach places data collection on a precise basis and will enable comparative work to be made more reliably.

The phenomenon of growth is one of the areas into which the kinanthropometrist has turned his attention. It has been recognized that growth patterns can be indicative of the development, health and nutritional status of the individual. Much of man's energies are directed toward providing populations and individuals with living conditions in which their inherited potentialiaties can best be realized, but with this approach there is an inherent danger, that by encouraging uniformity, we are reducing our own capacity for adaptability which may preserve the species in the event of catastrophe.

From anthropometric data an attempt has been made to predict adult stature and to determine selectivity within certain physical activities. Growth assessment can therefore be used as a counselling tool. Accordingly there have been several attempts to identify a child's position, according to his age and with respect to height and weight, when compared to a sample population for which mean values have been calculated. It has been noted however, that a secular change has been occurring. Over a period of time some values have been ever increasing, thus the norms of 10 years ago may be no longer useful - not only may the values themselves be changing, but also the pattern of growth might be expected to change, particularly with the onset of maturity which has a marked influence on the pattern of growth. In general, as discussed later, evidence appears to indicate that this secular trend is diminishing, and may even have ceased. While environmental conditions remain stable it is possible that growth norms will not vary significantly. The present study has given rise to prototypical data which should be seen as a self-monitoring system, enabling the continuous referral of successive sample to indicate significant change, at which time, revision of prototypical data would be necessary. Such revision could be based on significant height and weight differences, detected in any parallel study. It is also possible to develop data banks and use these to furnish updating norms.

Skeletal growth of the long bones is the race which occurs between the proliferation of cartilage cells and the closure of the epiphyses after which no further increase in the length of the bone can occur. Growth is known to be influenced by hormones but many other factors such as genotype, nutrition, activity, disease, infections, malformations, environment and climatic influences create a highly variable phenomenon. It is this variability which led to the development of the concept of skeletal age, as distinct from chronological age. Thus a method using radiographic techniques identified children according to their developmental age. However the reluctance of many parts of the world to use this invasive technique, has reduced the applicability of the method.

The growth of muscle and fat are still topics of controversy. The two processes of hypertrophy and hyperplasia may be involved in both instances and the degree of growth and pattern of growth of those cells is known to be different for male and females, so that body proportions vary between the two sexes and from one year to the next. For the complete and comprehensive assessment of growth, it is desirable to develop norms for large numbers within cohorts (age groups) to provide a standard against which selected individuals and groups can be compared.

One of the restricting influences in the development of these norms has been the perceived inadequacy of cross-sectional studies. While this method may be less desirable, it allows normative data to be produced in a short time, whereas longitudinal data may only be available 10 to 15 years after the commencement of the project and those factors which influence growth may have changed, as perhaps, will have the patterns of growth.

It is through continual monitoring of growth and developmental patterns that nutritional adequacy can be assessed, where modification of other genetic and environmental influences can be monitored, and where counselling can be provided to the individual.

Thus the purpose of this study was to develop male and female prototypical physique descriptions for each age from 6 to 18 using a sub-population of school children in the suburban municipality of Coquitlam, adjacent to Vancouver, British Columbia. This was done by descriptive statistics of selected anthropometric variables which were expressed as means and standard deviations. Also percentile data presented which indicated the extreme cases existing within the cohorts.

It was believed that this selection of children was essentially similar to other Canadian children and to those reported in other areas of the world having made similar technological advances, which are known to be conducive to the attainment of full growth protential. It was also considered that certain measurements a information regarding the health status of the individual and these were given special consideration, namely selected skinfolds and head girth. These aspects are more fully discussed on pages 20-25. Furthermore, while height and weight have been considered as being reflective of nutrition and indicative of the health staus of the individual, other anthropometric variables have been suggested as providing information which can be used as a counselling tool. In the area of sports science, structural specificety has been investigated in olympic athletes and other outstanding performers. However basic structrual data on children has a wider application in scientific and professional concern related to child health and nutrition.

II REVIEW OF LITERATURE

It may be asked, why is it considered necessary to monitor growth and develop standards of measurements for children? Since growth is a natural phenomenon why not accept Nature's dictates? Can man learn anything useful from these standards?

In attempting to understand growth and development, it is necessary to view the organism as an organized totality. To do this adequately the individual factors which contribute to change must be considered and the interrelationships between these factors which produce modification to the change must be assessed. Thus in seeking to discover the source of any change,it is necessary to relate an "immensely complicated system of biological processes to an entire world of social and physical influences that impinge on the individual over a period of time." (Coan, 1966)

It is unfortunate that many of the questions regarding human structure and function can not be answered satisfactorily in terms of statistical certainty, but as pointed out by Ross et al. (1978), this is no reason for dismissing the problem. Masses of data continue to be collected in the hope that out of the chaos, some order will be detected.

Philosophically, the understanding and development of any information aids in the "expansion of human consciousness" (Ross et al.,1978), and because of man's insatiable curiosity, knowledge evolves from many sources, a utilitarian function being adopted at some later date as inevitably more and more scientists investigate and evolve new aspects of the original concept.

THE SIGNIFICANCE OF GROWTH ASSESSMENT

Growth was described by Tanner (1976) as "a fine yardstick of the health of individuals and populations, perhaps the best there is." Likewise Jordan et al. (1975) reporting a Cuban national child growth study for the purpose of monitoring health, described it as "a sensitive index of the health and nutrition of a population."

Stuart and Meredith (1946) saw anthropometry as not only an "adjunct to medical examinations of school children", but also as being related to childrens' probable nutritional state, while Massler and Suher (1951) identified regular and reasonable gain in weight as being evidence of satisfactory health and nutrition, failure to gain weight evidence and a warning that the nutrition was inadequate or that growth was being retarded from within the body.

Other authors who have considered anthropometry as providing information regarding health and nutrition were Pett and Ogilvie (1956) Pryor (1966) Choovivathanavanich and Choovivathanavanich (1972) , Demirjian et al. (1972) Rode and Shephard (1973) , Habicht et al. (1974) , and Hammill et al. (1977)

Thus one of the more important aspects of the study of growth lies in the identification of sound health and nutrition associated with normal growth. Considering the relative simplicity involved in an anthropometric survey, as compared with a nutritional survey or any other methods for estimating changes in nutrition and health status on a national basis, it would seem fortunate that this relationship exists.

The increase in stature, seen in developing countries has been taken to be indicative of an improvement in technology which is probably also highly correlated with better nutrition and health (Irwig, 1976). Furthermore appropriately developed standards can serve as reference against which intervention programs can be evaluated and against which change in health and nutrition can be detected.

It is conceivable that with changes in the eating habits of the so called 'civilized world', together with economic recessions and a diminishing natural food supply, there may be a negative secular trend, populations becoming smaller and ligher,rather than taller and heavier, the situation which has been reported in the past - in the opposite direction to the one reported to be currently disappearing.

Deviation from the normal pattern of growth then may be due to inadequacy of the nutrition of the child and a decline in the health status. In addition it often constitutes a valuable sign of a specific disease or abnormality, as indicated by Vines (1977). While the abnomality may appear to be relatively minor, Vines was concerned that it could have "devastating psychological consequences."

Vines listed the cerebral gigantism of Sotos, the Beckwith- Wiedemann syndrome, Marfans syndrome, homocystinuria and 'pituitary' gigantism as manifesting unusual growth patterns - all characterized by excessive weight. But in Vines' experience most cases of extreme tallness were noticed when an anxious mother presented her daughter whc was larger than other girls of the same age. A little genetic counselling and dissemination of information regarding maturational growth patterns was necessary to allay the psychological and culturally imposed fears of tall girls.

Of more concern was the problem of the short girl - whom Vines considered to lie below the 3rd percentile - who may need further medical investigation with regard to possible systemic desease, malnutrition, emotional deprivation, genetic constitution and endocrine system function all of which singly or in concert predisposed to very short stature which Vines considered was hazardous in that emotional immaturity was prolonged.

Where pubertal delay or precociousness was the contributing factor to unusual shortness or tallness, Brock (1977) sympathized with the mental anguish or embarrassment of the child and he sought a reliable way to predict adult height in order to decide whether or not there should be medical intervention. by sex hormone therapy as outlined by Prader (1977).

Thus the evidence indicates that the monitoring of growth can be an important adjunct in assessing the totality of the physical and emotional development of the individual.

THE SIGNIFICANCE OF SKINFOLDS

It was reported by Choovivathanavanich and Choovivathananich (1972) that the mid-upper arm measurement had, for some time, been employed as a public health index of protein-calorie malnutrition of early childhood in different parts of the world, The authors claimed that this measure could be used, when compared with norms, to detect a deficiency in muscle protein, a diminished availability of calorie storage in the form of subcutaneous fat, or, more wide-spread, a growth failure of the body structures.

Unfortunately the authors employed no definitive landmarks in their measurement techniques and while the they claimed that this was not a significant factor, this was refuted by Ruiz et al. (1971), and is discussed under Errors of Measurement.

In the Western world, allegedly free from the problems of malnutrition and undernutrition, other problems beset the population, in particular, obesity as the result of overnutrition has been identified as one factor which predisposes the individual to diabetes mellitus and coronary heart disease.

Obesity refers to over-fatness (Garn, 1972) and is not necessarily related to weight which is contributed to by muscle and bone as well as fat tissue - a fact which was recognized over 30 years ago.

An operational definition of obesity, proposed previously by Seltzer and Mayer (1965) has been retained i.e. the 85th percentile is taken as the upper limit of triceps skinfold thickness, An individual having values above this, being described as obese.

Thus with accurate skinfold measurements, and by comparison of this with means of past and present populations it should be possible to detect a secular trend in this variable. This would also assist in the identification of persons who are obese and hence identify those who may be at risk in diseases associated with obesity.

Garn also identified the source of variation of skinfolds ('double fat folds') in children aged 2-18, presented in the 10- State Nutrition Survey Report as being a "systematic but non- linear relationship" with economic status. Thus individuals with the higher "Income-Needs Ratio" (INR) 2.25 - 3.00 were reported as being 40% fatter than those of least affluence (INR between 0.00 and 0.75) when triceps skinfold were assessed. The socio-economic influence on skinfold appeared to be dramatic and seemed to be demonstrable in males at all ages through to the ninth decade irrespective of skin colour, living within the same social structure. The positon of these factors with regard to females was much less clear, (Tan et al. 1974), being complicated by the onset of maturation which is related to increasing fat deposition.

In comparing skinfold measurements of high school children in metropolitan Manila, with those of U.S.A. norms, findings revealed racial differences which were in fact ascribed to economic and nutritional differences (Tan et al. 1974).

In the application of normative data to the clinical situation there may be little justification to assume that deviation from the mean is indicative of that deviation being beneficial. Such is the situation with skinfolds. An increasing mean of this parameter is indicative of increases in the quanitity of subcutaneous fat which may be deleterious to the individual and to the population which is used to establish the normative data.

In 1972 Jenicek and Demirjian reported triceps and subscapular skinfold assessment of over 5,000 French-Canadian school age children in Montreal. This was the first attempt at reporting this type of information on Canadian children since 1953. they compared the two sets of data and observed a "secular trend" towards higher fat. They attributed these differences to sampling and technique differences. Had the relevant information been collected, the INR could have provided more evidence of the relationship between economic status on skinfold thicknesses. Similarly with the continuing increase in coronary heart disease, monitoring skinfold thicknesses serially and comparing them with the incidence of disease, could be most informative.

HEAD CIRCUMFERENCE

The value of the measurement of head circumference is now established clinically in that it can indicate pathological mental conditions. Nellhaus (1968) established norms for this measurement from literature in the previous 20 years. He indicated that children with a head circumference two standard deviations from the mean, might show mental retardation which was suggestive of Down's syndrome. Furthermore, because of the apparent stability of head circumference in chilldren at various age levels, he suggested that any measurement more than the mean could be considered as atypical, and the indivdual's development required attention.

While this type of condition is more likely to be detected routinely between birth and two years of age, such measurement could be diagnostic for conditions such as hydrocephalus, and traumatic subdural hematomas, which may occur later in childhood. Further, Stephenson et al. (1968) investigating height and weight relationships in cerebral gigantism found that eight out of ten cases of gigantism displayed advanced height and weight for their age group, falling two to five standard deviations from the mean.

PHYSICAL PERFORMANCE

One of the more recent innovative and stimulating applications of anthropometry has occurred in attempts to identify those characteristics of body build in high performance athletes which would appear to 'select' those individuals who, other things being favourable, are more likely to achieve success.

Subjectively, it is relatively easy to identify between the long distance runner, the shot putter, the jockey and the basketballer on the basis of body size. It is also possible that objective measurement can be used to indicate possible success and moreover that objective data can be used as a tool in athletic counselling when applied to the young child.

In 1968 Clarke, after conducting a longitudinal study on young athletes, reported that at young ages and over a wide range of activities, the individuals who were successful on the athletic teams were those who were taller and heavier than their non-athletic peers. A trend toward taller and heavier athletes competing in the same event was detected by Jokl et al. (1966) in examining these variables during the 1928, 1960 and 1964 Olympic Games.

While this phenomenon could be explained by the secular trend which was still evident at that time, Malina (1972) noted an increase in the height and weight of footballers from 1899 to 1970 which appeared to be more marked than the secular trend, particularly in terms of weight which could not be fully explained in terms of the secular increase in height.

The phenomenon is more likely to be the result of improved technology in the sports services which has provided more information regarding training regimens and diet which have been designed to increase body mass. However it was reported by Garn et al. (1972) that the clinically obese tend to greater stature which might suggest that those individuals are 'selected' preferentially for some activities. However it is intuitive to suppose that in preference to this suggestion, stature is selective only when obesity is not involved.

The advantages of bulk in some athletic events might be seen as being related to strength, stability and the lesser likelihood of injury. However it is obvious that this characteristic may also be a handicap in certain types of athletics, and it is desirable that peculiarities of anthropometric measurement in all athletic endeavours be investigated.

Faulkner (1976) investigated Canadian figure skaters in an attempt to isolate those physical features which seemed predictive of success in that activity. The most significant feature he detected was the proportional shortness of the lower leg in young elite skaters which was consistent with the same dimension in senior elite skaters.

Unfortunately there were no current available Canadian norms to allow a comparison of any of Faulkner's results. Thus he was not able to assess how the young skaters compared with their own age group.

The ability to judge the relative position of the individual with respect to his age group in regard to any one variable is perhaps more indicative of future success than any other comparison. This is especially so if the report by Owen (1973) can be substantiated namely that there is an assumption that "small children tend to continue to be small ... and large children tend to be near the upper percentiles." The accuracy and reliability of that statement can only be judged by extensive longitudinal studies.

PSYCHOLOGICAL CONSIDERATIONS

The idea of a 'sound mind in a sound body' was paraphrased by Krogman (1955) to "a sound developing mind in a sound developing body" when it was suggested that physical growth may affect both the mental and behavioural development of the child.

This line of interest was pursued by Ketcham (1960) Who investigated the physical and mental traits of intellectually gifted and mentally retarded boys, concluding that the intellectually gifted boys were to be found in the higher percentiles with regard to height and weight while the retarded boys were found to be in the lower percentiles. It was tempting to draw the obvious conclusions, but due to the fact that no consideration was given to the maturity or to the social class of the subjects, both of which are known to significantly influence the growth pattern, the results of this survey have little real significance.

Nevertheless Douglas et al. (1965) took into account both social class and the stage of sexual development when reporting that there was a high degree of correlation between educational ability and height and that taller children tended to be superior in measured educational ability and attainment, at least up to 15 years of age.

Lundman (1972), investigating Swedish school children cited the work of Schiotz, who in 1917 proposed that on the average, Norwegian children with taller stature were from wealthier parents than were short children and that on the average, these same tall children achieved higher grades in school. Lundman validated what he referred to as 'Schiotz Rules' and discussed both the genetic and environmental factors which may have had some influence on his work. In addition he found a correlation between the size of head and success at school as well as an association between I.Q. and hair colour. The significance of these correlations have apparently not warranted futher investigation no doubt due to a lack of evidence that there is any real meaning in the correlation.

In his book, "Atlas of Men" in 1954, Sheldon appeared to identify personality with somatotype (boyd build) and it was this unfortunate aspect of his work which brought unfavourable reactions, thus setting back the work on somatotyping.

Walker (1963) examined body build and behaviour in young children, examining, in particular the parents ratings of the behaviour of the child, which he determined to be related to the current status of the childs physique. He detected a quasi-Sheldonian effect, in that the parent viewed the behaviour of the child to be modified by his growth status. It could be argued that this effect might then influence the actual behaviour of the child as well as the personality of the child. Alternatively it could be suggested that children of a particular body build display a certain type of behaviour and personality - an argument which has lost favour since the anti-Sheldonians.

In 1977, Harnett et al. examined personal space in relation to body height. They identified a personal influence which was related to the distance one individual stood from another, such that the taller the subject, the further away an observer stood as if to "mitigate the stimulus characteristics of the tall object person."

While this effect may seem to have little practical application, its identification enables man to more fully understand himself and his relationship with others, mediated to some extent, simply by diferences in stature.

The relationship of stature and presumably other anthropometrical detail to the psychology of the individual is a much more complex consideration than mere physical comparisons. There appear to be more factors which might influence this relationship and the identification of interaction effects between these factors poses an awesome task.

GROWTH STUDIES AND STANDARDS

At a meeting in Tunis, February 1971, of the International Union of Nutritional Sciences, several recommendations were made with regard to the establishment of growth standards. (Committee report, 1972).

From the recommendations, the most significant would appear to have been:

1) Each countries (sic) own standards must be derived from carefully selected samples representing children growing in an optimal environment for that country. Genetic and racial factors must be defined and appropriately represented in the sample.

2) Equally vital is the need for the standards to be derived from accurately obtained basic data. Five measures were recommended viz. height, (nude) weight, upper arm circumference, triceps skinfold and head circumference to three years of age.

3) Cross-sectional studies for the above would produce comparatively rapid results and would be of great practical value. ...these studies should be repeated at intervals of

several years to assess secular growth. Longitudinal study of some of the subjects would be an added and ideal projection.

In considering the first recommendation the determination of any mean parameters assumes that the measurements are distibuted normally i.e. exhibit a Gaussian distribution, and furthermore that the population from which the results are collected are normal with respect to all factors. In man this poses the impossible task of normalizing socio-economic, cultural, genetic, psychological and physical factors. In anthropometrical studies it is not always even possible to identify all these factors. Consequently, descriptions of the population under consideration are by no means definitive, but by considering sufficiently large numbers, variability rather than selectivity is hoped to be expressed in derived data.

Whether or not it is necessary for each country to develop its own standards depends on the questions which are being asked. International comparisions, require one standard reference whereas changes of one group within a country to a similar group within the same country are best detected by comparison against a local standard.

In establishing normative data there are supporters for considering the selection of the subjects living under optimal conditions as opposed to those who support selection of subjects from a middle-class environment and the difficulty of definition of either of these environments is understandably complex . Income, gross national product, education, and freedom from disease are all indicators which could be used to define status.

Tanner (1976) recommended that the "best-off group" should be used and that surveys should be made every five to seven years in all parts of a country. However he also argued against this group being used, recognizing that they mature earlier and grow up taller, thus not fully representing the mean of the population.

Habicht et al. (1974) suggested that "comparisons to estimate the nutrition and health status of populations are best made by choosing a large sample of middle class children ... as the standard comparison."

It might be asked whether we want to change the growth measures and patterns by the manipulation of those factors which influence growth, or does the interest in monitoring growth lie simply in observing changes which occur as ancillary results which are appropriate to the prevailing conditions? In some countries striving to create greater growth in individuals may in fact be deleterious to the whole economy of that country by placing a drain on natural resources. Unfortunately some of the writers in this area imply that biggest is best and smallest is inferior - a philosophy which needs reconsideration.

With regard to the second recommendation, it was in 1927 that Davenport described his reasons for writing his guide to measurement as an attempt to systematize measurement and thereby provide a framework within which differences could be expressed meaningfully and quantitatively. Furthermore he wrote, " We do not measure for measurements, but for scientific comparisons; and hence not a number, but the best number is to be obtained."

Since that publication, several others have appeared (Hrdlicka 1952, Montagu and Ashley 1960, Olivier 1969, Weiner and Lourie 1969, Borms et al. 1977). all have some modifications to Davenport's descriptions, and to others published before them brought about by the experiences of the authors, All showing a progressive degree of definition, up to the most recent publication of Ross et. al. (1977).

Specifications of measuring equipment and explicit instructions to describe the measuring technique, have led to a consistency of data collection where there can be little confusion, and future co-operative, joint international studies and surveys will enjoy a high level of standardization never before possible.

With regard to the third recommendation of the committee, Tanner (1962) reported the oldest study of growth in existence, when Count Philibert Gueneau de Montbeillard recorded the height of his son every six months from birth to eighteen years of age (1759-1777). It was virtually from this longitudinal record that the proliferation of growth curves have developed, and from which growth characteristics have been elucidated.

Typically, there are two methods used in the development of growth curves, namely, longitudinal studies in which the subjects are measured at, say, 6 month intervals over a period of years, and cross-sectional studies in which subjects from all age groups are measured at the one time, once only. Both have been used; both have advantages; both have their limitations; and it is recognized that they cannot be dealt with statistically or conceptually, in the same way.

Schaie (1965) and Baltes (1968) considered that neither types of study were adequate for comparative studies where there are genetic or cultural changes, since neither give information which could be regarded as true age effect. However the claims of these authors have evoked little response from anthropometrists, perhaps due to the sophistication and complexity of the mathematical procedures which they suggest as an alternative - procedures which may be statistically appropriate but conceptually confusing to the person using the derived data.

Meanwhile Van 'T Hof (1977) considered both longitudinal and cross-sectional data as the tests of measurement of growth. The longitudinal study he saw as "one well-defined statistical population." This implies heavy biases and consequently limited applicability. Only when very large populations are investigated using this method may a norm representative sample be tapped. It is characteristic of these studies that they are time consuming and indeed the Leuven Study of 21,174 children from age 12-19 (Simons et. al. 1974) states that after five years they "...need a few more years before all wanted computations and comparisons are carried out." The final report of this study is still not available, and by the time it is, it is conceivable that growth parameters and patterns will have occurred and reassessment will be necessary.

Further Van 'T Hof suggested that cross-sectional data taps different populations and is therefore more variable. This type of study does not give "as consistent a description of growth, and the applications ... are limited." Furthermore, if age effects are being determined, 'cohort effects', due to the secular trend, which accounts for the primary difference between cross and longitudinal studies, as well as 'time of measurement effects' (Billewicz 1967) are both disturbing features. However the presence of the secular trend is in doubt and 'time of measurement' effects can be eliminated by careful study organization, which makes cross-sectional studies more appealing.

Ideally all test measurements should be compared with a normalized sample collected at the same time of measurement to ensure that the standards are appropriate to the time and the place. From a practical point of view, this is obviously not possible.

One of the aims of the present study was to collect data as quickly and economically as possible so that they could be used immediately in any environment which was seen to be genetically, physically and biologically similar to that from which the sample was drawn. For this reason a cross-sectional study was selected despite its limitations. The data which have been collected, now enable an individual's growth attainment to be assessed in comparison with the appropriate age-sex prototype.

FACTORS INFLUENCING GROWTH

As with most areas of the study of human development, the problem of the nature and nurture conflict is equally applicable in terms of physical growth and development. Thus an appraisal of the factors influencing growth involves consideration of genetic constitution and influential environmental factors.

GENETIC CONSTITUTION

It has long been recognized that stature is largely determined by genetic constitution, so that tall parents tend to have tall children and short parents tend to have short children, (Malina et al. 1970.) Furthermore Parnell (1958) noted that there was a strong tendency for children to follow the "parental line principle." This was supported by Osborne and De George (1959) in classical twin studies where arm girth, wrist breadth and, to a lesser degree skinfolds, were seen to follow a familial pattern.

There is nevertheless some degree of variability since tall parents have short children and vice versa. Some of this variability can be attributed to genetic assortment. Furusho (1974) identified additivity of gene action in children in the 6 to 17 years age period, and calculated the presence of 7 gene loci, each having an effect of 3 centimeters, there being also an allele having a negative effect on stature.

Other variability in stature has been related to sereological incompatibility (Wolanski, 1974). This study showed that parents of different ABO blood type had taller children as adults (and in particular, boys) than did parents of the same blood type, perhaps suggesting a modification effect. The same study also suggested that parents with Rh incompatibility produced taller children as adults, but that prior to adulthood the children were relatively shorter for their age.

While there is evidence for genetic variability within a population even greater variability is observed in ethnic comparisons particularly with regard to stature, and a consideration of the Watutsi with a mean adult height of 176 cm., and the Ituri pygmies with a mean adult height of 140 cm. (Habich et al. 1974) quickly illustrates the point. However studies of children of different ethnic origins are lacking (Malina, 1969). Studies by Smit et al. (1967) on white South African Bantu, coloured and Indian children aged 7 -15 years all living in South Africa identified differences between the three groups. However the political situation of that country and the marked heterogeneity of living standards could well have been the major contributing cause of the observed differences. Indeed the criticisms of this study by Marshall (1971) indicated that due to omission of population description, results of statistics and the numbers of subjects involved, this work may be of doubtful value.

Ethnic differences were reported by Barr et al. (1972), investigating children in the San Francisco area between 1967 and 1970. They detected striking differences not only in size but also in the patterns of growth in children of three skin colours.

Lowenstein et al. (1974), comparing Indian, Southern Tunisian, Egyptian and USA children, and Habicht et al. (1974) examining ethnic differences in growth potential, both concluded that while there may be genetic differences as evidenced by children from different countries having different growth patterns and measures, the socio-economic and environment factors play greater roles in growth determination than genetic constitution.

The effect of environment on growth potential was well illustrated by Greulich (1976) who observed the superiority in stature of American born Japanese when compared with native Japanese born children. On the assumption that there were no outstanding genetic differences of the two groups it was suggested that the more favorable conditions of the American population facilitated the better expression of growth potential.

SECULAR TREND

One of the most thorough examinations of the secular trend, i.e. change perceived in different generations, presented by Boyne et al. (1957), when they examined data from British children from 1883 onwards, but concentrated on the period from 1911 to 1953. They indicated a noticeable increase in the height and weight of children at each age level up to that time, and suggested that the "...secular trend is not merely an expression of acceleration of development towards physical maturity, but signifies increasing fulfilment of growth potential and thus implies a net increase in the height of the adult population." But by 1964, Bakwin and McLaughlin were suggesting that the secular increase in growth had been completed by certain sections of the population, in particular entrants to the select public schools of Harvard and Wellesley. Factors which were seen to have contributed to the secular trend but had stabilized were diet socio-economic and outbreeding (heterosis).

The cessation of the secular trend was again identified by Damon (1968) who in examining height and weight in families entering Harvard between 1870 and 1965, suggested that it was in the upper socio-economic group where the cessation apparently first occurred. Implicit in this suggestion was that a cessation could be expected in other socio-economic groups, if better economic conditions could improve the environmental aspects of life in the so-called lower classes.

However Lavelle (1972) could find no decline in the secular trend. Neither could Bowden et al. (1976) nor Blanksby et al. (1974) in their studies of Australian children aged 0-18 and 5-13 in the respective studies. But in the latter study there was a long period between comparisons and there is no certainty that the increase which was observed, had not ceased years before. In both cases failure to isolate socio- economic groups could well have influenced their conclusions in that the lower socio-economic groups might well have been the only ones contributing to the observed changes.

While Damon (1974) still believed body size to be nearly stabilized, Meredith (1976), in a four continent study, continued to refer to a secular increase in mean height during mid-adolescence, declining then to adulthood. He considered this trend as being a phenomenon of childhood and early adolescence, with "growth in body height proceeding at a faster pace in recent decades than about a century ago." Rona and Altman (1977) reported that the secular trend of height increase had stopped in the 5 to 11 age range in English children.

ENVIRONMENT

The living conditions of the individual includes geographical location, nutrition, clothing, housing, and health care; emotional conditions of security, love and family strength; and the environmental conditions which influence psychological development. It is generally impossible to isolate these conditions and so the environment is taken to be defined by the group which is specified.

With regard to geographical location Bergman's Law, (Hulse, 1963) states that "mammals of any one variety which inhabit colder regions are as a rule larger than those of the same variety in warmer regions." This has been found to apply to many species which live in a wide climatic range. It would seem that more often than not, short people native to cold areas are stocky in build, whereas short people native to a hot climate are slight. Thus weight has been found to be related to climate, (Roberts, 1953).

Clegg et al. (1972) observed linearity with increasing altitude and suggested that "lowlanders" have a tendency to be smaller (shorter) than those at low altitude due to an inhibitory effect on genetic expression.

Much of the literature in this area relates to small ethnic groups. Reports have been presented on Czechoslovakian gypsies (Mala, 1973), Canadian eskimos (Rode and Shephard, 1973), northern Indians (Ganguly, 1974) and rural Columbian children (Mueller, 1977). Consensus of opinion was that

1) within a racial groupenvironment has a stronger influence on stature than genetics.

2) within the group differences can be found in environmental (economic) levels which produce differences in stature.

3) levels of health and nutrition are primarily responsible for observed differences.

4) as the full integration of one racial group into a genetically different group takes place, "size differentials will disappear." (Rode and Shepherd).

While it is not possible to relate particular phenotypical differences in body build to particular environmental differences, major relationships can be identified which may give insight into the influence these conditions have on the individual's genotype.

RADIATION

While not the most common environmental condition experienced, one of the most devastating changes to the environment occurred with the explosion of the atomic bomb. Greulich et al. (1953) recorded the adverse changes which occurred in children who survived in Hiroshima and Nagasaki.

Despite improved food and general living conditions, they found retardation in height, weight and skeletal development five and a half years after the blasts. But while radiation may have been the principle cause of the growth retardation, it is also possible that the traumatic physical, emotional and psychological consequences may well have equally contributed.

EXERCISE

Increasing importance is being given to formal physical activity which is by no means synonymous with exercise undertaken as part of environmental or cultural demands. It should therefore be possible to isolate the effect of an exercise program on growth, using longitudinal studies with controls. While this information is by no means definite, evidence seems to indicate that exercise is a stimulant to growth.

Simon (1961) reported an acceleration of growth in body bulk in 14-15 year old children during a six-month training program and Parizkova (1968) in a longitudinal study, detected striking differences in body compositon between more active boys and less active boys, although their basic anthropometry and skeletal maturity did not differ after four years. However it was noted that pelvic breadth in relation to stature and shoulder breadth was narrower in the more active group which led her to suggest that "the skeleton could be influenced by physical exercise ... without remarkable changes in absolute values of most traditionally measured indicators."

Many studies in this area have lacked adequate controls which is a departure from classical experimentation imposed on almost all work in this area, and using the 'technique' of retrospective guesswork could hardly be described as a scientific approach e.g. de Wijn (1968) asking of the ectomorphic child:

> what the pattern of clinical growth ... would be when his father gave him, at an early stage at school, a pair of boots to play football with .... Maybe he would grow up as a medium build muscular type.

More recent studies have strongly pointed to the stimulating effect of exercise on growth. Parizkova (1974) concluded, "It is possible that moderate exercise tends to be detrimental to growth whereas greater quantities or intensities of physical activites enhance growth". In a review of the topic, Rarick (1960) came to a similar conclusion, namely, that there is a minimum level of physical activity which is required to support normal growth. However since growth is influenced by so many factors it is difficult to provide the control conditions which are necessary to determine to what extent exercise contributes to growth. This is reflected by Cumming (1976) when he pessimistically concluded, "We do not know the optimal amount of physical activity for childhood, and likely never will." Similarly Bailey (in press) could be no more definite than concluding that exercise is a "contributing environmental influence to bone growth length and bone density, though the position of children in the latter case is not clear."

Irrespective of the uncertainties, it would seem safe to conclude, as Borms et al. (1974) did, that one of the main aims of physical education, is to provide an activity environment which will contribute to the optimal growth of the individual. The position with regard to severe training regimens for children may need to be approached more carefully.

The literature on growth is evidence of the wide range of interests from which the topic can be viewed. This ranges from the significance of growth assessment, to methodological approaches, to a consideration of the multitude of factors which have been investigated as their modifying influence on the essentially genetically determined phenomenon of growth.

III. METHODS AND PROCEDURES

The project was conceived of as the initial phase of a Coquitlam Growth Study and was soon identified by its computer acronym COGRO. This convention is used throughout the body of the thesis.

SUBJECTS:

The subjects for the present study consisted of 923 school children from three schools in the Coquitlam district of British Columbia, Canada. The children ranged in age from 5.57 years to 18.22 years (girls) and 5.58 years to 18.22 years (boys). Children who had obvious physical handicaps were measured but excluded from the analyes.

The mean and standard deviation in age for each age group and the number of subjects included in the group, are shown in Table 1.

Table 1

GIRLS

AGE MEAN	(S.D.)		NUMBER
6.109	0.343		18
7.009	0.280		25
8.082	0.283		15
9.043	0.304		30
10.127	0.277		20
10.958	0.308		24
11.950	0.300		35
13.065	0.265		37
14.037	0.284		67
15.015	0.282		66
15.919	0.298		52
16.931	0.244		47
17.871	0.248		10
		TOTAL	446

BOYS

5.910	0.237		17
6.937	0.284		22
8.031	0.263		22
8.935	0.280		27
9.994	0.302		21
11.006	0.319		26
11.915	0.306		34
13.100	0.298		35
14.010	0.288		76
14.987	0.261		77
16.014	0.280		56
16.935	0.291		43
17.857	0.219		21
		TOTAL	477

TOTAL (MALES + FEMALES) = 923

The suburban municipality of Coquitlam, adjacent to Vancouver was selected for several reasons:-

a) the superintendent of Physical Education for that school district had earlier, prior to the conception of COGRO, expressed an interest in research of this nature.

b) the area was considered 'mixed' in view of the socio-economic diversity and cultural backgrounds of the general populace.

c) the close proximity to Simon Fraser University facilitated the transportation of equipment and personnel who were to be involved in the study.

The selection of the three particular schools, Glenayre Elementary School (Kindergarten to Grade 7), Mary Hill Junior Secondary (Grades 8 to 10) and Port Moody Senior Secondary (Grades 11 and 12), was based on the following considerations:

a) recommendation by the Superintendent of Physical Education.

b) facilities, staffing and activity programmes of the schools were considered to be representative of schools within the district.

c) the agreement by Principal and staff within the schools to support the project and accept any minor inconveniences which might stem from the study.

Prior to the measuring sessions, students in the selected schools were given a letter of explanation (Appendix A) to take home to their parents. The letter explained the purpose of the study, the methods which were to be employed and gave the parents an opportunity to withdraw their child from the study. In all, five children were withdrawn on parental wishes and one child was excluded as it was necessary for her to wear a heavy body cast as part of her treatment for scoliosis. One 16 year old boy was included since it was possible to make all the anthropometric measures except body weight which was altered by a cast for a broken leg.

PROCEDURE:

The COGRO study was conducted in two parts - anthropometric measurement which is reported herein, and performance testing. The performance tests consisted of a standing broad jump, vertical jump, softball push (throw) and a timed sprint over 6 metres. The results of these tests will be reported elsewhere.

The children from each class reported to the testing area on two occasions within one week, one for each aspect of the total procedure. They were dressed in minimal clothing, generally the boys wore shorts only and girls wore a T-shirt and shorts. The children changed and were assembled by a marshall who gave them instructions for filling in the required information on the data sheets, A sample of which is shown in Appendix B. The class registers were used to record bith date for all elementary school children. Older subjects supplied the information themselves under the supervision of the Marshall. The class was then subdivided, one half going to each of the two test areas.

To gather anthropometric data, the landmarks were identified and the child proceeded to each of six stations which were established to measure:

1) height and weight

2) skinfolds

3) lengths

4) girths

5) breadths

6) sitting height, head and neck girths and A-P chest depth.

Each child moved from station to station with their data sheets. The marshall ensured that there were no long queues at any one station by directing subjects to free stations. This organization enabled, on an average, eighteen children to be measured in one forty minute period.

As children completed their assessement, their data sheets were collected by the marshall who checked for missing or obviously 'errored' items (in either measurement or recording), converted date of birth to decimal years and ensured that the forms were ready for computer input by completing items 1.01, 1.02, 1.03 and 21 on the data sheet. In the evening after each measuring day, all data were entered into information retrieval files (WYLBUR) in readiness for error checking and statistical analysis.

PERSONNEL:

One of six trained and experienced anthropometrists (either faculty members or graduate students from Simon Fraser University-S.F.U.) was responsible for each of the six measurement stations. The measuring skill of the six trained kinanthropometrists had been validated against a single recognized criterion measurer (W.D.R.) Four (D.D., R.M., A.R., W.R.,) had been involved in earlier extensive kinanthropometric studies (Montreal Olympic Games Anthropologic Project, and Canadian Synchronized Swimmers Project). The other two members (R.W., N.W.,) had been involved in extensive, independent kinanthropometric studies.

This team of measurers had contributed to the production of an audio-visual tape on methodological procedures which will be used as a teaching resource. Five of the six members made a positive contribution to the 1st International Course for Kinanthropometric Certification in Brussels, Belgium, July 1978. These six members were solely responsible for all measurement at that station. This meant a minimization of inter-measurer variability which can occur when the same item is measured by different anthropometrists. This procedure has been used in many other studies where inter-measure reliability has been of concern.

Undergraduate students, undertaking a course in Kinanthropometry at S.F.U., were assigned to each of the trained personnel as recorders. These assistants had received instruction in the anthropometrical methods which were employed and were also asked to assist when necessary. They were taught to check maintenance of the erect position at the length station, alignment of the tape in the horizontal position at the girth station since mirrors were not avaiable for the trained personel to self-check, and to set the head piece at the height station. In some instances at the Secondary Schools, senior students assisted in recording when there were insufficient S.F.U. students available. In all instances Trained personnel supervised the work of these recorders.

EQUIPMENT:

Standing stature was measured against the wall using a stadiometer as described by Ross (1975). All other heights and lengths (items 4.14 - 4.20 and 7.38 on the data sheet) were measured using a Martin design sliding anthropometer (manufactured by GPM, distributed by Siber Hegner). A large spreading caliper (GPM - Siber Hegner) was used in the measurement of large breadths (items 6.32 - 6.35), while the lesser breadths (items 6.36 and 6.37) were assessed using Mitutoyo vernier calipers, as adapted by Carter (1975).

All skinfolds were measured with Harpenden calipers (manufactured by Holtain Ltd.).

Weight was measured to the nearest 0.1 kg. using a Homs Full Capacity Beam Scale.

A linen tape obtained from Siber-Hegner was used in the measurement of all girths (items 5.23 - 5.31 and 7.40 and 7.41).

TECHNIQUES:

The following section indicates the equipment used for each measurement, the definition of the specific measurements, the approppropriate landmarks, the position of the subject while the measurements were taken, and other information which was considered essential for standardized measurements. Specific instructions for individual measurements follow each general description.

LANDMARKS:

These were the skeletal points which were identified by palpation and enabled reliable and comparative measurements to be made. The landmarks used in this study were those established by a Leon and Thea Korner Foundation Kinanthropometric Study Group as reported by Ross et. al. (1977) .

Landmarks which were marked on the subject prior to measurement were acromiale, radiale, stylion, tibiale, ilio-spinale, mesosternale and mid-humerus.

Figures 2, 3 and 4 indicate basic terminology which is used throughout the remainder of this section. Figure 2 indicates the planes and axes of the body when it is in the anatomical position, except that the forearms should be supinated (palms facing forward). The planes indicated are in the mid-position.

An ANTERO-POSTERIOR or SAGITTAL PLANE is any plane parallel to the vertical plane through the long axis of the body which divides it into right and left halves. The sagittal plane labelled in the diagram which bisects the body is specifically referred to as the MID-SAGITTAL PLANE.

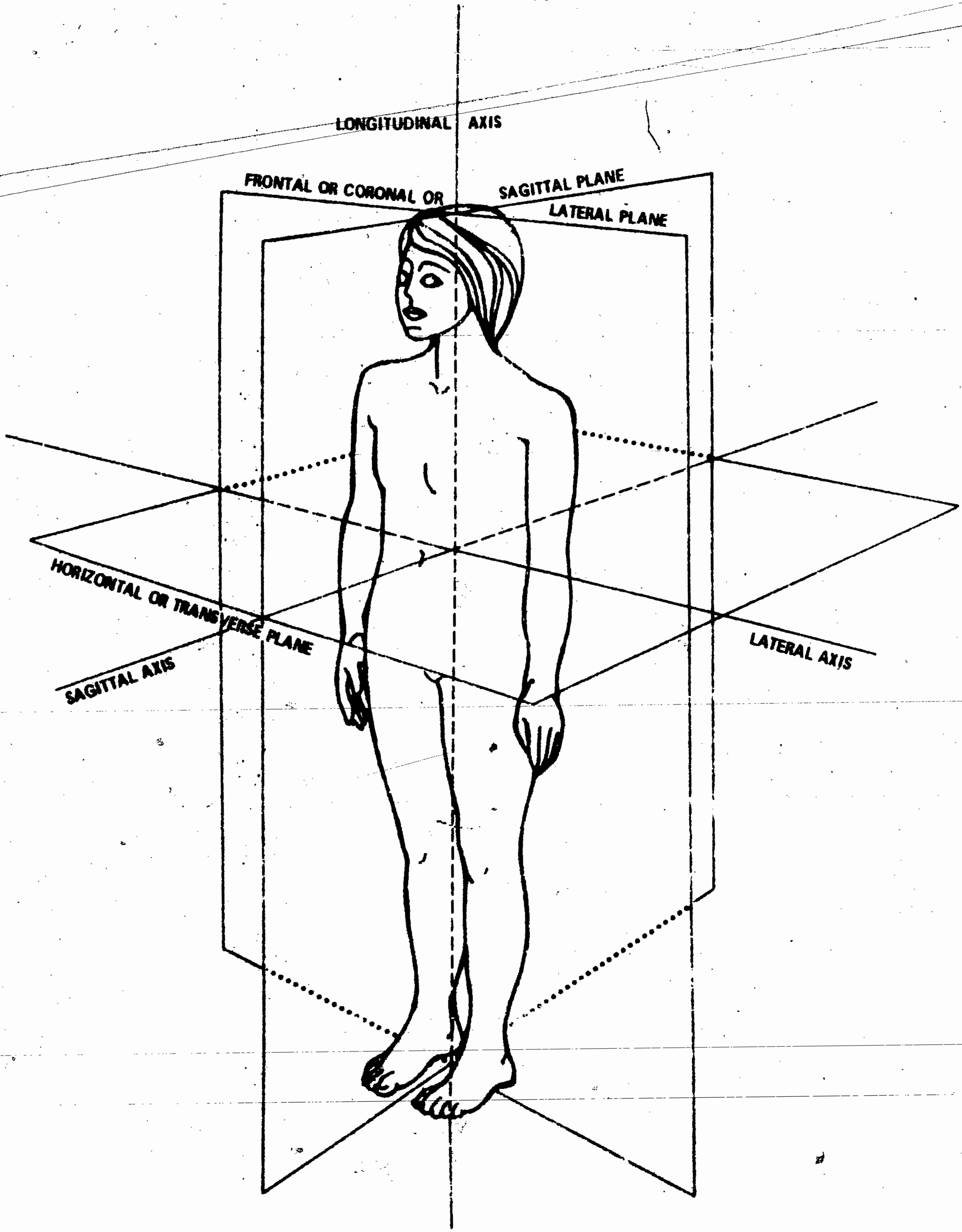


Figure 2: Planes and Axes

A FRONTAL OR CORONAL PLANE is any vertical plane at right angles to a sagittal plane which divides the body into front and rear portions.

A TRANSVERSE PLANE is any horizontal plane at right angles to the other two planes which divides the body into upper and lower parts.

a LATERAL AXIS is any line which is parallel to the ground, passing from one lateral aspect to the other.

a LONGITUDINAL AXIS is any line which is perpendicular to the ground.

a SAGITTAL AXIS is any line which passes from the anterior to the posterior aspect, and is parallel to the ground.

Figure 3, indicates the skeletal landmarks some of which were marked on the skin surface. Care was taken in the marking, especially movement of the underlying skin which mis-placed the actual landmark. Routinely, the landmark was palapated and marked without displacing the skin. The mark was then rechecked. In the active measurement, often, the anthropometrist again identified the point. Thus, repeated checking was encouraged to ensure that landmarks were identified accurately.

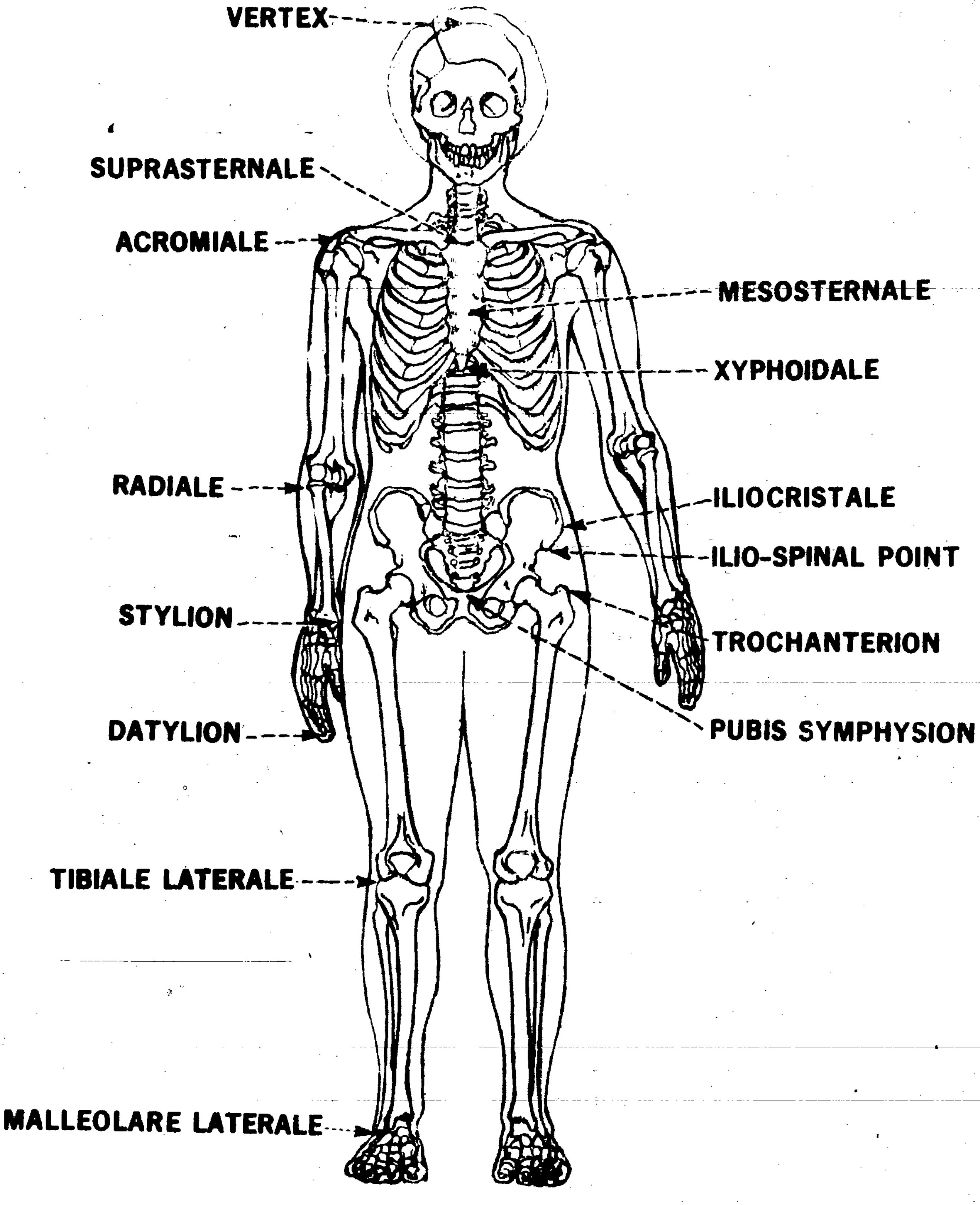
Figure 4, indicates the two landmarks used in the establishment of the the Frankfort plane. This was especially important when measuring stature, sitting height, head and neck girths.

HEIGHT

Instrument :The Stadiometer headpiece was mounted on a calibrated board. Subjects stood on a flat measuring surface formed by a properly levelled piece of laminated wood which was included in the calibration.

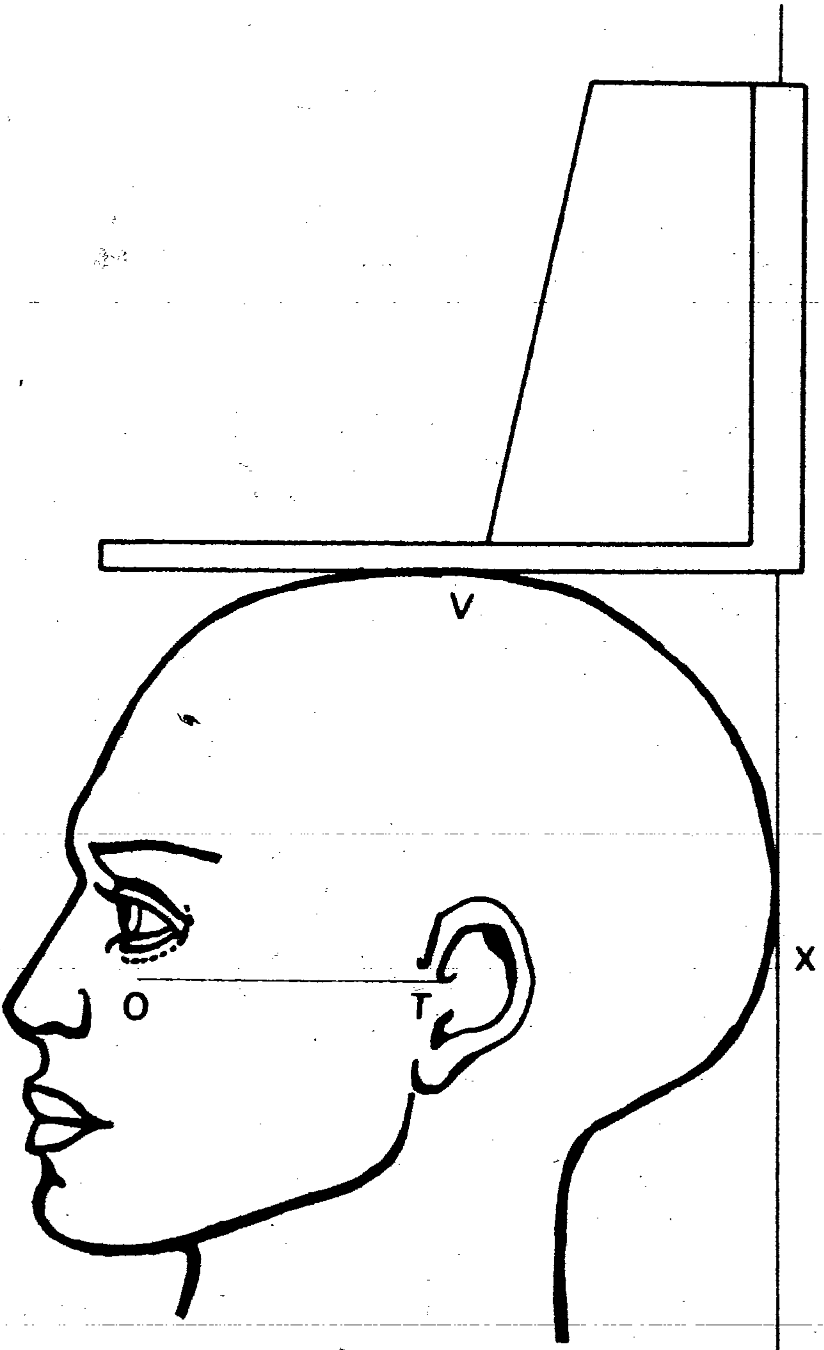
Definition of measurement : maximum height from the soles of the feet tc the vertex when the head is in the Frankfort plane.

Landmark : Vertex. The most superior point on the skull, In the mid-sagittal plane, when the head is held in the Frankfort plane.



Figue 3: LANDMARKS

Figure 4: The Frankfort Plane



ORBITALE: Lower margin of eye socket

TRAGION: Notch above tragus of ear or at upper margin of zygomatic bone at that point

FRANKFORT PLANE: Orbitale-tragion line horizontal

VERTEX: Highest point on skull when head is held in Frankfort plane.

Position : The subject stood erect, feet together, heels against the measuring board, arms hung naturally to the sides.

Technique : During maximum voluntary inspiration, light upward traction was applied to the mastoid processes in order to achieve a maximal measurement, and minimize diurnal variation, some of which has been recognized as being due to compression of the intervertebral discs as the day progresses. (Olivier, 1969). The horizontal board of the stadiometer was brought down to sit very firmly on the subject's vertex.

Accuracy : Measurement was to the nearest 0.1 centimeter.

SITTING HEIGHT:

Instrument : Anthropometer on a base.

Definition of measurement : The maximal height of the vertex while seated with the head in the Frankfort plane.

Landmark : Vertex.

Position : The subject sat comfortably erect with the hands on the thighs and the knees at approximately 90 degrees, with the feet on the floor. The sacral and thoracic spine rested against the anthropometer. The head was in the Frankfcrt plane.

Technique : The subjects were instructed to 'sit tall' and were manually assisted to do so. They were also cautioned to relax and not push off the floor or bench. During minimal voluntary inspiration, slight upward traction was applied to the mastoid processes, while maintaining the Frankfort plane. The horizontal arm of the anthropometer was brought down to sit firmly on the subjects vertex, the measurement arm being in the mid-sagittal plane.

Accuracy : Measurement was to the nearest 0.1 centimeter.

WEIGHT:

Instrument : Beam balance. Platform scale.

Definition of measurement : The body mass in kilograms in minimal clothing.

Position : The subject stood comfortably on the platform, with body weight distributed equally on both feet, facing away from the measuring beam.

Technique : A spring balance scale was used to ascertain approximate weight before accurate weight was assessed on the beam balance. This was found convenient since it minimized the need for adjustment of the beam balance. The subject was instructed to stand still.

Accuracy : Measurement was to the nearest 0.1 kilogram.

SKINFOLDS

General Description : Unless otherwise indicated the following conditions applied to all measurements of skinfold.

Instrument : Harpenden skinfold calipers.

Position : The subject assumed a comfortable, relaxed position.

Landmarks : The location of points at which the skinfolds were taken are illustrated in Figure 5. In all instances the fold was picked up AT the landmark

Technique : A fold of skin plus underlying fat was grasped between the thumb and three fingers, with the back of the hand facing the measurer. Keeping the jaws of the calipers at right angles to the body surface, the contact faces of the caliper were placed one centimeter below the lowest finger, and at the depth of the mid-finger tip. The trigger of the caliper was released and while the pressure on the fingers was maintained the measurement was taken. If the calipers began to slip off, as they sometimes did with a very tight or very large skinfold, the technique was repeated. The measurement was recorded in millimeters, two seconds after the caliper jaws were applied. The arms of the caliper were always at right angles to the skinfold.

Accuracy : Measurement was made to the nearest 0.1 millimeter.

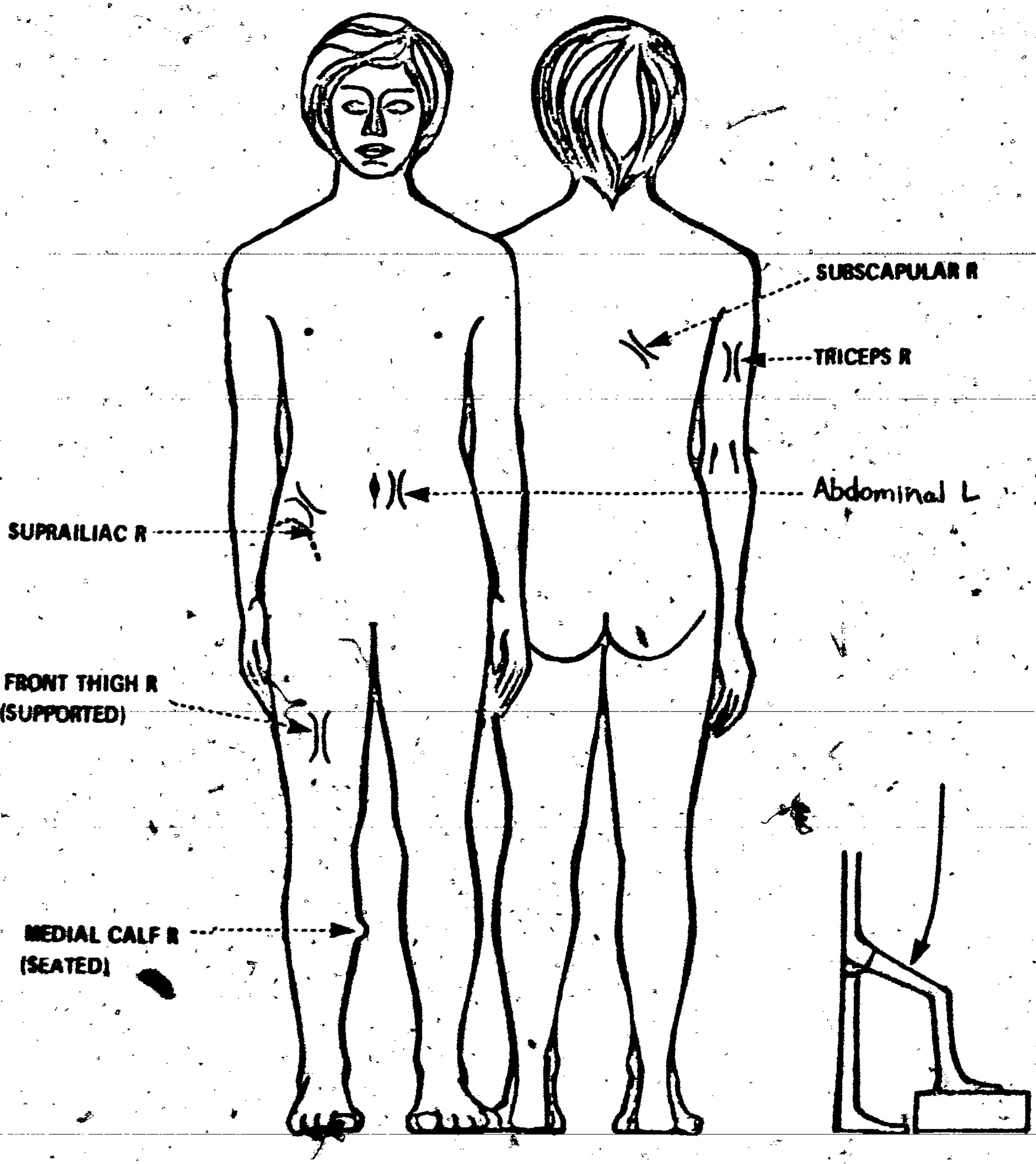


Figure 5: SKINFOLDS

SKINFOLD MEASUREMENTS:

1) TRICEPS:

Point of measurement : The distance between the acromiale and radiale was halved while the forearm was extended at the elbow. This point was projected as a horizontal line posteriorly. With a tape on the posterior aspect of the upper arm linking the acromiale and the point of the elbow, with the elbow slightly flexed. A vertical line was drawn to intersect with the horizontal line. This point, the triceps landmark, was located prior to measuring, together with other designated landmarks.

Technique : The skinfold was picked up with the fingers across the landmark. The line of the fold was vertical.

2) SUBSCAPULAR:

Point of measurement : The inferior angle of the scapula.

Technique : The forefinger was placed on the landmark and the thumb picked up the natural fold such that the line of the fold ran at approximately 40 degrees to the horizontal.

3) SUPRA-ILIAC:

Landmarks : ilio-spinale, and acromiale (See heights for specifications)

Point of measurement : A line was imagined joining the acromiale and iliospinale, the precise point was five to seven centimeters superior to the iliospinale, along the imagined line.

Technique : The line of the fold sloped downwards toward the midline at an angle of approximately 45 degrees.

4) ABDOMINAL

Point of measurement : The para-umbilicus.

Technique : The skinfold was selected five to seven centimeters to the left of, and level with, the umbilicus. The line of the fold was vertical.

5) MID-THIGH:

Point of measurement : The midpoint of the thigh. This was judged visually, as half the distance between the iliac fold and the patella when the right foot was placed on a box such that the knee was approximately at right angles. The fold was selected at the midline of the thigh.

Technique : The line of the skinfold was parallel to the long axis of the thigh. In some subjects the front thigh skinfold was a little difficult to grasp and the procedure was sometimes painful. If this was the case the subject supported the underside of the thigh with the hands. When the weight of the underthigh was particularly heavy (as found in some girls) it was necessary for the anthropometrist to give further support using a knee under the thigh.

6) MID-CALF:

Point of measurement : The leg was in the same position as for the previous measurement. The measurement was taken at that part of the calf on the most medial aspect where the girth was seen to be maximal.

Technique : The line of the skinfold was vertical.

LENGTHS:

General description : Unless otherwise stated, the following conditions applied to these measurements.

Instrument : Anthropometer on small base.

Position : The subject stood erect, feet together, head and eyes fixed, arms extended down the sides, fingers extened but not held along the thighs.

Technique : The anthropometer base was stabilized on the standing surface by the measurer, and was located in front of the right side of the subject. The anthropometer arm indicated the height from the floor. of each designated landmark.

Accuracy : Measurement was made to the nearest 0.1 centimeter.

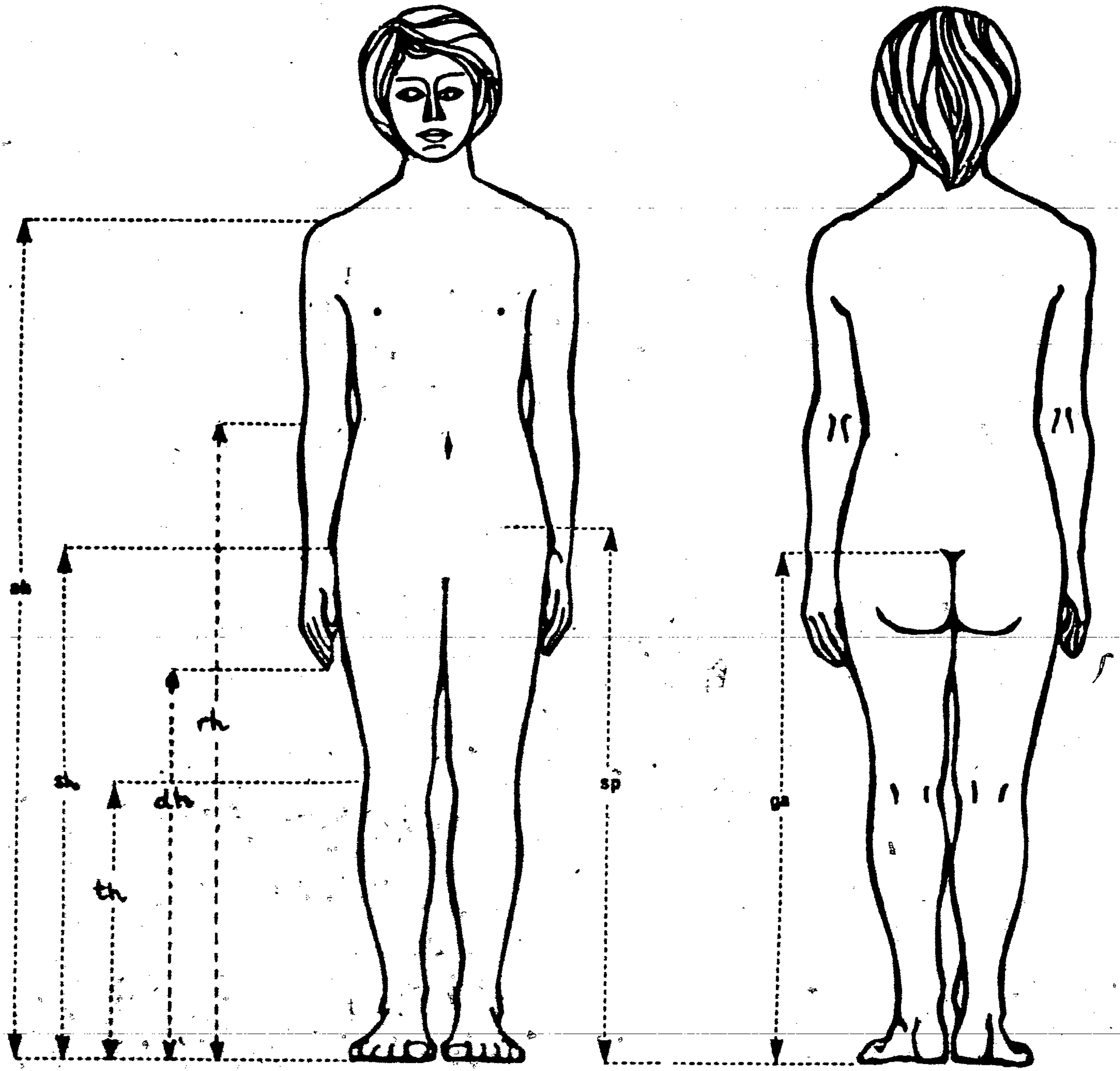


Figure 6: LENGTHS

Figure 6 indicates the points from which all length measurements were taken.

LENGTHS (HEIGHTS)

1) Acromiale (Figure 6 = ah)

Landmark : Acromiale or Acromial point. The point at the superior and external border of the acromion process when the subject stood erect with relaxed arms. This definition of the point at the superior and external border is in accord with the 1912 Geneva Convention and is not identical with "the most lateral" description by Martin and Saller (1957) or "inferior-external border" in Weiner and Lourie (1969).

Technique of location : This point could be more easily recognized by palpating along the length of the spine of the scapula. If the landmark was still difficult to identify, the subject bent laterally at the trunk thus relaxing the deltoid, and simplifying the location.

2) RADIALE: (Figure 6 = rh)

Landmark : Radiale. The point at the upper and lateral border of the head of the radius (or Capitulum radius).

Technique of location : This point was located by palpating downward in the lateral dimple at the elbow where the rotating head of the radius could easily be felt under the stationary condyle of the humerus, especially when the subject slightly pronated and supinated the forearm.

3) STYLION: (Figure 6 = sh)

Landmark : Stylion. (Fr. = Apophyse Styloide). Styloid process. The most distal point of the processus Styloideus radius.

Technique of location : This point was located in the so-called "Anatomical snuff box", or that triangular area formed when the thumb was extended laterally and the area was defined by the raised tendons of muscles of the abductor pollicus longus and extensor pollicus brevis with the extensor pollicus longus. If this method was not satisfactory, the landmark was also palpated during passive abduction and adduction of the hand at the wrist. The point was identified by approach from the distal aspect of the wrist joint.

4) DACTYLION: (Figure 6 = dh)

Landmark : Dactylion. (Fr. = Extremite inferieure du doigt medius). Tip of the middle finger.

Technique of location : The point located at the most distal point of the middle finger or digit when the arm and fingers were extended. The corresponding tips of the other fingers were designated as dactylion I, II, IV and V.

5) ILIOSPINALE: (Figure 6 = sp)

Landmark : Iliospinale. (Fr. = Epine iliaque antero-superieure). The anterior superior iliac spine. The pronounced inferior tip and not the most frontally curved site of the crista iliaca was the designated landmark.

Technique of location : The anthropometrist palpated along the crest of the ilium anteriorly following the curve downward until an obvious posteriorly directed curve was detected. This was the point which was being sought.

6) TIBIALE: (Figure 6 = th)

Landmarks : Tibiale Internum. (Fr. = Ligne articulaire du genou). Superior extremity of the tibia or the most proximal point of the margo glenoidalis of the medial border of the head of the tibia. Tibiale externum (te). This point corresponds to the tibiale above, but was located on the lateral border of the head of the tibia. It is above the capitulum fibulare.

Technique of location (Tibiale externum) : The anthropometrist located the upper border of the tibia by palpating the tendon of the quadriceps muscle at the distal end of the patella. This was facilitated by having the subject slightly flex the knee then palpating at the frontal border of the ligamentum collaterale tibiale. An additional aid to identifying this point was to locate the centre of the triad of the epicondylar femur, epicondylar tibia, and head of the fibula. Both tibial landmarks are situated in practically the same transverse plane.

7) GLUTEALE: (Figure 6 = gh)

Landmark : Gluteale or mid-gluteal arch. The point at the sacrococcygeal fusion at the mid-sagittal plane.

Technique of location : The thumb was placed at the top of the gluteal furrow in the mid-sagittal plane and palpated in a downward direction until the sacro-coccygeal fusion, or ridge of the coccyx, was identified. The level of the fusion was the designated landmark which was felt in a region near the top of the gluteal furrow and not more than two centimeters inferiorly.

GIRTHS

General description: Unless otherwise stated the follwing general conditions applied to these measurements.

Instrument : Anthropometric linen tape.

Position : The subject stood erect in a relaxed manner, arms loosely at the sides.

Techniques : A crossed tape technique was used such that the zero line of the tape was in line with the measuring aspect of the tape. Light pressure was applied to the tape, sufficient to maintain the position of the tape, but insufficient to produce indentation of the skin.

The tape was always in the horizontal plane of the body part being measured.

Accuracy : Measurement was to the nearest 0.1 centimeter.

Figure 7, indicates the points at which these measurements were made and for which more specific directions follow.

GIRTHS:

1) RELAXED ARM (Upper arm circumference).

Point of measurement: mid-point distance between the acromiale and radiale (see also triceps skinfolds for identification of point of measurement).

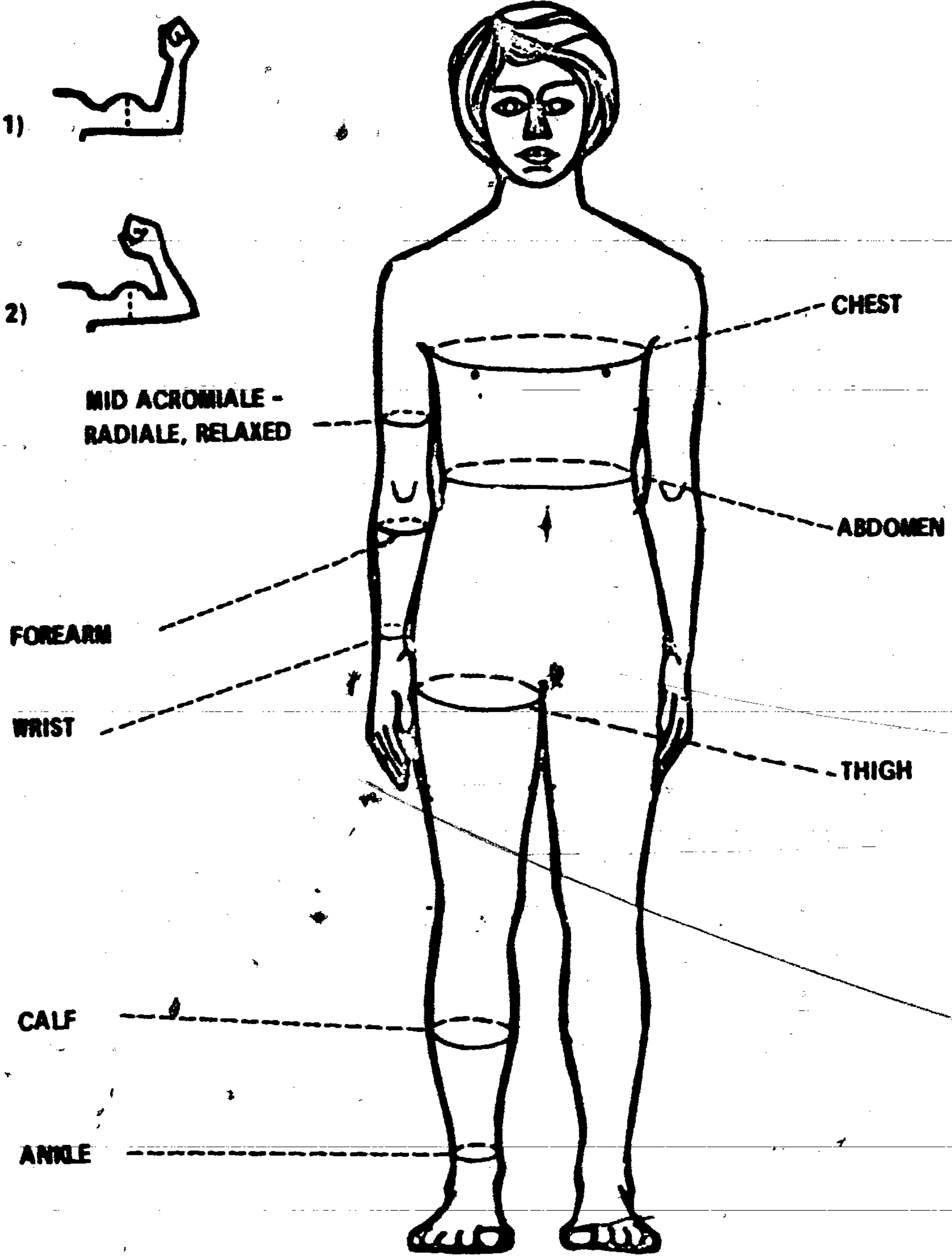


Figure 7: GIRTHS

2) FLEXED ARM GIRTH

Definition of measurement : The maximum girth of the flexed arm when measured at right angles to the long axis of the humerus.

Position : The upper arm of the subject was horizontal, the forearm was supinated and fully flexed at the elbow. The subject was instructed to clench the fist and contract the biceps as strongly as possible.

Technique: The subject was asked to 'make a muscle' thereby developing voluntary tension in the full flexed position prior to the measurement. This preliminary flexing of the biceps helped visually identify the likely position for obtaining maximal girth.

3) FOREARM:

Definition of measurement : Maximum forearm girth when measured at right angles to the long axis of the radius when the forearm was extended at the elbow and held in the anatomical position (i.e. open palm to the front).

Technique : The tape was passed around the forearm one to two centimeters distal to the elbow. It was then manipulated to obtain the maximum girth measuring at right angles to the long axis of the radius.

4) WRIST:

Definition of measurement : Minimal girth of the wrist when measured at right angles to the long axis of the radius at a point proximal to the styloid processes of the radius and ulna.

Technique : The tape was passed around the wrist proximal to the styloid processes of the radius and ulna and the tape was manipulated to obtain the minimal girth when the tape was at right angles to the long axis of the radius.

5) CHEST:

Definition of measurement : Girth at the level of the fourth costosternal articulation obtained when the subject was in the end-tidal phase of expiration.

Landmark : Mesosternale. Point located on the corpus sterni at the intersect of the mid-sagittal plane and the horizontal plane at the mid- Level of the fourth costosternal articulatum (mesosternale)

Location of landmark : The anthropometrist palpated down the sternocostal margin to the fourth articulation. This was done recognizing that the first articulation was under the clavicle and starting the count at 'two'. The mid-level of the fourth articulation was palpated and the mesosternale identified as that point on a horizontal line on the corpus sterni at the mid-sagittal plane.

Technique : The measurement was made facing the subject by passing the tape around the chest at the level of the landmark. The subject was asked to raise the arms to the horizontal to help place the tape, then the arms were lowered to hang freely at the sides, making sure that the tape was kept horizontal.

6) WAIST:

Definition of measurement : Girth at the level of the noticeable waist narrowing located approximately half-way between the costal border and the iliac crest.

7) THIGH:

Definition of measurement : One centimeter distal to the horizontal gluteal fold at the lower border of the gluteus maximus.

Position : The subject stood erect, legs slightly parted to permit passage of tape, weight was distributed equally on both feet.

8) CALF:

Description of measurement : Maximum calf girth when measured at right angles to the long axis of the tibia.

Position : The subject stood with the feet about twenty centimeters apart distributing weight equally through both lower limbs.

Technique : The tape was passed around the leg near the top of the calf muscle and lowered and manipulated to obtain the greatest girth measuring at right angles to the long axis of the tibia.

9) ANKLE:

Definition of measurement : Minimal girth of the ankle located proximally to the malleoli.

Technique : The tape was passed around the ankle proximal to the malleoli and manipulated to obtain minimal girth at right angles to the long axis of the tibia. It should be noted that visual judgement of "minimal girth" was inaccurate when viewed lateraly due to the elliptical shape of the ankle. Manipulation of the tape for this measurement was mandatory.

10) HEAD: Definition of measurement : The maximum girth of the head, immediately superior to the glabellar point. (brow ridges).

Position : The subject was seated, erect; the head was in the Frankfort plane.

Technique : the tape was pulled tight to minimize the contribution of soft tissue and hair to the true boney measurement.

11) NECK:

Definition of measurement : The circumference of the neck taken at a level immediately superior to the larynx. ("Adams Apple") While Tanner et al. (1969) used the point inferior to the larynx, the point of measurement used here was in agreement with the methodology suggested by Carter (1975 b), in which The superior point was favored because in the wrestlers and the more mesomorphic athletes, the inferior point was particularly difficult to identify.

Position : The subject was seated, erect; the head was in the Frankfort plane.

Technique : The tape was kept horizontal to the longitudinal axis of the neck with little tension applied to the tape.

BREADTH (widths)

General description : Unless otherwise stated the following general conditions were applied to these measurements.

Instruments : A broad blade caliper was used for the measurement of large breadths and foot length. Vernier calipers were used for the assessment of epicondylar breadths.

Position : Except where indicated the subject sat erect, arms hanging loosely to the sides.

Technique : With the exception of the foot length measurement, the instrument was kept quite firm against the subject, since the aim was to measure skeletal breadth. In the case of obese subjects it was necessary to apply very strong pressure to ensure complete accuracy and validity. The arms of the spreading caliper were applied at apporximately half way along their lenght - not at the points.

Accuracy : Measurement using the broad blade calipers was to the nearest 0.01 centimeter. Measurement using the vernier calipers was to the nearest 0.01 centimeter.

Figure 8 illustrates the points at which breadths were measured.

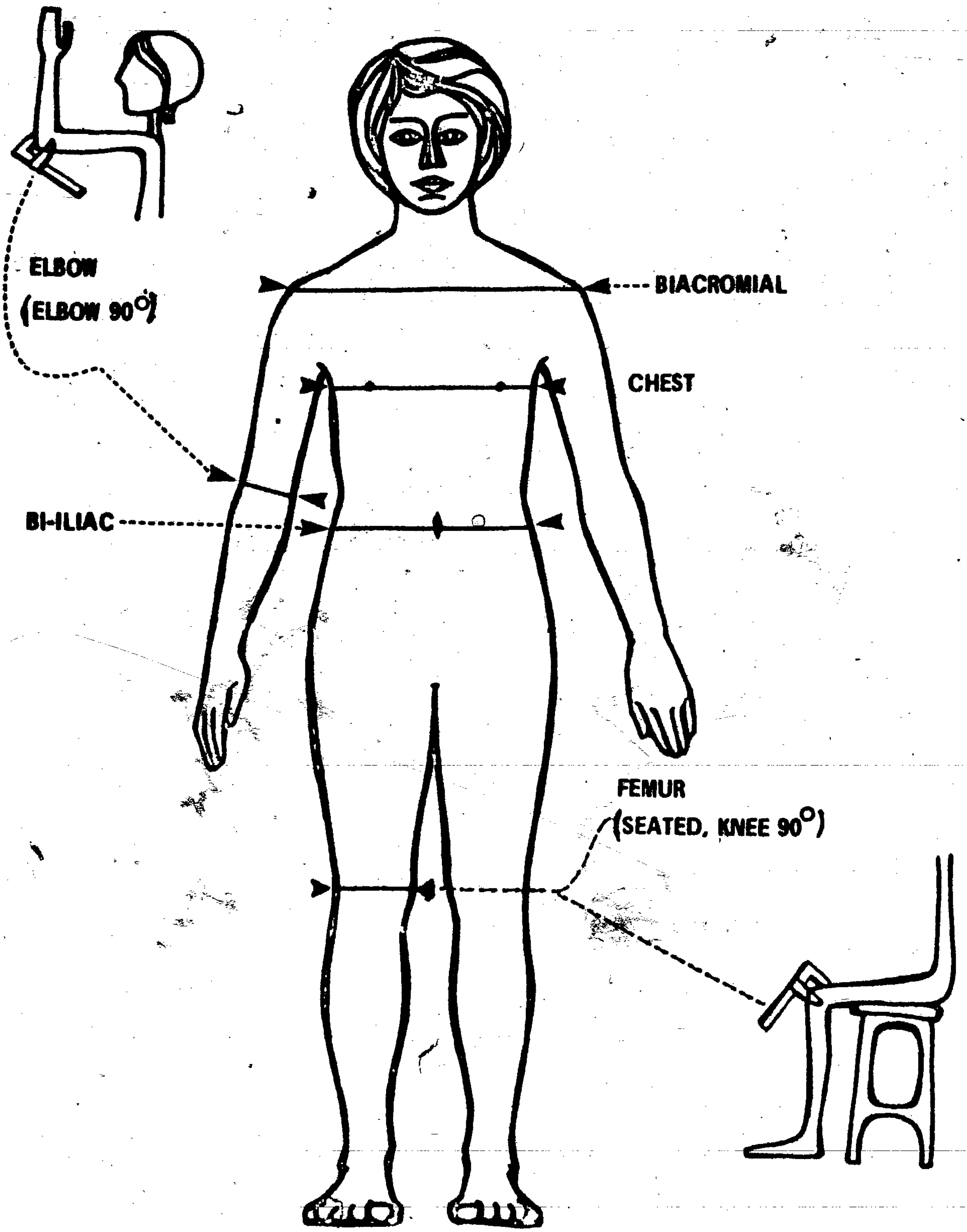


Figure 8: BREADTHS

BREADTHS

1) BIACROMIAL BREADTH

Definition of measurement : The maximal distance between the most lateral aspect of the acromion processes.

Landmarks : The most lateral aspects of the right and left acromion processes which were slightly inferior to the most superior lateral margin defined as the acromiale.

Position : The subject stood comfortably erect, arms hanging loosely to the sides.

Technique : The caliper cross bar was kept horizontal. The arms of the caliper were directed upwards as the cross bar was supported on the measurer's forearms. Measurement was taken from the rear.

2) BI-ILIOCRISTAL BREADTH

Definition : The maximal distance between the two iliac crests or, the iliocristal diameter.

Position : The subject stood completely erect, arms hanging to the sides, weight equally distributed on both feet.

Technique : By bilateral palpation, the two iliac crests (lateral aspects) were identified. The calipers were placed so that the arms pointed upward toward the posterior at an angle of approximately 30 degrees. Measurements were taken from the front.

3) TRANSVERSE CHEST

Definition of measurement : The transverse distance from the most lateral points of the chest at the level of the fourth rib.

Technique : It was important to locate the rib and ensure that the caliper arms did not slip into an intercostal space. Care was taken not to apply pressure which could distort the rib cage which was more likely in young children.

4) FOOT-LENGTH

Definition of measurement : The distance from the pternion to the akropodion.

Landmarks : Pternion. The most posterior point on the heel of the foot when the subject was seated. AKROPODION. The most anterior point on the toe of the foot when the subject was seated. This was either the I or II phalange, whichever was the longer.

Technique : The caliper was fixed at the pternion and adjusted to the akropodion.

5) BI-EPICONDYLAR HUMERUS WIDTH

Definition of measurement : Bi-epicondylar diameter of the humerus.

Position : the arm was raised forward to approximately the level of the shoulder and the forearm flexed at the elbow to form a 90 degree angle with the upper arm.

Technique : the epicondyles were palpated, starting several centimeters proximal to the elbow joint. This measurement was often made oblique since the inner condyle of the humerus was lower than the outer one. The arms of the caliper pointed upward at an angle of approximately 45 degrees, as indicated in Figure 8.

6) Bi-epicondylar femur width:

Definition of measurement : Bi-epicondylar diameter of the femur.

Position : In the seated position the tibia was vertical to the floor and at right angles to the femur.

Technique : The most lateral points on the condyle were palpated, starting several centimeters proximal to the knee joint. The arms of the caliper pointed downward at an angle of approximately 45 degrees. as seen in Figure 8.

DEPTH

ANTERIOR - POSTERIOR CHEST

Instrument : Spreading arm calipers

Definition of measurement : The depth of the chest at the level of the fourth intercostal articulation at end-tidal expiration.

Landmark : Mesosternale

Technique : One of the arms of the caliper was placed on the landmark, the other on a spinous process which was judged to be at the same level as the landmark. Only light pressure was applied as the force generated in this caliper is magnified.

Accuracy : Measurement was to the nearest 0.1 centimeter.

ERRORS OF MEASUREMENT

By failing to apply rigidly controlled methodology to the measurements of subjects, error can be introduced which makes any results or conclusions invalid.

Possible measurement errors which were recognized either prior to or during the data collection and which were immediately attended to were as follows:

height : In applying upward pressure to the mastoid processes, it was very easy for the adult to lift the child's heels off the floor. When a maximal stretch of more than about a centimeter was encountered, suspicion was that the subject raised his heels and re-measurement was made ensuring that this was not the case. Maintaining the head in the Frankfort plane was mandatory for accuracy of this measurement. This was achieved by having the measurer concentrate on positioning and manipulation of the stadiometer. Reading was done after the head piece was fixed in position of height by means of the thumbscrew.

lengths : Much of the error of this measurement was seen to occur because of movement of the subject, especially laterally thus elevating one shoulder. This was overcome by the assistant at this station making sure that the shoulders were square and the subject maintained his position for all length measurements. The anthropometrist, being skilled, was able to make the measurements quickly, thus accommodating the motionless subject.

Weight distributed equally on both feet with the feet together prevented errors in leg length. However there were a number of subjects who appeared to exhibit a marked degree of genu valgum (knock-knees). When this was obvious to the extent that the weight had to be carried more on one leg than the other, the subject was instructed to place the knees together rather than the feet.

An error of parallax was also anticipated if the anthropometrist failed to keep the eyes level with the indicator when reading off measurements.

skinfolds : The accuracy of skinfold measurements, as well as their validity has often been questioned, especially by workers in the area of body composition (Sloan, 1967). Doubts as to the accuracy of these measures has been due to soft tissue being sensitive to the compression of the jaws of the caliper as well as difficulty involved in the precise identification of the point at which the measurement was made.

It was appropriate to assume that, since the one instrument was used by the one anthropometrist, inter-measurer variability and equipment variability were eliminated, and that compression would be the same for all individuals and for all sites. However skinfolds have been reported as being compressible up to 50% or more by Garn and Gorman (1956). This variability has produced an underestimation of skinfold measurements, and it is reasonable to assume that all reported values, including those of this study, are imprecise. However until an acceptable alternative is proposed, Harpenden calipers will no doubt continue to be widely used for assessment of these parameters.

It was reported by Tanner and Whitehouse (1962) that with a reading greater than 20 millimeters, there is a compression factor which was seen as the indicator needle continued falling. While they recommended a repetition of the measurement and an immediate record after the application of the spring pressure, this was considered to overestimate the measurement. The measurement in these cases was recorded at the point of marked slowing of the needle at which point it was considered that compression was nearly maximal.

Ruiz et al.(1971) reported that the site of application of calipers was a source of variation, the measurements being over-estimated the more proximal the fold, and underestimated the more distal the fold. More specific directions as to the point of measurement were laid down for these assessments in an attempt to minimize this source of error.

breadths : Most error was anticipated in failure to apply sufficient pressure to minimize the amount of soft tissue which interfered with these measurements. The anthropometrist was aware of this problem and ensured that for the bi-iliocristal and bi-acromial breadths,very firm pressure was applied. A similar procedure was not followed for the transverse chest because of the elasticity of the ribs which could lead to an underestimation of this measurement. However care was taken to avoid the chest muscles by directing the pointers of the calipers downwards. Similarly the pointers were directed upwards in assessing the bi-iliocristal breadth to prevent them sliding off the iliac crest, and under-estimating the true measurement.

girths : Excessive tension on the tape, failure to keep the tape horizontal to the axis of the part being measured, and failure to manipulate the tape where required, were recognized as the possible sources of error. Continual attention was given to these details.

METHODS OF ANALYSIS

DATA ACCURACY

After the subjects were measured, their data sheets were collected by the marshall, an experienced kinanthropometrist, who checked to see that all data was filled in, and quickly scanned the recorded values of the measurements in an effort to detect any gross errors. However this could not be relied upon as the only assessment of accuracy.

The data was cleaned and processed as follows:

a) each subject was allocated a unique identity number which was recorded on the data sheet.

b) the identity number incorporated a code to indicate the school and the class in which the subject was located. This facilitated the location of any one data sheet, if and when required.

c) all data were transferred to computer card images. Since this transfer was done by trained kinanthropometrists, there was another opportunity at this point for further gross errors or omissions to be observed and immediately corrected. Due to time constraints, this data was not 'verified' (i.e. double key punched) to check for keypunch errors. Verification was performed later with a visual check comparing the data sheets with the computer record.

d) all data to this point were stored in class groups.

e) the data were then processed using the SPSS (Statistics Package for the Social Sciences) frequency and statistics programs (Nie et al. 1975).

f) trained and experienced kinanthropometrists reviewed the frequency data and applied a subjective evaluation on those subjects outside the generally observed range. These were generally those subjects in the 1st and 100th percentiles. Because of the structure and organization in Canadian schools, there was very little age variation within any one class, and hence it was relatively easy to estimate within what range, values of each variable lay. In composite classes e.g. Grade 1 plus Grade 2, it was necessary to extend the range to account for age differences.

g) all questionable values as determined above for every measurement were examined. The computer listed all subjects in the one class, and the values of any one selected variable. In this way it was possible to isolate the subject(s) with the suspected aberrant values.

h) doubtful values were then compared with the original data sheet, and where corrections were made, this fact was noted on the data sheet as well as in the computer data set. It is well established that there are several sources of error which may occur in both the recording and the transfer of written information into a data bank, (Duquet et al. 1977). Obvious errors which were experienced in this study were:

Phonetic error: an anterior-posterior chest depth was recorded as 80 and this was corrected to 18.

Transposition error: iliospinale height was recored as 36.4 this was changed tc 63.4, especially in consideration of the difference between standing height and sitting height which gave a measure of the leg length, and therefore an approximation of iliospinale height..

Essentially this procedure identified all measurements where the first figure of the recorded value was inappropriate. Where the error could not be resolved the value was set tc zero and treated as missing data in further computer analysis.

Of all the recorded measurements, obvious errors were detected and adjusted, this represented 0.14 percent of the approximate 31,000 measurements.

i) all class data was merged and separated into sex groups.

j) each age cohort for each sex was then identified, with each age being rounded off to include those subjects 0.5 years on either side of the 'rounded year'. Thus the six year group included those between 5.50 years and 6.49 years.

k) considering the whole group of 923 subjects, the SPSS statistics package was used to calculate the gross range (maxima and minima) and gross mean for each variable.

l) the statistics program of Clauser (1972), requiring a user defined maximum, minimum and mean (determined from the previous procedure) was then appled to each age cohort for each variable. Raw and smoothed percentiles were calculated routinely, together with the mean, standard deviation, standard error of the mean, standard error of the standard deviation, kurtosis, skewness and the coefficient of varation for each variable within each age cohort for each sex.

m) percentile graphs were computer generated for height and weight. A smoothing technique was applied to the raw percentiles. A fifth degree polynomial was used for this manoeuver in preference to the splining method which is used when the investigator assumes that the curves are parallel. This assumption was believed to be inappropriate and by observation, this was justified since the curves are not consistently parallel.

Curves were generated for the 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles, which is in accordance with the general methods of presentation of results employed by European authors.

PROPORTIONAL ASSESSMENT

It has been traditional for anthropometric indices to estimate body proportions. An index is the ratio of one measurement, to another expressed as a percentage of the larger one. e.g. the cephalic index is the ratio of head breadth expressed as a percentage of head length.

Davenport (1929) indicated the uses of "relative". indices which could be used for inter-individual comparisons. This he obtained by dividing any absolute dimension, by stature, Thus relative arm length is arm length divided by stature. Montagu (1960) listed 10 anthropometric indices most commonly used, but it is obvious that the number of those indices is limited only by the numbers of measurements which are available. Malina and Rarick (1973) indicated that indices have limitations and that "used alone, they are not completely adequate and accurate indications of body form", while Tanner (1951) indicated conceptual and statistical problems associated with indices since "the function of the two dimensions involved is independent of the scale of measurement of either dimension."

In 1974, Ross and Wilson developed a PHANTOM stratagem for proportional growth assessment. Essentially derived from large samples of male and female data, an arbitrary unisex model was developed and over one hundred anthropometric values were expressed as means and standard deviations against which any measured variable could be compared by z-score analysis according to the formula in Fig. 9.

Figure 9:Formula for the calculation of proportionality z-values.

PHANTOM Z – VALUES

$$Z = \frac{1}{S}\left[v\left(\frac{170.18}{h}\right)^{d} - P\right]$$

WHERE:

Z IS A PROPORTIONALITY VALUE OR Z–VALUES

v IS ANY VARIABLE

S IS THE PHANTOM STANDARD DEVIATION FOR THE GIVEN VARIABLE

h IS THE SUBJECT'S HEIGHT
170.18 IS THE PHANTOM HEIGHT CONSTANT

d = IS A DIMENSIONAL EXPONENT BASED ON GEOMETRICAL CONSIDERATIONS:

d = 1 FOR ALL HEIGHTS, LENGTHS, BREADTHS, GIRTHS, AND SKINFOLD THICKNESSES

d = 2 FOR ALL AREAS AND STATIC STRENGTH MEASURES

d = 3 FOR ALL WEIGHTS AND VOLUMES OF TOTAL BODY OR ANY BODY PART

P IS THE PHANTOM VALUE FOR THE VARIABLE

ROSS & WILSON, 1974

IV RESULTS

The COGRO data were derived from anthropometrical measures from 923 children from three schools in the Coquitlam area of British Columbia, Canada. The sample included ages 6 to 18 for each sex.

All the data collected from this study are available for subsequent analysis and thus one of the purposes of this study has been achieved, namely the collection of a sizeable bank of cross-sectional anthropometric information of West Coast Canadian children.

A common problem in the presentation of such a study involving 923 subjects and 34 variables is in the voluminous nature of the results. All data, both original score sheets and computed results are available on application from the Department of Kinesiology, Simon Fraser University. A sample of the score sheet is to be found in Appendix B.

A sample of the computer print out is presented in Appendix C. The results considered here are confined to the presentation of statistics and percentile curves.

PROTOTYPICAL DATA

Tables 2 - 27 present basic statistical data for 34 measured variables for 923 girls and boys age 6 to 18. Data includes number of subjects , mean, standard deviation, range, skewness and kurtosis.

Table 2 Girls : Aged 6

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	18	21.38	3.69	27.7-14.5	0.00	1.98
height	18	116.66	5.68	128.0-107.7	0.18	1.92
triceps sf.	16	11.51	3.24	18.7-7.20	0.63	2.34
subscap sf	16	7.14	2.85	15.6-4.60	1.53	5.02
suprail sf	16	5.23	2.25	12.8-2.70	2.22	8.11
abdom sf	16	7.46	2.63	13.6-4.00	0.62	2.64
fr thigh sf	16	17.87	7.30	32.8-9.60	0.92	2.44
med calf sf	16	10.23	3.41	17.9-5.20	0.48	2.48
acrom ht	18	90.64	4.85	100.4-82.90	0.31	2.04
radial ht	18	69.51	4.24	78.8-63.10	0.25	2.20
stylion ht	18	53.32	3.40	61.5-48.60	0.57	2.71
dacty ht	18	40.05	2.79	46.3-36.30	0.33	2.28
tibial ht	18	28.74	2.17	33.6-26.00	0.54	2.32
spinale ht	18	60.84	3.76	68.3-55.40	0.49	2.15
glut ht	18	59.74	4.05	67.9-53.20	0.44	2.35
arm g (rel)	14	18.41	1.95	22.0-15.80	0.09	1.56
arm g (flex)	14	19.31	1.91	22.5-16.80	0.03	1.42
forearm g	14	17.84	1.47	20.4-15.40	0.07	1.64
wrist g	14	12.57	0.94	14.2-11.20	-0.08	1.64
chest g	14	58.92	3.76	65.2-51.80	-0.02	2.11
waist g	14	54.77	4.11	61.5-46.20	-0.21	2.20
thigh g	14	35.64	3.67	40.8-31.00	0.14	1.23
calf g	13	24.28	2.01	27.2-21.70	0.17	1.10
ankle g	14	16.71	1.33	18.5-14.70	-0.12	1.47
biacr br	18	24.96	1.42	27.2-22.30	0.06	1.82
biilio br	18	18.47	1.23	21.2-16.30	0.27	2.53
trans chest	18	17.27	1.04	19.0-15.20	-0.04	2.01
foot len	18	17.56	1.08	19.5-16.00	0.08	1.81
biep hum wd	18	4.94	0.40	5.89-4.34	0.34	2.59
biep fem wd	18	7.13	0.46	8.00-6.33	0.22	2.14
sitt ht	17	64.99	3.19	70.8-59.60	0.25	2.00
a-p chest	17	12.87	1.24	15.0-10.20	-0.21	2.23
head g	17	51.11	1.66	54.5-48.00	0.17	2.49
neck g	17	25.66	1.64	28.3-22.50	0.02	2.04

Table 3 Boys : Aged 6

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	17	21.75	2.98	29.1-18.30	1.06	2.97
height	17	117.04	6.30	132.0-107.70	0.54	2.73
triceps sf.	10	9.54	2.01	13.8-6.90	0.70	2.48
subscap sf	10	6.02	3.22	14.8-3.90	1.94	5.59
suprail sf	10	4.76	3.54	14.7-2.90	2.17	6.24
abdom sf	10	6.19	5.58	22.0-3.50	2.23	6.44
fr thigh sf	10	12.88	4.81	24.6-7.10	1.20	3.80
med calf sf	10	8.29	1.97	12.9-6.00	1.05	3.28
acrom ht	15	90.86	5.78	101.0-81.20	0.28	2.10
radial ht	15	70.19	4.61	78.5-62.90	0.24	1.99
stylion ht	15	53.84	3.62	60.3-49.30	0.38	1.76
dacty ht	15	40.29	2.64	45.4-36.30	0.36	1.87
tibial ht	15	29.20	1.88	32.5-26.70	0.70	2.11
spinale ht	15	61.36	4.48	69.9-54.40	0.40	1.94
glut ht	15	60.47	4.12	68.2-54.50	0.54	1.98
arm g (rel)	7	18.26	2.49	23.6-16.20	1.27	3.12
arm g (flex)	7	19.19	2.66	24.9-17.20	1.30	3.13
forearm g	6	17.97	1.41	20.8-17.10	1.26	2.76
wrist g	6	12.62	0.79	13.6-11.70	-0.12	1.05
chest g	6	58.90	5.50	69.8-55.20	1.19	2.63
waist g	6	55.63	4.96	64.9-50.30	0.86	2.26
thigh g	6	34.32	5.24	43.8-28.30	0.71	2.09
calf g	6	24.03	1.79	27.4-22.30	0.91	2.26
ankle g	6	16.30	1.36	18.1-14.70	-0.13	1.20
biacr br	16	25.59	1.37	28.1-24.10	0.67	1.84
biilio br	16	18.68	0.88	20.4-17.50	0.59	2.12
trans chest	16	18.10	0.89	19.8-16.80	0.54	2.05
foot len	16	17.63	1.20	20.3-15.30	-0.08	3.13
biep hum wd	16	5.10	0.51	6.16-4.35	0.60	2.28
biep fem wd	16	7.47	0.44	8.28-6.77	0.33	1.83
sitt ht	15	65.18	3.00	70.1-60.00	-0.27	1.82
a-p chest	15	13.47	0.74	15.2-12.40	0.47	2.71
head g	15	51.80	0.93	53.3-50.70	0.57	1.62
neck g	15	26.83	1.31	29.5-25.20	0.92	2.68

Table 4 Girls : Aged 7

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	25	23.52	3.94	30.1-18.40	0.23	1.56
height	25	122.36	5.25	134.2-113.10	0.21	2.59
triceps sf.	25	11.70	4.37	25.5-6.90	1.41	4.69
subscap sf	25	7.41	3.89	16.8-4.00	1.31	3.20
suprail sf	25	6.28	3.18	13.3-3.20	0.90	2.23
abdom sf	25	8.39	5.19	20.7-3.80	1.20	3.17
fr thigh sf	25	16.88	6.34	32.2-9.00	0.74	2.44
med calf sf	25	9.44	3.73	21.9-4.70	1.33	5.52
acrom ht	25	95.20	4.63	103.6-86.60	-0.07	2.13
radial ht	25	73.40	3.81	79.7-66.70	-0.07	1.83
stylion ht	25	56.55	2.88	61.5-50.60	-0.19	2.09
dacty ht	25	43.09	2.60	47.8-38.00	-0.19	2.15
tibial ht	25	31.08	1.43	34.8-28.60	0.40	3.01
spinale ht	25	64.98	3.55	74.1-57.50	0.38	3.21
glut ht	25	63.56	4.32	72.7-56.10	-0.04	2.01
arm g (rel)	25	18.96	2.22	24.4-16.40	0.82	2.64
arm g (flex)	25	19.97	2.31	25.3-17.20	0.73	2.54
forearm g	25	18.08	1.39	20.9-16.20	0.30	1.70
wrist g	25	12.84	1.24	16.4-11.30	1.00	3.49
chest g	25	60.86	4.00	69.5-52.20	-0.07	2.48
waist g	25	54.05	4.87	68.0-47.30	0.75	3.34
thigh g	25	38.22	3.99	45.0-32.40	0.25	1.66
calf g	25	24.75	1.98	28.2-21.90	0.13	1.50
ankle g	25	16.88	1.21	19.3-14.90	0.06	1.81
biacr br	25	26.13	1.68	29.1-22.40	-0.23	2.24
biilio br	25	19.58	2.50	28.5-17.00	2.11	7.54
trans chest	25	18.36	2.28	28.3-16.20	3.21	14.55
foot len	25	18.41	1.00	20.3-16.10	-0.50	2.75
biep hum wd	25	4.98	0.30	5.62-4.29	-0.11	2.72
biep fem wd	25	7.38	0.38	8.00-6.60	-0.30	2.28
sitt ht	25	66.83	2.33	72.3-63.00	0.45	2.30
a-p chest	25	12.93	0.88	14.7-11.10	0.41	2.66
head g	25	51.16	1.77	53.1-44.40	-2.13	8.67
neck g	25	26.06	1.33	28.7-24.20	0.40	1.99

e

Table 5 Boys : Aged 7

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	22	23.92	2.85	29.9-19.40	0.44	2.30
height	22	122.80	5.07	131.3-113.70	0.10	1.95
triceps sf.	22	10.39	2.18	15.5-7.00	0.48	2.52
subscap sf	22	6.28	1.98	11.1-4.50	1.35	3.68
suprail sf	22	4.93	1.56	9.7-2.80	1.26	4.64
abdom sf	22	7.20	2.50	12.9-3.50	0.90	2.99
fr thigh sf	22	15.22	4.66	29.9-10.10	1.24	4.90
med calf sf	22	9.43	2.77	15.8-5.60	0.59	2.48
acrom ht	22	96.18	4.63	103.1-88.70	-0.11	1.86
radial ht	22	74.15	4.06	80.5-67.20	-0.19	1.90
stylion ht	22	56.86	3.37	62.8-50.90	-0.38	1.95
dacty ht	22	42.82	3.00	48.2-37.00	-0.30	2.17
tibial ht	22	30.96	1.59	34.2-28.50	0.24	2.02
spinale ht	22	64.96	3.44	71.9-59.60	0.32	2.13
glut ht	22	63.78	3.65	70.2-57.10	-0.14	2.22
arm g (rel)	22	18.94	1.14	22.0-17.10	0.77	3.33
arm g (flex)	22	20.16	1.23	23.3-17.60	0.33	3.35
forearm g	22	18.77	0.91	20.5-17.00	0.26	2.23
wrist g	22	12.97	0.78	14.4-11.80	0.31	1.90
chest g	22	61.40	2.89	67.0-57.10	0.33	1.85
waist g	22	55.46	2.66	61.2-50.30	0.30	2.71
thigh g	22	36.45	2.51	41.4-32.20	0.58	2.31
calf g	22	25.15	1.63	28.6-21.60	0.27	3.03
ankle g	22	17.08	1.01	19.4-15.60	0.68	2.74
biacr br	22	26.65	1.19	29.3-25.20	0.60	2.00
biilio br	22	19.56	1.95	27.3-17.80	2.79	11.47
trans chest	22	18.52	1.04	20.4-17.00	0.11	1.72
foot len	22	18.57	1.26	21.3-16.30	0.25	2.22
biep hum wd	22	5.24	0.26	5.75-4.84	0.34	1.89
biep fem wd	22	7.70	0.39	8.50-7.24	0.56	2.07
sitt ht	22	67.48	2.71	72.1-61.60	-0.20	2.22
a-p chest	22	13.54	0.93	15.9-12.30	0.76	2.92
head g	22	52.45	1.76	56.0-49.00	0.07	2.25
neck g	22	27.16	1.34	29.6-25.10	0.20	1.78

Table 6 Girls : Aged 8

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	15	25.12	3.81	33.9-19.00	0.57	2.85
height	15	126.71	4.99	134.5-115.60	-0.66	2.63
triceps sf.	15	11.22	2.68	15.6-6.60	-0.14	1.83
subscap sf	15	5.86	1.37	8.0-4.40	0.38	1.34
suprail sf	15	5.51	1.71	9.1-3.20	0.60	2.09
abdom sf	15	6.45	2.01	10.0-4.50	0.51	1.52
fr thigh sf	15	15.97	6.48	35.2-7.50	1.39	5.59
med calf sf	15	9.21	3.89	18.6-4.80	0.91	2.90
acrom ht	15	99.58	4.32	106.8-91.30	-0.27	2.11
radial ht	15	76.67	3.26	81.7-69.80	-0.38	2.22
stylion ht	15	59.21	2.62	64.4-53.30	-0.28	3.02
dacty ht	15	44.96	2.17	48.6-40.30	-0.21	2.43
tibial ht	15	32.95	1.56	35.8-29.90	-0.43	2.50
spinale ht	14	68.59	3.17	74.8-62.20	-0.24	2.63
glut ht	15	67.94	3.17	74.4-61.30	-0.21	2.83
arm g (rel)	15	19.00	1.72	22.3-16.20	0.45	2.04
arm g (flex)	15	19.98	1.43	22.6-18.30	0.58	1.88
forearm g	15	18.46	1.15	20.4-16.60	0.00	1.73
wrist g	15	12.68	0.77	13.7-11.40	0.02	1.44
chest g	15	62.47	3.88	71.1-56.40	0.58	2.56
waist g	15	54.26	2.78	60.4-50.30	0.41	2.52
thigh g	15	37.28	4.45	46.5-28.70	0.44	2.94
calf g	15	25.32	1.75	29.1-22.80	0.47	2.25
ankle g	15	16.96	1.20	18.9-14.30	-0.40	2.45
biacr br	15	27.63	1.77	31.7-24.80	0.24	2.84
biilio br	15	19.76	1.49	22.3-17.50	0.07	1.62
trans chest	15	18.50	1.13	21.2-17.10	0.85	2.87
foot len	15	19.19	1.36	22.5-17.20	0.62	3.09
biep hum wd	15	5.09	0.30	5.7-4.69	-0.10	1.27
biep fem wd	15	7.44	0.42	8.12-6.68	-0.23	1.97
sitt ht	15	68.35	3.09	72.5-62.10	-0.66	2.43
a-p chest	15	13.44	1.00	15.1-11.30	-0.33	2.35
head g	15	51.61	1.17	53.6-49.40	-0.27	2.12
neck g	15	26.49	1.06	28.5-24.50	0.08	2.21

Table 7 Boys : Aged 8

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	22	27.50	4.53	36.3-21.50	0.63	2.27
height	22	129.64	6.01	140.2-118.90	0.06	2.14
triceps sf.	22	10.43	3.43	19.4-6.00	0.81	2.88
subscap sf	22	6.94	4.36	18.4-3.90	1.72	4.53
suprail sf	22	6.32	5.29	22.8-2.80	2.07	6.28
abdom sf	22	7.81	5.70	24.2-3.40	1.56	4.35
fr thigh sf	22	15.25	7.88	37.4-6.90	1.34	3.93
med calf sf	22	9.11	3.88	21.8-5.40	1.65	5.68
acrom ht	22	102.49	5.57	112.4-92.20	0.06	2.07
radial ht	22	78.87	4.48	89.0-72.20	0.30	2.29
stylion ht	22	60.43	3.95	68.7-54.50	0.16	2.02
dacty ht	22	45.99	3.55	52.8-40.30	0.31	1.79
tibial ht	22	33.27	1.90	37.1-30.70	0.52	2.14
spinale ht	22	69.43	4.05	77.4-62.10	-0.09	2.25
glut ht	22	68.80	4.04	77.1-61.90	0.20	2.15
arm g (rel)	22	19.78	2.22	24.5-17.20	0.92	2.49
arm g (flex)	22	20.96	2.09	25.1-18.40	0.72	2.18
forearm g	22	19.55	1.41	22.5-17.50	0.79	2.47
wrist g	22	13.37	0.96	15.2-11.90	0.36	2.00
chest g	22	64.06	4.20	73.6-55.80	0.35	2.93
waist g	22	58.20	3.95	67.8-52.70	1.01	3.41
thigh g	22	38.37	3.79	46.6-34.00	0.86	2.45
calf g	22	26.32	1.90	29.8-23.40	0.36	2.00
ankle g	23	17.76	1.15	19.5-15.40	-0.15	2.04
biacr br	22	28.17	1.29	29.7-25.00	-1.01	2.97
biilio br	22	20.54	1.93	27.0-18.20	1.59	6.19
trans chest	22	19.25	1.50	21.2-17.30	-0.28	1.86
foot len	22	19.56	1.12	22.6-17.60	0.51	3.48
biep hum wd	22	5.50	0.34	6.11-4.94	-0.01	1.90
biep fem wd	22	8.05	0.37	8.79-7.32	0.06	2.46
sitt ht	22	69.99	2.92	75.8-65.30	0.19	1.94
a-p chest	22	14.06	1.01	15.7-11.5	-0.46	2.81
head g	22	53.03	1.18	55.0-51.00	-0.28	1.80
neck g	22	28.24	1.74	32.4-24.80	0.51	2.83

Table 8 Girls : Aged 9

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	30	28.74	5.02	42.0-19.70	0.78	3.43
height	30	133.41	6.56	149.6-119.00	0.33	3.37
triceps sf.	30	12.52	3.37	21.6-6.60	0.50	3.11
subscap sf	30	7.14	2.79	16.4-4.20	1.58	5.35
suprail sf	30	6.46	2.88	15.8-3.40	1.45	4.76
abdom sf	30	8.12	3.12	17.7-3.40	1.04	4.18
fr thigh sf	30	18.71	6.74	36.1-8.20	0.48	2.79
med calf sf	30	10.43	3.02	16.6-5.30	0.03	1.98
acrom ht	30	105.38	5.72	119.6-95.20	0.43	3.16
radial ht	30	81.04	4.50	93.0-73.00	0.30	3.20
stylion ht	30	62.49	3.65	71.4-55.00	0.00	2.84
dacty ht	30	47.29	3.26	55.7-40.50	-0.04	2.88
tibial ht	30	34.95	2.33	40.7-31.00	0.50	2.94
spinale ht	30	72.94	4.15	85.9-64.70	0.53	3.60
glut ht	30	72.45	4.19	83.8-64.90	0.63	3.49
arm g (rel)	30	19.95	1.91	24.5-16.80	0.42	2.61
arm g (flex)	30	21.10	2.10	26.3-17.20	0.43	2.71
forearm g	30	19.26	1.40	22.7-16.60	0.24	2.98
wrist g	30	13.05	0.90	15.3-11.30	0.40	2.82
chest g	30	64.73	5.69	76.3-54.50	0.40	2.23
waist g	30	56.00	4.68	66.8-48.10	0.70	2.60
thigh g	30	40.71	4.32	51.4-30.90	0.19	3.01
calf g	30	26.59	2.17	31.3-21.40	0.25	3.31
ankle g	30	17.98	1.32	21.0-15.20	0.51	2.89
biacr br	30	28.98	1.69	32.2-26.30	0.46	2.01
biilio br	30	20.67	1.30	24.1-18.30	0.41	2.73
trans chest	30	19.17	1.22	22.2-16.80	0.42	3.09
foot len	30	20.29	1.08	22.9-18.70	0.72	3.08
biep hum wd	30	5.37	0.30	6.29-4.91	0.74	3.77
biep fem wd	30	7.76	0.50	9.28-6.88	0.70	3.96
sitt ht	30	71.29	3.35	80.0-64.60	0.58	3.40
a-p chest	30	13.32	0.96	15.4-12.00	0.86	2.77
head g	30	52.30	1.15	54.6-49.70	-0.20	2.22
neck g	30	26.88	1.39	30.1-24.10	0.22	2.87

Table 9 Boys : Aged 9

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	27	28.80	5.15	43.4-22.10	0.89	3.41
height	27	133.35	7.37	147.6-117.20	0.03	2.25
triceps sf.	27	9.77	3.21	19.4-5.60	1.26	4.25
subscap sf	27	6.88	4.24	26.4-4.20	3.59	16.70
suprail sf	27	5.74	5.07	28.5-3.00	3.41	15.16
abdom sf	27	7.72	6.38	34.8-3.20	2.97	12.33
fr thigh sf	27	15.20	6.88	38.9-7.30	1.52	5.87
med calf sf	27	9.05	4.12	21.6-3.80	1.24	4.11
acrom ht	27	104.80	5.64	115.4-91.70	0.13	2.46
radial ht	27	80.91	4.14	88.8-72.00	0.19	2.34
stylion ht	27	62.32	3.05	70.5-55.30	0.40	3.57
dacty ht	27	48.11	2.87	56.5-43.20	0.79	3.90
tibial ht	27	34.71	3.36	45.6-29.90	1.10	4.72
spinale ht	27	71.79	4.49	80.8-63.00	0.27	2.24
glut ht	27	70.54	4.47	81.1-62.50	0.36	2.48
arm g (rel)	27	19.88	2.15	25.9-16.50	0.87	3.53
arm g (flex)	27	21.16	2.07	26.3-17.00	0.54	3.29
forearm g	27	19.75	1.42	22.7-17.00	0.35	2.47
wrist g	27	13.63	1.42	18.5-11.10	1.28	5.90
chest g	27	66.20	7.75	97.7-58.60	2.51	10.42
waist g	27	57.93	4.06	70.0-50.40	0.63	3.91
thigh g	27	39.26	3.94	49.3-33.50	0.60	2.76
calf g	27	27.18	3.10	37.2-22.70	1.44	5.12
ankle g	27	18.17	1.47	21.1-15.00	0.03	2.51
biacr br	27	28.63	1.91	32.7-24.60	0.18	2.30
biilio br	27	20.46	1.44	24.6-18.00	0.83	3.57
trans chest	27	19.42	1.22	21.5-17.20	0.03	1.75
foot len	27	20.13	1.32	22.7-17.20	-0.15	2.91
biep hum wd	27	5.57	0.36	6.29-4.88	0.34	2.11
biep fem wd	27	8.13	0.77	9.85-5.45	-0.94	6.66
sitt ht	27	71.54	3.20	76.4-64.50	-0.31	1.93
a-p chest	27	14.31	1.10	16.7-12.30	0.12	2.59
head g	27	52.54	1.10	54.5-50.70	0.10	1.80
neck g	27	27.99	1.63	32.2-24.80	0.31	3.16

Table 10 Girls : Aged 10

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	20	35.84	9.18	59.4-25.50	0.84	2.93
height	20	141.52	8.19	160.1-131.00	0.78	2.58
triceps sf.	20	13.16	5.41	26.2-5.70	0.71	2.67
subscap sf	20	11.09	8.13	40.4-5.20	2.34	8.61
suprail sf	20	9.65	6.20	25.4-4.10	1.18	3.29
abdom sf	20	12.31	8.63	34.2-3.80	0.98	2.83
fr thigh sf	20	22.60	10.23	46.6-11.40	1.10	3.19
med calf sf	20	12.97	6.65	28.6-5.40	0.81	2.43
acrom ht	20	113.61	8.41	133.3-103.60	0.89	2.76
radial ht	20	88.02	7.14	104.4-79.80	0.89	2.64
stylion ht	20	67.98	5.55	79.1-61.40	0.63	2.07
dacty ht	20	52.62	4.66	62.1-47.60	0.55	1.87
tibial ht	20	37.57	3.08	44.3-33.30	0.83	2.64
spinale ht	20	79.46	6.14	92.2-71.40	0.64	2.40
glut ht	20	77.10	5.45	87.7-67.70	0.20	1.90
arm g (rel)	20	22.11	3.14	29.8-18.20	0.99	3.10
arm g (flex)	20	23.32	2.88	29.9-19.90	0.94	2.89
forearm g	20	20.79	1.89	24.8-18.50	0.61	2.11
wrist g	20	13.81	1.15	16.8-12.40	1.06	3.23
chest g	20	70.38	6.90	89.0-61.80	1.03	3.42
waist g	20	59.51	6.56	73.7-51.20	0.83	2.59
thigh g	20	45.50	6.15	60.0-37.90	0.83	2.72
calf g	20	28.58	3.19	37.0-24.60	0.88	3.22
ankle g	20	19.30	2.28	24.4-15.80	0.64	2.33
biacr br	20	30.73	1.51	33.5-28.90	0.41	1.79
biilio br	20	22.32	2.12	28.9-18.80	1.24	5.36
trans chest	20	20.62	1.64	24.7-18.20	0.93	3.51
foot len	20	21.26	1.62	25.6-18.90	0.69	3.20
biep hum wd	20	5.64	0.37	6.55-5.06	0.48	2.75
biep fem wd	20	8.29	0.70	9.90-7.36	0.66	2.62
sitt ht	20	75.13	4.00	83.5-69.90	0.28	1.89
a-p chest	20	15.14	1.70	18.6-12.50	0.35	2.27
head g	20	52.81	1.42	55.4-49.10	-0.57	3.47
neck g	20	28.20	2.12	32.6-24.40	0.30	2.29

Table 11 Boys : Aged 10

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	21	33.23	5.90	50.8-25.30	1.43	4.84
height	21	140.14	6.99	153.9-128.70	0.31	2.03
triceps sf.	21	9.94	3.64	21.3-6.10	1.50	5.14
subscap sf	21	7.11	3.75	20.6-4.20	2.36	8.33
suprail sf	21	5.97	3.45	18.1-3.40	2.16	7.61
abdom sf	21	8.81	7.40	35.3-3.50	2.33	8.20
fr thigh sf	21	17.67	7.86	43.5-10.80	1.86	6.21
med calf sf	21	9.70	4.41	24.6-4.50	1.97	6.89
acrom ht	21	110.90	6.76	125.6-99.80	0.44	2.38
radial ht	21	86.40	5.24	96.6-77.60	0.63	2.43
stylion ht	21	66.10	4.64	75.4-59.10	0.65	2.31
dacty ht	21	50.86	3.80	58.8-45.90	0.71	2.24
tibial ht	21	36.87	2.58	41.9-32.30	0.20	2.07
spinale ht	21	77.33	5.33	85.5-67.10	-0.08	1.75
glut ht	21	75.56	4.92	85.3-67.30	0.37	2.07
arm g (rel)	21	20.88	2.46	29.1-18.00	1.69	6.38
arm g (flex)	21	22.43	2.29	29.8-19.50	1.54	5.65
forearm g	21	20.61	1.36	24.7-18.80	1.50	4.90
wrist g	21	14.03	1.08	16.9-12.10	1.00	3.97
chest g	21	69.69	5.18	84.5-62.40	1.09	4.01
waist g	21	61.31	5.32	78.9-55.70	1.64	6.06
thigh g	21	41.55	3.90	52.2-37.30	1.05	3.35
calf g	21	27.77	1.92	33.4-25.20	1.20	4.32
ankle g	21	18.93	1.34	22.0-16.00	-0.18	3.45
biacr br	21	30.40	1.43	32.8-27.50	-0.28	1.94
biilio br	21	21.72	1.58	25.9-19.40	0.72	3.14
trans chest	21	20.96	1.56	24.5-18.30	0.72	3.16
foot len	21	21.52	2.19	29.4-18.70	2.09	8.33
biep hum wd	21	5.93	0.39	6.87-5.30	0.79	3.06
biep fem wd	21	8.52	0.52	9.89-7.67	1.38	4.71
sitt ht	21	74.09	3.93	82.5-66.80	0.24	2.60
a-p chest	21	14.58	0.95	16.6-13.20	0.53	2.05
head g	21	54.02	1.53	56.8-50.30	-0.29	2.70
neck g	21	28.94	1.31	32.0-26.40	0.25	2.89

Table 12 Girls : Aged 11

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	24	39.12	10.22	68.6-23.30	0.88	3.75
height	24	145.15	7.78	155.4-131.50	-0.16	1.56
triceps sf.	24	14.28	4.18	22.6-7.50	0.45	2.17
subscap sf	24	10.20	4.50	23.2-4.90	0.98	3.64
suprail sf	24	10.00	5.45	25.8-3.80	1.34	4.14
abdom sf	24	13.14	6.46	32.4-5.30	1.01	3.92
fr thigh sf	24	23.53	8.16	42.4-11.40	0.68	3.02
med calf sf	24	12.90	5.45	25.8-5.40	0.91	2.99
acrom ht	23	116.07	6.84	126.1-103.80	-0.09	1.61
radial ht	23	89.00	5.44	97.8-79.90	-0.05	1.58
stylion ht	23	68.38	4.48	75.8-61.10	0.01	1.58
dacty ht	23	53.12	3.83	59.9-47.00	0.06	1.73
tibial ht	23	37.97	2.46	41.0-32.70	-0.58	2.04
spinale ht	23	80.77	4.80	89.3-73.40	-0.01	1.63
glut ht	23	77.99	5.18	87.1-71.20	0.32	1.72
arm g (rel)	24	22.27	2.58	27.9-17.30	0.31	2.46
arm g (flex)	24	23.59	2.68	29.1-17.90	0.03	2.40
forearm g	24	21.00	1.75	24.4-17.60	0.11	2.08
wrist g	24	14.12	1.05	16.2-11.90	-0.18	2.34
chest g	24	71.45	6.05	83.4-60.30	0.04	2.30
waist g	24	61.17	5.79	74.3-52.70	0.53	2.69
thigh g	24	45.89	5.24	55.0-34.80	0.03	2.09
calf g	24	29.55	3.14	34.7-22.40	-0.30	2.16
ankle g	24	19.85	1.95	23.0-15.40	-0.30	2.23
biacr br	24	30.50	2.53	34.3-21.70	-1.63	6.70
biilio br	24	23.12	2.53	32.2-19.90	1.69	7.29
trans chest	24	20.73	1.65	24.9-18.30	0.39	2.56
foot len	24	21.75	1.43	23.9-18.50	-0.33	2.15
biep hum wd	24	5.75	0.42	6.61-4.83	-0.42	2.89
biep fem wd	24	8.46	0.53	9.45-7.42	-0.12	2.14
sitt ht	24	76.22	4.28	83.2-67.50	-0.22	1.96
a-p chest	24	15.30	1.56	18.1-11.90	0.15	2.37
head g	24	53.02	1.50	55.5-49.80	-0.07	2.10
neck g	24	28.79	2.08	32.3-24.90	-0.11	1.94

Table 13 Boys : Aged 11

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	26	37.21	7.95	61.3-29.10	1.24	4.02
height	26	143.68	6.89	157.5-132.00	0.36	2.16
triceps sf.	26	10.03	3.39	18.8-6.60	1.19	3.37
subscap sf	26	7.95	5.72	26.7-4.20	2.15	6.60
suprail sf	26	6.74	4.83	22.8-3.40	2.18	6.79
abdom sf	26	9.85	8.83	33.4-4.00	1.79	4.81
fr thigh sf	26	16.99	5.82	37.3-10.80	2.12	7.55
med calf sf	26	10.01	3.59	21.2-5.00	1.47	4.80
acrom ht	26	115.60	6.28	129.6-105.00	0.42	2.34
radial ht	26	88.93	4.98	101.0-80.80	0.61	2.76
stylion ht	26	68.26	4.05	77.3-62.30	0.54	2.57
dacty ht	26	52.55	3.40	60.2-45.90	0.28	2.81
tibial ht	26	38.30	2.66	43.8-34.10	0.25	2.04
spinale ht	26	80.30	4.89	90.0-74.50	0.54	2.09
glut ht	26	77.68	5.16	90.6-67.90	0.38	2.75
arm g (rel)	26	21.32	2.28	26.5-17.70	0.95	3.14
arm g (flex)	26	22.84	2.18	28.2-18.90	0.80	3.08
forearm g	26	21.25	1.45	24.2-18.80	0.53	2.04
wrist g	26	14.10	1.04	16.5-12.70	0.65	2.36
chest g	26	70.83	6.15	85.0-61.50	0.73	2.46
waist g	26	62.01	5.65	78.7-55.80	1.31	4.09
thigh g	26	42.71	2.95	49.2-38.30	0.85	2.53
calf g	26	29.11	2.34	35.2-25.30	0.90	3.43
ankle g	26	19.43	1.48	22.4-16.20	-0.01	2.52
biacr br	26	31.01	1.95	35.0-28.70	0.64	2.04
biilio br	26	22.42	1.40	24.9-20.00	0.03	2.05
trans chest	26	21.09	1.73	25.2-16.50	-0.07	3.67
foot len	26	22.21	1.41	25.5-20.00	0.47	2.29
biep hum wd	26	6.06	0.77	9.14-4.76	2.30	10.32
biep fem wd	26	8.66	0.51	9.83-7.82	0.56	2.42
sitt ht	26	75.27	2.99	81.5-70.60	0.31	2.09
a-p chest	26	15.28	1.44	18.8-13.20	0.75	2.91
head g	26	53.45	1.18	55.6-50.90	-0.19	2.27
neck g	26	29.46	1.93	33.1-26.80	0.56	2.04

Table 14 Girls : Aged 12

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	35	42.79	7.95	64.6-29.90	0.46	2.90
height	35	152.89	7.84	166.5-134.70	-0.27	2.21
triceps sf.	35	13.43	4.62	26.6-7.40	0.99	3.38
subscap sf	35	9.97	3.66	17.2-5.20	0.43	1.89
suprail sf	35	10.57	5.23	22.6-4.10	0.75	2.57
abdom sf	35	13.19	6.75	30.6-4.40	0.73	2.82
fr thigh sf	35	23.65	9.15	55.6-11.10	1.37	5.35
med calf sf	35	14.18	4.81	25.2-6.60	0.34	2.20
acrom ht	35	123.58	6.40	134.7-109.30	-0.23	2.35
radial ht	35	95.27	5.44	105.8-83.60	-0.05	2.23
stylion ht	35	73.30	4.71	82.3-64.20	-0.03	2.02
dacty ht	35	57.10	3.75	64.7-48.80	0.00	2.41
tibial ht	35	40.87	2.41	46.5-36.00	0.11	2.38
spinale ht	35	86.01	4.47	95.4-77.70	0.23	2.13
glut ht	35	83.85	4.46	90.5-71.40	-0.56	2.90
arm g (rel)	35	23.09	2.76	29.8-19.00	0.50	2.38
arm g (flex)	35	24.19	2.55	29.9-20.20	0.45	2.26
forearm g	35	21.77	1.78	25.2-19.30	0.23	1.78
wrist g	35	14.70	1.20	17.3-12.80	0.37	2.43
chest g	35	74.22	5.76	85.3-64.20	0.08	1.96
waist g	35	62.13	5.32	74.4-53.60	0.55	2.41
thigh g	35	48.25	5.44	61.0-40.40	0.48	2.24
calf g	35	30.80	2.51	37.1-25.60	0.29	2.51
ankle g	35	20.21	1.72	23.2-16.70	-0.17	2.32
biacr br	35	32.00	2.39	37.2-26.00	-0.29	3.01
biilio br	35	24.06	2.52	32.5-19.10	0.98	5.22
trans chest	35	21.63	2.03	27.0-17.00	0.35	3.21
foot len	35	22.71	1.24	25.1-19.80	-0.27	2.71
biep hum wd	35	6.02	0.45	6.8-5.23	-0.11	1.71
biep fem wd	35	8.74	0.52	10.03-7.78	0.20	2.58
sitt ht	35	79.41	4.15	88.3-71.70	-0.03	2.52
a-p chest	35	15.48	1.21	18.1-12.80	0.09	2.42
head g	35	53.24	1.92	57.5-49.90	0.47	2.29
neck g	35	29.37	1.84	33.2-26.20	0.16	2.03

Table 15 Boys : Aged 12

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	33	42.18	8.61	60.2-27.90	0.38	2.52
height	33	149.25	6.45	163.1-137.10	0.13	2.26
triceps sf.	34	13.15	7.20	30.4-5.50	0.83	2.40
subscap sf	34	11.16	8.52	33.9-4.30	1.43	3.91
suprail sf	34	11.21	8.60	32.4-3.50	1.05	2.67
abdom sf	34	14.60	11.73	43.6-3.70	0.99	2.51
fr thigh sf	34	21.53	12.33	48.6-8.50	0.93	2.51
med calf sf	34	13.50	8.52	35.2-4.00	1.14	3.28
acrom ht	34	119.92	5.47	132.6-107.30	0.19	2.74
radial ht	34	92.40	4.50	102.7-81.60	0.10	2.86
stylion ht	34	70.69	3.60	78.1-61.30	-0.31	2.74
dacty ht	34	54.76	3.18	59.8-45.60	-0.65	3.19
tibial ht	34	39.02	2.51	44.4-34.50	-0.07	2.20
spinale ht	34	83.29	4.42	92.6-75.70	0.18	2.20
glut ht	34	81.36	4.92	91.8-72.70	0.21	2.11
arm g (rel)	34	32.66	3.52	31.2-19.20	0.76	2.46
arm g (flex)	34	25.19	3.39	33.4-21.40	0.89	2.69
forearm g	34	22.50	2.00	27.0-19.30	0.48	2.44
wrist g	34	14.87	1.37	17.6-12.50	0.11	1.91
chest g	34	74.23	6.77	91.4-65.60	0.85	2.76
waist g	34	66.03	7.70	83.2-54.90	0.66	2.38
thigh g	34	46.50	5.74	58.0-38.50	0.43	1.96
calf g	34	30.91	3.24	38.2-26.10	0.46	2.37
ankle g	34	20.43	2.20	25.4-16.90	0.46	2.69
biacr br	34	31.79	3.16	42.8-21.70	0.28	7.59
biilio br	34	23.19	1.80	26.9-18.80	-0.13	2.64
trans chest	34	21.77	1.58	24.6-18.30	-0.16	2.26
foot len	34	22.92	1.07	25.5-21.00	0.53	2.79
biep hum wd	34	6.25	0.67	9.08-5.23	2.09	9.96
biep fem wd	34	8.99	0.52	9.84-8.08	-0.16	1.81
sitt ht	34	77.77	3.04	83.0-72.60	-0.03	1.69
a-p chest	34	16.17	1.52	19.7-13.50	0.11	2.32
head g	34	53.55	1.51	56.0-50.20	-0.42	2.38
neck g	34	30.08	2.12	35.1-26.10	0.23	2.26

Table 16 Girls : Aged 13

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	37	47.92	9.44	70.9-31.60	0.52	2.78
height	36	159.33	7.00	173.4-144.70	-0.46	2.68
triceps sf.	37	13.04	4.85	24.6-6.70	0.80	2.68
subscap sf	37	11.09	6.75	30.9-5.00	1.59	4.60
suprail sf	37	11.12	6.25	28.0-3.80	1.33	3.93
abdom sf	37	14.61	7.86	32.4-4.90	0.91	2.78
fr thigh sf	37	21.45	7.79	39.2-8.50	0.65	2.43
med calf sf	37	13.25	4.76	27.4-5.20	0.88	3.65
acrom ht	37	128.31	5.91	140.0-116.00	-0.34	2.42
radial ht	37	98.64	4.75	108.0-89.80	-0.20	2.29
stylion ht	37	75.79	3.69	82.6-68.5	-0.10	2.11
dacty ht	37	58.71	3.28	64.8-53.60	0.10	1.78
tibial ht	37	42.39	2.23	46.5-37.80	-0.11	2.40
spinale ht	37	89.59	4.67	97.6-80.10	-0.30	2.50
glut ht	37	88.05	4.54	97.3-78.40	-0.04	2.68
arm g (rel)	37	23.58	2.83	28.6-17.40	0.32	2.31
arm g (flex)	37	24.56	2.73	29.7-18.00	0.03	2.51
forearm g	37	22.32	1.65	25.3-18.30	-0.08	2.62
wrist g	37	14.82	1.10	16.9-12.40	-0.04	2.54
chest g	37	78.73	6.17	95.8-67.90	0.64	3.21
waist g	37	64.41	6.05	83.8-56.20	1.03	3.92
thigh g	37	49.31	5.68	63.0-34.60	0.07	3.20
calf g	37	32.14	2.97	38.5-27.20	0.46	2.35
ankle g	37	21.00	1.45	25.3-17.90	0.30	3.69
biacr br	37	33.88	2.11	40.4-28.80	0.26	4.35
biilio br	37	25.29	2.48	33.7-20.60	1.10	4.91
trans chest	37	22.96	2.18	32.7-20.00	2.43	11.48
foot len	37	23.42	1.29	26.3-20.20	-0.21	3.09
biep hum wd	37	6.21	0.42	7.34-5.41	0.23	3.13
biep fem wd	37	8.76	0.51	10.14-7.61	0.48	3.71
sitt ht	36	82.86	4.16	90.8-73.80	-0.23	2.27
a-p chest	36	16.32	1.34	19.3-13.90	0.30	2.31
head g	36	53.82	1.54	57.7-51.20	0.40	2.59
neck g	36	30.40	1.91	34.2-26.70	-0.12	2.30

Table 17 Boys : Aged 13

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	35	48.00	7.46	64.9-32.20	0.21	2.38
height	35	159.20	6.94	175.4-148.00	0.25	2.13
triceps sf.	35	11.58	6.16	39.3-52.00	2.71	12.13
subscap sf	35	8.70	5.83	31.4-4.60	2.83	10.64
suprail sf	35	8.46	5.35	28.1-3.40	1.82	6.44
abdom sf	35	12.38	9.38	46.6-4.40	1.87	6.08
fr thigh sf	35	16.45	7.64	46.6-8.80	2.21	8.37
med calf sf	35	11.18	5.57	36.1-5.40	2.58	11.84
acrom ht	35	127.84	6.01	144.9-118.30	0.66	2.89
radial ht	35	98.24	4.99	111.0-88.80	0.43	2.44
stylion ht	35	75.00	3.87	84.9-68.70	0.33	2.41
dacty ht	35	57.56	3.16	65.1-53.00	0.37	2.42
tibial ht	34	43.06	2.57	49.4-36.90	0.12	2.93
spinale ht	35	89.77	4.22	102.2-84.00	0.75	3.12
glut ht	35	87.41	4.73	98.1-76.10	-0.14	2.70
arm g (rel)	35	24.13	2.37	32.2-19.70	0.88	4.96
arm g (flex)	35	26.03	2.59	34.1-21.70	0.85	3.92
forearm g	35	23.55	1.54	27.2-20.00	0.14	2.91
wrist g	35	15.55	0.91	17.4-13.60	-0.05	2.32
chest g	35	79.55	5.98	91.8-69.20	0.12	2.11
waist g	35	68.11	5.57	81.0-56.00	0.57	2.86
thigh g	35	48.20	4.47	62.0-38.40	0.69	4.02
calf g	35	32.36	2.50	38.6-27.10	0.45	3.29
ankle g	35	21.20	1.61	24.7-17.60	0.10	2.42
biacr br	35	34.29	1.91	39.5-29.90	0.24	3.58
biilio br	35	24.95	3.47	42.4-21.00	3.55	18.38
trans chest	35	23.45	1.48	26.7-19.80	0.17	3.24
foot len	35	24.46	1.47	28.3-22.00	0.59	2.96
biep hum wd	35	6.54	0.68	7.38-3.38	-2.75	13.91
biep fem wd	35	9.54	0.48	10.66-8.62	0.32	2.39
sitt ht	35	81.82	4.06	91.9-74.90	0.35	2.53
a-p chest	35	17.12	1.49	19.4-13.60	-0.54	2.51
head g	35	54.59	1.24	56.8-52.10	0.11	1.90
neck g	35	31.91	1.70	36.2-28.30	0.10	3.01

Table 18 Girls : Aged 14

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	67	52.42	9.44	72.4-25.10	0.04	2.90
height	67	162.53	6.19	180.8-149.10	0.36	3.15
triceps sf.	67	14.57	4.84	28.4-6.10	0.29	2.52
subscap sf	67	11.72	5.74	29.3-5.00	1.42	4.40
suprail sf	67	12.26	5.89	27.5-3.80	1.03	3.34
abdom sf	67	16.83	8.14	37.2-5.20	0.76	2.58
fr thigh sf	67	23.21	7.65	44.4-8.80	0.48	3.01
med calf sf	67	14.79	5.64	26.7-5.20	0.43	2.36
acrom ht	67	130.46	5.43	145.5-117.90	0.36	3.25
radial ht	67	100.43	4.19	112.8-90.70	0.31	3.25
stylion ht	67	77.32	3.46	86.3-69.40	0.20	2.73
dacty ht	67	60.10	2.98	67.2-53.00	0.06	2.68
tibial ht	67	42.55	1.99	48.5-38.00	0.35	3.59
spinale ht	67	89.97	4.24	102.3-78.40	0.08	3.47
glut ht	67	88.53	4.22	101.2-78.00	0.34	3.24
arm g (rel)	67	24.99	2.83	31.9-19.8	0.33	2.44
arm g (flex)	67	26.35	2.76	32.4-21.00	0.31	2.59
forearm g	67	23.30	1.55	26.9-20.00	0.20	2.65
wrist g	67	15.47	1.20	21.1-13.20	1.54	8.44
chest g	67	81.94	5.40	97.2-68.70	0.31	3.51
waist g	67	66.56	5.97	82.2-53.30	0.62	3.13
thigh g	67	52.75	5.26	65.4-42.40	0.14	2.59
calf g	67	33.60	2.76	42.0-26.90	0.20	3.22
ankle g	67	21.55	1.58	26.0-17.60	0.05	3.24
biacr br	67	34.95	1.84	40.7-30.70	0.07	3.63
biilio br	67	26.20	1.96	34.5-32.10	1.57	7.33
trans chest	67	32.50	1.85	28.0-17.70	-0.08	3.47
foot len	67	23.57	1.13	26.3-21.10	-0.09	2.51
biep hum wd	67	6.31	0.34	7.27-5.21	-0.10	3.67
biep fem wd	67	8.93	0.47	10.14-7.75	0.08	2.88
sitt ht	65	85.16	3.45	92.9-77.10	0.21	2.67
a-p chest	66	16.67	1.59	20.9-14.00	0.63	2.87
head g	66	54.33	1.35	57.7-49.80	-0.35	4.13
neck g	66	31.06	1.50	34.3-27.80	0.06	2.33

Table 19 Boys : Aged 14

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	76	52.60	9.69	80.7-33.20	0.07	2.62
height	76	165.52	8.64	186.4-140.70	-0.27	2.84
triceps sf.	76	9.96	4.35	28.5-4.40	1.67	6.31
subscap sf	76	8.28	4.43	25.8-3.60	2.50	9.71
suprail sf	76	7.76	4.84	30.2-3.30	2.57	10.60
abdom sf	76	10.89	7.16	37.4-4.30	2.00	7.01
fr thigh sf	76	14.63	6.33	36.6-4.80	1.09	4.12
med calf sf	76	10.45	4.62	25.0-3.70	1.24	4.07
acrom ht	76	132.77	7.15	149.5-113.10	-0.17	2.79
radial ht	76	101.99	5.46	114.7-86.80	-0.24	2.85
stylion ht	76	78.18	4.33	87.1-67.80	-0.32	2.61
dacty ht	76	60.17	3.41	68.0-51.40	-0.23	2.78
tibial ht	76	44.42	2.89	51.0-34.60	-0.40	3.58
spinale ht	76	92.76	5.43	107.5-77.60	-0.04	2.94
glut ht	76	90.64	5.25	101.9-74.40	-0.24	3.08
arm g (rel)	76	24.75	2.52	30.8-20.00	-0.03	2.27
arm g (flex)	76	26.79	2.66	31.1-21.30	-0.22	2.01
forearm g	76	24.48	1.81	27.6-20.20	-0.36	2.28
wrist g	76	16.04	1.23	18.9-13.10	-0.21	2.66
chest g	76	82.03	6.41	100.9-67.30	0.12	3.00
waist g	76	68.31	5.72	82.0-51.60	-0.12	3.01
thigh g	76	49.12	5.14	62.8-35.50	0.20	2.99
calf g	76	33.29	3.01	39.4-22.20	-0.67	3.97
ankle g	76	21.74	1.62	25.1-18.40	-0.10	2.24
biacr br	76	35.55	2.36	40.7-30.60	-0.11	2.42
biilio br	76	25.01	1.85	29.1-21.00	0.07	2.50
trans chest	76	24.21	1.94	29.5-19.60	0.15	2.86
foot len	76	25.27	1.51	28.2-21.80	0.05	2.11
biep hum wd	76	6.89	0.47	8.01-5.85	-0.10	2.55
biep fem wd	76	9.61	0.58	11.23-8.41	0.48	2.80
sitt ht	76	85.08	4.38	94.7-74.20	-0.36	2.68
a-p chest	75	17.46	1.68	22.8-13.90	0.39	3.06
head g	74	55.28	1.74	60.0-51.50	0.50	3.26
neck g	76	32.81	2.42	39.1-27.50	-0.06	2.97

Table 20 Girls : Aged 15

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	66	53.89	7.57	73.6-39.90	0.16	2.32
height	66	163.12	6.77	178.8-142.70	0.04	3.14
triceps sf.	66	15.05	4.68	27.0-6.50	0.61	2.83
subscap sf	66	11.95	5.47	31.3-5.60	1.38	4.51
suprail sf	66	11.70	5.18	26.4-5.00	0.94	3.01
abdom sf	66	16.16	6.94	35.0-5.80	0.70	2.63
fr thigh sf	66	24.74	7.31	43.4-10.20	0.50	2.51
med calf sf	66	15.21	5.26	27.8-5.40	0.34	2.59
acrom ht	66	131.12	6.26	144.1-113.30	0.02	2.93
radial ht	66	101.00	4.69	110.2-88.40	0.00	2.67
stylion ht	66	78.11	3.80	86.5-68.90	0.06	2.59
dacty ht	66	60.67	3.59	67.8-53.70	-0.03	2.27
tibial ht	66	42.31	2.22	48.4-35.10	-0.03	3.94
spinale ht	66	89.57	6.17	102.2-60.90	-1.38	8.67
glut ht	66	88.51	4.51	99.9-75.80	-0.23	3.59
arm g (rel)	66	25.53	2.37	31.4-21.30	0.26	2.23
arm g (flex)	66	26.71	2.22	32.3-22.70	0.31	2.50
forearm g	66	23.52	1.86	32.9-19.10	1.65	10.90
wrist g	66	15.38	1.15	19.6-12.90	0.48	3.22
chest g	66	82.26	4.87	98.4-72.90	0.44	3.55
waist g	66	65.15	4.84	78.6-56.70	0.42	2.60
thigh g	66	53.69	3.79	61.5-45.70	0.05	2.24
calf g	66	34.23	2.53	39.4-29.30	0.11	2.33
ankle g	66	21.45	1.26	24.8-19.00	0.35	2.93
biacr br	66	34.93	2.06	38.2-26.00	-1.45	7.16
biilio br	66	26.34	2.02	36.6-22.30	1.70	11.11
trans chest	66	23.57	2.02	34.4-20.10	2.39	13.55
foot len	66	23.38	1.08	25.9-20.50	-0.17	2.67
biep hum wd	66	6.25	0.36	7.03-5.67	0.24	2.11
biep fem wd	66	8.82	0.56	9.85-6.42	-0.88	6.18
sitt ht	66	86.23	3.25	93.2-78.60	0.13	2.41
a-p chest	66	16.75	1.70	22.1-10.20	-0.34	5.84
head g	66	54.07	1.44	58.3-49.80	0.23	3.54
neck g	66	31.22	1.76	39.5-28.60	1.70	8.54

Table 21 Boys : Aged 15

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	77	58.63	11.23	88.5-33.10	0.59	3.11
height	77	170.46	8.73	190.0-145.90	-0.13	2.64
triceps sf.	77	9.64	4.62	26.2-4.20	1.75	5.63
subscap sf	77	9.46	6.83	46.1-4.80	3.08	13.90
suprail sf	77	8.43	6.39	38.4-3.80	2.62	10.64
abdom sf	77	11.63	8.70	39.8-4.60	1.84	5.52
fr thigh sf	77	14.50	7.61	44.3-6.20	1.71	5.77
med calf sf	77	10.36	5.26	31.5-4.30	1.82	6.50
acrom ht	77	137.14	7.19	151.4-116.00	-0.26	2.72
radial ht	77	105.47	5.74	116.1-88.40	-0.29	2.75
stylion ht	77	80.83	4.81	90.1-67.10	-0.28	2.62
dacty ht	77	62.45	4.04	69.8-51.70	-0.25	2.41
tibial ht	77	45.49	2.91	51.7-37.80	-0.17	2.65
spinale ht	77	95.35	5.62	109.2-82.20	0.09	2.57
glut ht	77	92.75	5.63	106.2-80.10	0.10	2.42
arm g (rel)	77	26.27	2.95	33.8-20.80	0.69	2.86
arm g (flex)	77	28.72	3.28	37.5-22.80	0.76	3.11
forearm g	77	25.56	2.00	30.0-20.70	0.21	2.62
wrist g	77	16.49	1.21	19.3-13.00	-0.29	3.34
chest g	77	86.25	7.80	105.1-60.70	-0.02	3.68
waist g	77	70.76	6.60	97.0-59.80	1.52	5.50
thigh g	77	51.46	5.68	68.4-41.00	0.83	3.19
calf g	77	34.46	2.82	42.4-27.40	0.48	3.61
ankle g	77	22.35	1.68	27.1-18.10	0.24	3.16
biacr br	77	36.86	2.38	44.2-30.70	0.09	3.48
biilio br	77	26.01	1.81	31.0-20.20	-0.04	3.72
trans chest	77	25.41	2.11	30.7-21.70	0.65	2.90
foot len	77	25.46	1.41	28.5-21.80	-0.16	2.67
biep hum wd	77	7.09	0.47	7.85-5.57	-0.88	3.60
biep fem wd	77	9.74	0.56	11.92-8.44	0.41	5.09
sitt ht	77	87.78	5.24	97.3-74.00	-0.30	2.86
a-p chest	77	18.16	1.89	22.4-15.00	0.14	2.05
head g	77	55.77	1.61	59.8-51.40	-0.11	3.07
neck g	77	34.07	2.75	42.3-25.70	0.37	4.17

Table 22 Girls : Aged 16

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	53	54.87	8.03	80.1-43.70	0.86	3.64
height	53	164.61	6.64	185.2-149.10	0.15	3.50
triceps sf.	53	14.48	4.38	25.5-7.00	0.43	2.52
subscap sf	53	11.72	5.51	35.8-6.60	2.29	9.16
suprail sf	53	11.83	5.34	31.4-4.80	1.59	5.97
abdom sf	53	16.42	8.31	48.2-5.00	1.41	5.66
fr thigh sf	53	24.16	7.14	44.3-11.60	0.31	2.84
med calf sf	53	15.02	5.88	32.7-6.00	1.05	4.19
acrom ht	53	132.64	5.93	152.8-121.20	0.28	4.04
radial ht	53	102.10	4.36	118.3-94.40	0.62	4.84
stylion ht	53	78.74	3.49	91.9-72.20	0.55	5.20
dacty ht	53	61.19	3.05	73.0-55.20	0.66	5.66
tibial ht	53	42.94	2.01	48.6-38.00	-0.10	3.33
spinale ht	53	90.87	4.56	103.2-80.40	-0.13	3.15
glut ht	53	88.73	3.88	98.5-79.90	-0.02	2.86
arm g (rel)	53	25.36	2.42	31.2-20.30	0.15	2.67
arm g (flex)	53	26.62	2.46	32.1-20.90	0.08	2.84
forearm g	53	23.59	1.31	26.6-21.00	0.27	2.28
wrist g	53	15.44	0.78	17.2-13.60	0.18	2.79
chest g	53	82.74	5.28	103.5-71.50	0.88	5.87
waist g	53	66.10	6.29	89.5-57.00	1.48	5.61
thigh g	53	53.91	4.89	68.8-44.90	0.70	3.76
calf g	53	34.34	2.56	42.6-29.30	0.67	3.55
ankle g	53	21.43	1.35	25.2-18.70	0.37	2.63
biacr br	53	35.35	2.49	38.4-24.60	-1.72	7.62
biilio br	53	26.57	1.46	30.9-24.10	0.39	2.96
trans chest	53	24.42	1.49	28.2-21.70	0.48	2.91
foot len	53	23.37	1.01	25.6-21.50	0.03	2.23
biep hum wd	53	6.29	0.26	6.81-5.66	-0.03	2.58
biep fem wd	53	8.87	0.44	10.00-7.82	0.43	3.24
sitt ht	53	86.94	3.19	96.0-79.40	0.37	3.14
a-p chest	53	16.66	1.53	22.2-13.40	1.22	5.43
head g	53	54.10	1.32	57.0-51.50	0.08	2.44
neck g	53	30.90	1.72	36.9-27.60	1.15	5.06

Table 23 Boys : Aged 16

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	55	62.16	8.86	78.7-40.30	-0.19	2.56
height	56	174.59	8.37	193.2-151.90	-0.18	2.94
triceps sf.	56	8.93	3.75	24.2-4.30	2.00	7.74
subscap sf	56	8.63	4.21	25.3-4.40	2.19	7.71
suprail sf	56	8.25	5.55	30.1-3.50	2.22	7.77
abdom sf	56	11.47	8.75	44.2-4.30	2.02	6.40
fr thigh sf	56	13.10	7.26	44.2-5.00	2.13	8.28
med calf sf	56	9.96	5.46	37.4-4.40	2.68	12.67
acrom ht	56	140.63	7.50	158.2-120.80	0.02	3.05
radial ht	56	107.90	6.11	123.9-93.60	0.09	2.91
stylion ht	56	82.39	4.94	95.4-71.40	0.25	2.80
dacty ht	56	63.86	4.46	75.8-53.80	0.29	2.87
tibial ht	56	45.84	2.32	50.6-39.60	-0.04	2.64
spinale ht	56	97.17	5.03	106.3-84.10	-0.25	2.49
glut ht	56	93.73	4.88	106.0-81.30	-0.03	3.01
arm g (rel)	56	27.28	2.17	31.5-21.40	-0.28	2.76
arm g (flex)	56	29.83	2.35	35.0-22.50	-0.46	3.68
forearm g	56	26.38	2.07	36.1-21.30	1.40	10.17
wrist g	56	16.86	0.92	18.9-14.10	-0.16	3.70
chest g	56	87.97	5.60	97.1-73.50	-0.44	2.39
waist g	56	72.28	5.40	86.0-58.4	0.15	3.19
thigh g	56	52.80	4.50	70.5-44.70	1.07	5.69
calf g	55	35.35	2.48	40.5-29.50	-0.33	2.60
ankle g	56	22.71	1.31	24.9-19.40	-0.43	2.60
biacr br	56	37.56	3.03	41.8-21.20	-2.78	15.63
biilio br	56	26.67	1.82	31.1-21.90	-0.35	3.27
trans chest	56	26.57	1.80	30.5-22.80	-0.10	2.32
foot len	56	25.79	1.47	29.6-22.80	0.34	2.76
biep hum wd	56	7.13	0.40	8.75-6.38	0.89	6.28
biep fem wd	56	9.79	0.49	10.97-8.95	0.53	2.84
sitt ht	56	90.69	5.16	99.8-78.70	-0.41	2.91
a-p chest	56	18.23	1.72	22.0-14.70	0.14	2.29
head g	56	56.16	1.44	59.5-53.50	0.26	1.89
neck g	56	34.84	1.82	37.7-28.00	-0.97	4.81

Table 24 Girls : Aged 17

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	47	55.76	6.79	77.7-43.60	1.13	4.49
height	47	165.13	5.69	179.4-156.40	0.37	2.27
triceps sf.	47	16.15	4.56	30.2-9.00	0.81	3.68
subscap sf	47	11.10	4.22	28.2-5.60	2.17	8.43
suprail sf	47	11.08	3.98	22.4-5.40	0.98	3.45
abdom sf	47	14.91	5.51	32.4-6.60	0.82	3.34
fr thigh sf	47	25.66	7.35	45.3-7.90	0.42	3.22
med calf sf	47	16.33	5.44	35.0-7.60	0.92	4.31
acrom ht	47	133.06	5.78	147.9-122.50	0.46	2.51
radial ht	47	102.38	4.78	112.9-94.00	0.35	2.20
stylion ht	47	78.55	4.08	87.5-70.60	0.16	2.06
dacty ht	47	61.35	3.53	68.9-54.10	-0.13	2.16
tibial ht	47	42.51	2.64	51.4-36.30	0.70	4.19
spinale ht	47	90.96	4.59	104.4-80.60	0.20	3.04
glut ht	47	88.41	5.11	100.1-78.90	0.18	2.27
arm g (rel)	47	26.07	2.16	30.2-20.00	-0.25	3.28
arm g (flex)	47	27.27	2.04	31.3-22.70	0.16	2.31
forearm g	47	23.96	1.45	28.7-21.00	0.56	3.90
wrist g	47	15.38	0.69	17.1-14.10	0.30	2.70
chest g	47	82.45	3.82	94.7-75.40	0.89	4.66
waist g	47	66.21	3.94	77.6-58.20	0.92	3.83
thigh g	47	55.23	4.29	65.8-47.80	0.69	2.94
calf g	47	34.62	2.41	40.8-29.20	0.52	2.95
ankle g	47	21.18	1.25	23.8-18.60	0.03	2.19
biacr br	47	35.30	1.76	38.2-29.90	-1.10	4.40
biilio br	47	27.10	1.82	32.4-22.80	-0.06	3.83
trans chest	47	24.66	1.82	29.3-21.30	0.41	2.43
foot len	47	23.40	1.29	27.3-21.40	1.04	3.82
biep hum wd	47	6.17	0.33	6.90-5.54	0.05	2.03
biep fem wd	47	9.02	0.47	10.05-8.11	0.26	2.69
sitt ht	47	87.54	4.56	97.0-64.00	-2.62	15.67
a-p chest	47	16.67	1.34	19.6-13.10	-0.15	3.19
head g	47	53.73	1.56	57.5-51.10	0.61	2.89
neck g	47	30.67	1.26	34.6-28.00	0.78	4.01

Table 25 Boys : Aged 17

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	43	64.86	9.85	93.3-44.30	0.39	3.32
height	43	175.63	6.23	190.9-163.50	0.39	2.46
triceps sf.	43	9.46	5.18	31.8-3.60	2.25	9.10
subscap sf	43	8.92	4.72	30.2-4.40	3.02	12.91
suprail sf	43	7.36	5.29	34.5-3.40	3.50	17.28
abdom sf	43	10.87	6.96	37.0-4.60	2.14	8.05
fr thigh sf	43	12.13	5.70	33.8-4.80	1.63	6.01
med calf sf	43	9.48	4.98	30.7-4.20	1.94	8.33
acrom ht	43	140.91	5.38	153.0-130.80	0.45	2.41
radial ht	43	107.78	4.44	117.3-100.40	0.38	2.28
stylion ht	43	81.99	3.68	89.8-76.20	0.46	2.26
dacty ht	43	63.04	3.46	70.5-57.70	0.58	2.37
tibial ht	43	45.36	2.33	55.2-41.20	0.14	2.15
spinale ht	43	96.90	4.16	105.3-86.30	-0.12	2.48
glut ht	43	92.53	4.36	102.3-82.70	0.26	2.79
arm g (rel)	42	28.57	3.21	39.9-23.10	0.99	4.74
arm g (flex)	43	31.25	2.98	41.3-25.90	0.79	4.42
forearm g	43	26.87	1.63	32.1-23.30	0.55	3.94
wrist g	43	16.95	1.05	20.1-15.20	0.56	3.20
chest g	43	90.25	6.56	107.2-74.30	0.16	3.05
waist g	43	74.68	7.72	109.2-64.20	2.03	10.13
thigh g	43	53.82	5.16	66.6-42.50	0.41	2.95
calf g	43	35.91	2.98	42.2-28.60	0.15	2.59
ankle g	43	22.36	1.52	26.2-19.40	0.43	2.78
biacr br	43	38.26	2.58	42.4-28.50	-1.24	5.64
biilio br	43	27.35	1.94	33.6-22.10	0.42	4.73
trans chest	43	27.21	1.92	33.9-24.00	0.75	4.39
foot len	43	25.79	1.03	28.1-24.10	0.19	2.03
biep hum wd	43	7.05	0.36	7.82-6.20	-0.21	2.61
biep fem wd	43	9.71	0.52	10.63-8.43	-0.42	2.54
sitt ht	43	91.76	3.44	100.3-82.20	-0.07	3.40
a-p chest	43	18.70	1.63	22.9-14.40	0.02	3.02
head g	43	55.68	1.75	59.4-52.00	0.15	2.34
neck g	43	35.41	2.13	39.3-30.40	-0.27	2.36

Table 26 Girls : Aged 18

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	10	59.51	6.44	71.5-49.90	0.11	2.16
height	10	165.88	7.23	179.0-156.10	0.33	1.93
triceps sf.	10	17.01	3.73	25.7-13.20	1.03	3.25
subscap sf	10	12.61	3.82	19.8-7.30	0.29	1.86
suprail sf	10	11.71	4.43	19.5-6.60	0.40	1.49
abdom sf	10	15.84	4.41	21.2-9.70	-0.17	1.23
fr thigh sf	10	24.85	6.63	38.0-13.20	0.21	2.62
med calf sf	10	15.44	3.03	21.0-11.60	0.32	1.76
acrom ht	10	133.37	7.05	145.5-123.50	0.19	1.92
radial ht	10	102.64	5.94	112.2-93.90	0.20	1.97
stylion ht	10	78.62	5.18	86.5-70.00	0.02	1.83
dacty ht	10	61.08	4.14	68.0-53.30	0.27	1.71
tibial ht	10	42.44	3.59	47.3-36.20	-0.38	2.02
spinale ht	10	91.59	5.79	102.2-82.20	0.33	2.14
glut ht	10	88.74	1.36	99.2-78.500	-0.24	2.13
arm g (rel)	10	27.57	1.85	30.4-25.00	-0.11	1.47
arm g (flex)	10	28.66	1.82	31.8-26.00	-0.02	1.73
forearm g	10	24.37	1.16	25.9-22.70	0.06	1.28
wrist g	10	15.32	0.53	16.3-14.80	0.59	1.68
chest g	10	84.84	3.77	91.0-78.20	-0.30	2.07
waist g	10	67.23	2.52	69.8-62.40	-0.66	1.90
thigh g	10	57.04	3.62	65.9-53.20	1.28	3.86
calf g	10	36.32	2.05	39.6-32.60	-0.04	1.96
ankle g	10	21.53	1.33	23.5-19.80	0.30	1.38
biacr br	10	34.65	2.55	38.9-31.30	0.24	1.47
biilio br	10	27.82	1.21	29.4-25.80	-0.52	1.72
trans chest	10	25.43	1.68	27.4-22.40	-0.89	2.23
foot len	10	23.81	1.08	25.6-22.10	0.29	1.94
biep hum wd	10	6.26	0.32	6.91-5.78	0.32	2.42
biep fem wd	10	8.94	0.39	9.77-8.36	0.58	2.59
sitt ht	10	87.98	1.80	90.8-85.10	-0.05	1.73
a-p chest	10	17.62	0.77	19.0-16.40	0.10	1.84
head g	10	54.37	1.92	57.6-51.70	-0.06	1.64
neck g	10	31.53	1.12	32.9-29.60	-0.48	1.91

Table 27 Boys : Aged 18

	Number	Mean	S.D.	Range	Skew.	Kurt.
weight	21	68.82	7.70	82.1-56.20	-0.08	1.79
height	21	179.04	7.66	192.5-166.20	0.01	2.05
triceps sf.	21	9.40	2.62	14.3-5.30	0.40	1.94
subscap sf	21	8.97	1.56	12.1-5.50	0.09	2.73
suprail sf	21	6.25	1.67	9.8-4.00	0.66	2.21
abdom sf	21	10.47	3.67	18.2-6.00	0.59	1.95
fr thigh sf	21	12.66	4.16	20.4-7.00	0.26	1.67
med calf sf	21	9.08	3.33	16.1-4.30	0.33	2.03
acrom ht	21	143.49	7.57	155.5-129.70	0.00	2.08
radial ht	21	109.45	6.43	121.8-97.50	-0.09	2.21
stylion ht	21	83.32	5.15	93.3-72.40	-0.21	2.41
dacty ht	21	64.39	4.66	74.3-55.70	0.02	2.24
tibial ht	21	46.41	3.17	53.7-40.90	0.28	2.57
spinale ht	21	98.58	5.69	107.2-90.70	0.17	1.46
glut ht	21	94.31	5.92	105.1-85.70	0.31	2.02
arm g (rel)	21	29.18	1.92	33.2-25.40	0.09	2.75
arm g (flex)	21	31.58	2.01	35.9-38.00	0.16	2.40
forearm g	21	27.31	1.16	30.0-25.30	0.42	2.51
wrist g	21	17.46	0.71	19.6-16.30	1.19	4.62
chest g	21	93.03	3.68	100.5-87.60	0.68	2.25
waist g	21	75.64	3.78	83.1-68.60	-0.09	2.05
thigh g	21	55.30	3.54	62.0-49.80	0.07	1.83
calf g	21	36.70	2.33	41.9-33.40	0.61	2.57
ankle g	21	22.94	1.25	26.1-21.10	0.63	2.75
biacr br	21	39.27	2.16	44.0-34.70	-0.11	2.84
biilio br	21	27.44	1.39	30.5-25.10	0.19	2.68
trans chest	21	27.80	1.50	30.7-25.00	0.17	2.45
foot len	21	26.41	1.27	29.1-23.80	0.25	2.81
biep hum wd	21	7.24	0.37	7.99-6.61	0.28	2.23
biep fem wd	21	9.93	0.50	10.66-9.18	0.02	1.41
sitt ht	21	93.09	3.06	98.4-87.80	-0.14	2.05
a-p chest	21	18.97	1.22	21.3-16.60	-0.13	2.22
head g	21	56.70	1.85	59.1-52.60	-0.36	2.13
neck g	21	36.79	1.76	40.0-33.40	0.10	2.33

The numbers in each age group were a reflection of the size of the schools involved and indicative of the economics and time available for the project. Numbers were greater at the middle age groups where the Junior High Schools had a much larger population in total drawing students from a number of relatively small Elementary Schools.

Variations in the number of subjects within a cohort indicated that for some reason the measurement was not recorded or that the measurement was in error and was deleted.

Skewness, i.e. deviation from a Gaussian distribution, might be expected to be zero since in a normal distribution a value greater than the mean should be matched by a value equally less than the mean, so that the cubes of the deviations from the mean would approach zero. While the converse may not be true - the size of this sum is regarded as an indication of the symmetry of the distribution.

Observation of this data indicated a greater degree of positive skewness i.e. towards the lower end of the range. There were fewer instances of negative skewness and these values were generally of smaller magnitude than the instances of positive skewness.

Kurtosis, as the degree of peakedness of a distribution, is conventionally considered as having a normal value of 3, and in excess of 3, the distribution is described as leptokurtic, i.e. having a marked peakedness rather than a flatness. In the relatively small COGRO sample, occasionally leptokurtic distributions were found. These were noted when scores were concentrated around modal values. In general this was noted at younger age levels more so than at the higher age levels were the samples were somewhat smaller and there was greater variability.

Some very large values of kurtosis were reported, the incidence being most marked in the under 18 age range. At 18, there was a marked reduction in the number of platykurtically distributed variables and the degree of playkurtosis is markedly less than in the younger age groups, possibly an indication of full maturity in the oder group.

PERCENTILE DISTRIBUTIONS

Distributions, based on raw data of height for girls were depicted in Figure 10 and the same parameters for boys were indicated in Figure 11. The 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles of the parameters were plotted against age in each case.

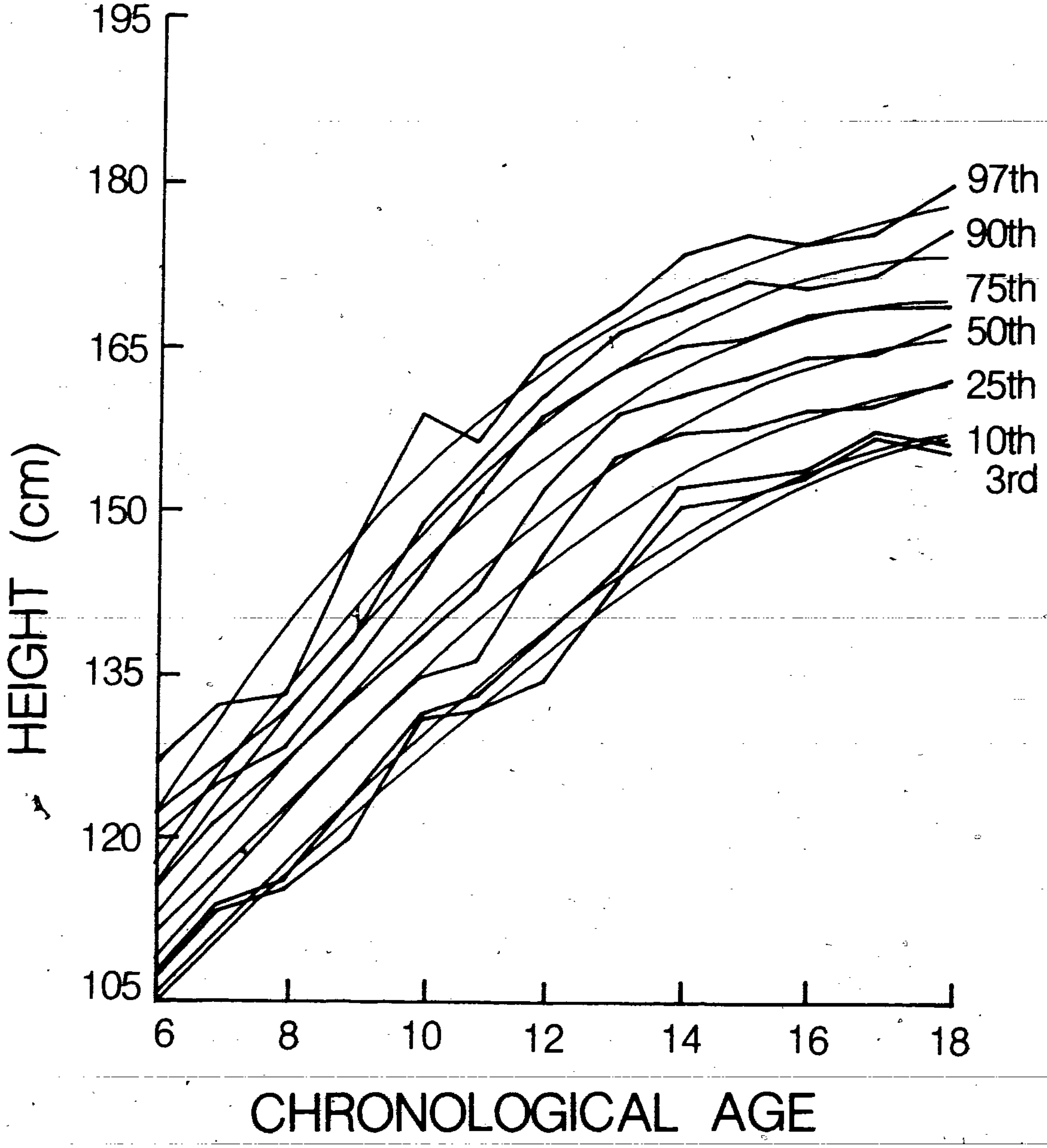
By inspection there was little difference between the sexes in the results for both height and weight. At all ages the boys mean heights were greater than the girls. Up to 14 years, there was little to distinguish between the two patterns. At 14 there was a marked difference in the boys height. At all percentile levels the boys height continued to increase while those of the girls began to plateau.

Figures 12 and 13 presents the percentile distributions of weight for girls and boys respectively.

Between 6 and 14, there was a tendency for girls to be heavier than boys, but this was only marginal. there was a divergence at 14 years from which point boys became markedly heavier than girls of the same age. By 18 years of age the boy's mean weight was larger than the 97th percentile of the girls.

Figures 10 and 11: Height percentile distributions for COGRO girls and boys.

LEAF 138 OMITTED IN PAGE NUMBERING.



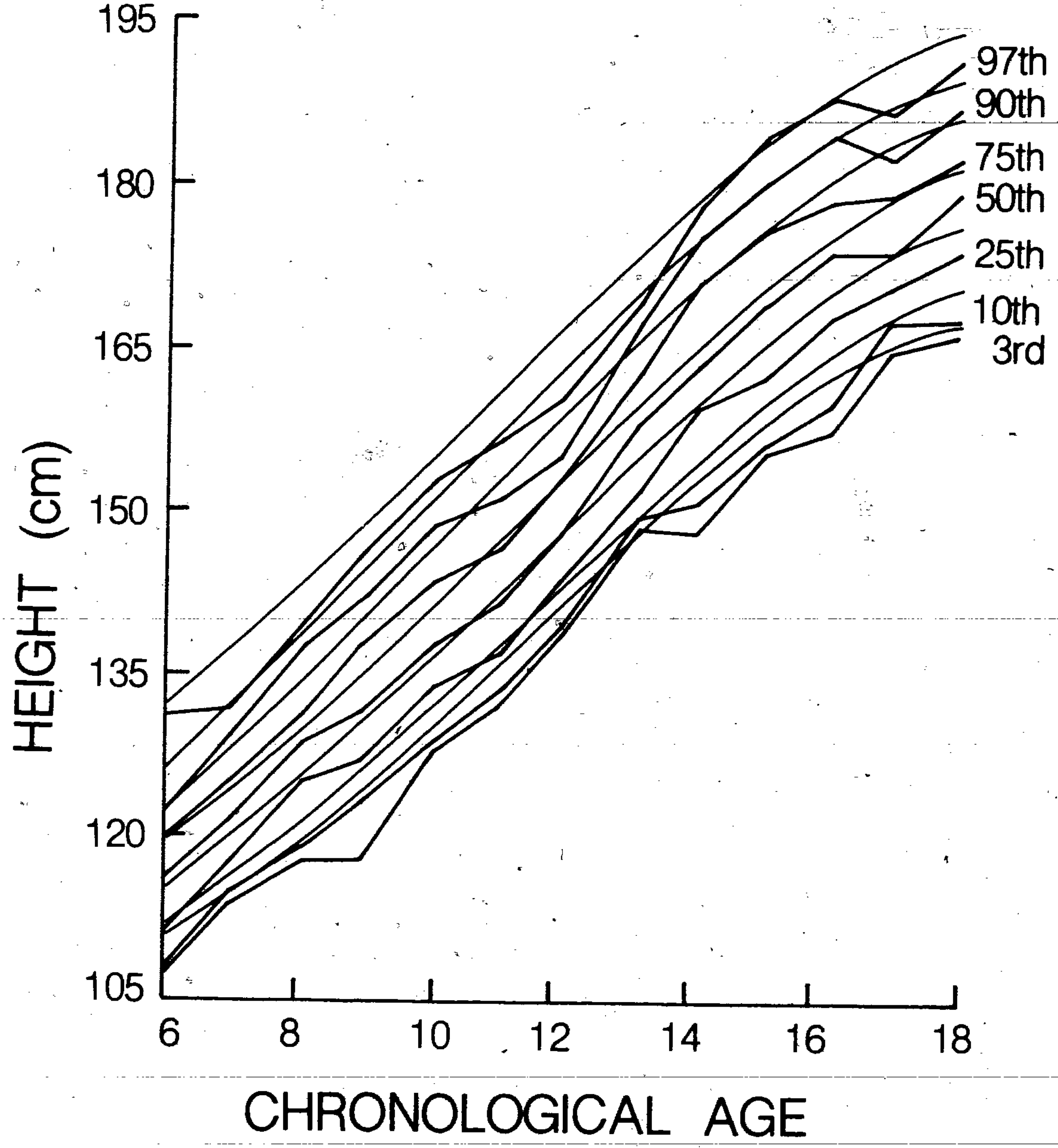
Coquitlam Growth Study

Cross-Sectional Height Percentiles - Girls

LEAF 139 OMITTED IN PAGE NUMBERING.

Coquitlam Growth Study

Cross-Sectional Height Percentile - Boys

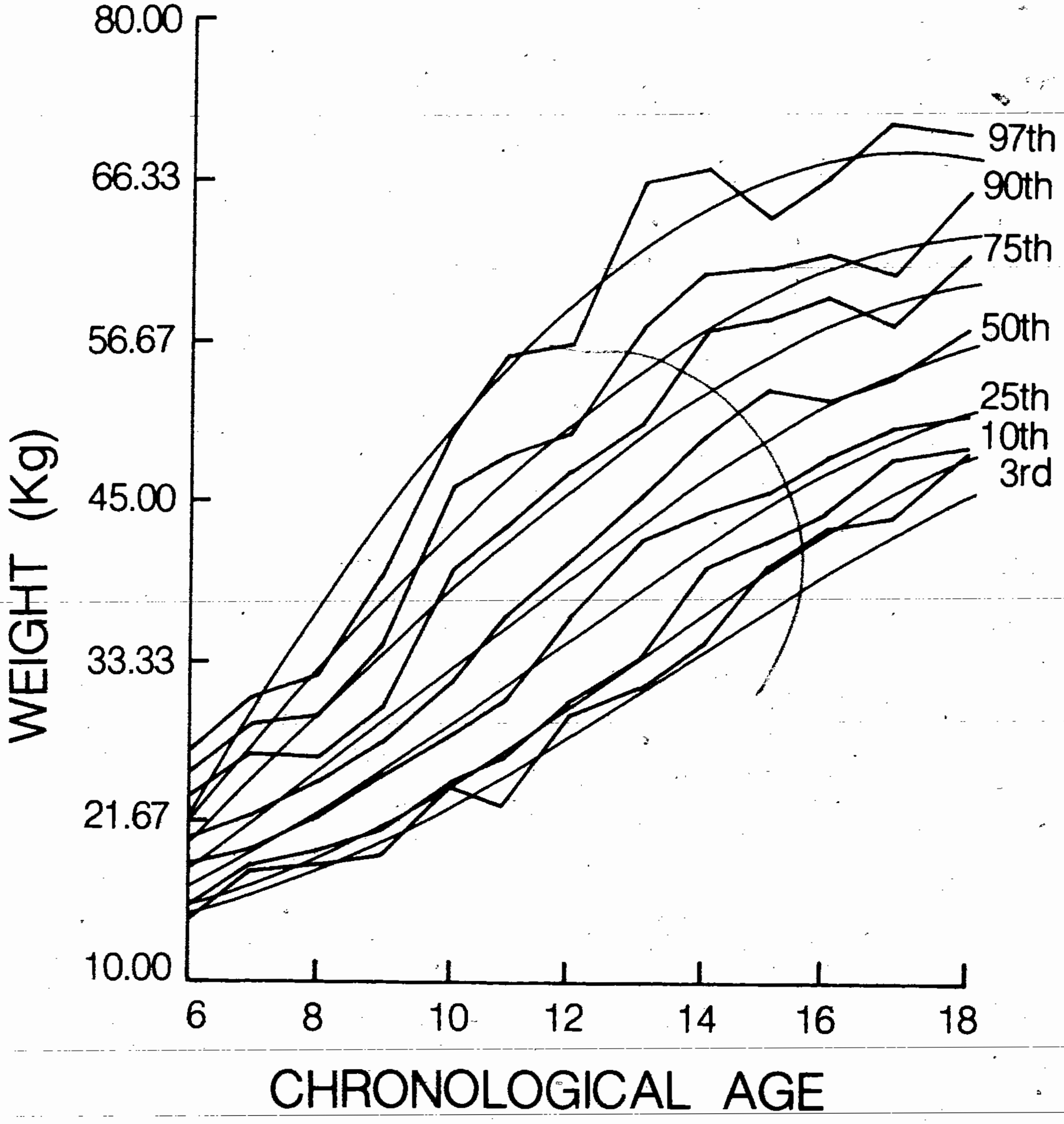


Figures 12 and 13: Weight percentile distributions
COGRO girls and boys.

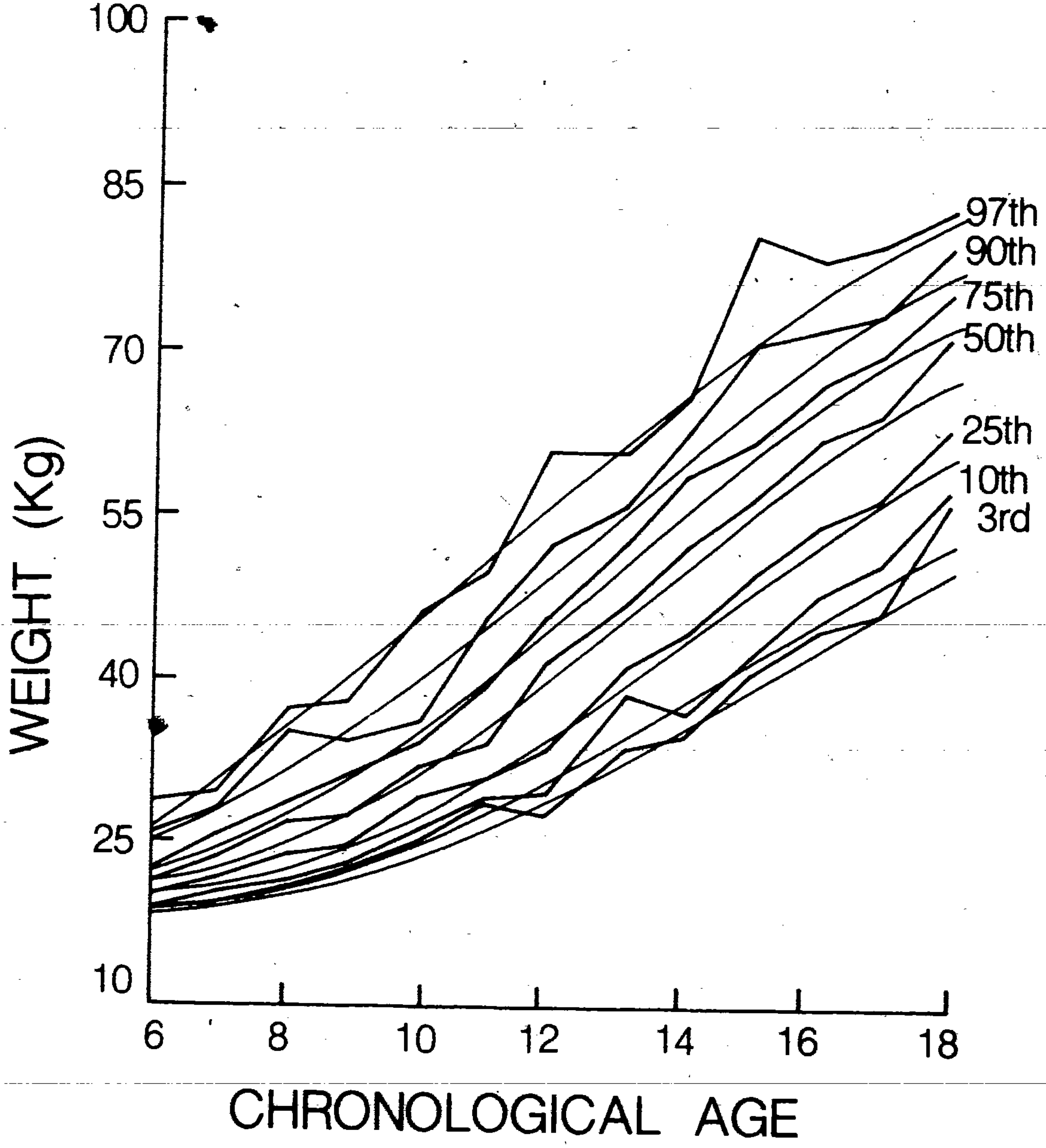
LEAF 141 OMITTED IN PAGE NUMBERING.

Coquitlam Growth Study

Cross-Sectional Weight Percentiles - Girls



LEAF 142 OMITTED IN PAGE NUMBERING.



Coquitlam Growth Study

Cross-Sectional Weight Percentiles - Boys

SMOOTHED PERCENTILES

These results were presented as transparency overlays on Figures 10, 11, 12 and 13. They were constructed from raw data using a smoothing technique. It is in this form that such data are invariably presented.

While there was initially little difference in absolute weight in the various percentile group either within each sex or between the sexes, marked differences began to appear at around 8 years of age. Within the male groups these differences appeared to be maintained as indicated by the parallel nature of the curves, there was wide divergence within the female population. This divergence seemed to become most marked at around 11 years of age which is approximately coincident with the onset of menarche in early maturer. This is associated with the adolescent growth spurt and includes the deposition of body fat.

Further inter-sex differences were noted in that the attainment of maximal height for boys appeared to occur at beyond 18 years of age, while girls maximal height appeared to occur at close to 18 years of age except that the growth period was delayed for the tallest group. This was taken to be an indication of the earlier age of maturation of girls.

HEIGHT AND WEIGHT DATA FOR 11 YEAR OLD GIRLS.

Height and weight data for 11 year old girls are presented in Appendix C. Similar displays were generated for each variable for each age-sex group and are available in addendum volumes.

COMPARISION OF MANITOBA NORMATIVE AND COGRO PROTOTYPICAL DATA

Tables 28 to 31 were presented to make a comparison of the means, medians (P50) standard deviations and interquartile range (P25 and P75) for girls and boys at each age in both the Manitoba and COGRO studies.

If a secular trend was evident, this was expected to be seen in the COGRO study, when compared with the Manitoba norms.

Tables 28-31: Comparative statistics on Manitoba and COGRO data including numbers, means, standard deviations, P50, P25, and P75.

Table 28 Girls Height

		Number	Mean	P50	S.D.	P25	P75
Age 6	Ma	2369	118.33	119.40	6.35	114.30	121.90
	CO	18	116.66	115.73	5.68	111.64	120.60
Age 7	Ma	3083	123.60	124.40	6.78	119.40	127.00
	CO	25	122.36	121.83	5.25	117.00	125.20
Age 8	Ma	3235	128.75	129.50	6.78	124.40	132.10
	CO	15	126.71	127.30	4.99	123.00	128.80
Age 9	Ma	3303	134.26	134.60	7.54	129.50	139.70
	CO	30	133.41	132.80	6.56	129.00	135.67
Age 10	Ma	3330	140.00	139.70	7.62	134.60	144.80
	CO	20	141.52	138.50	8.19	135.00	144.33
Age 11	Ma	3051	146.61	147.30	8.08	142.20	152.40
	CO	24	145.15	142.87	7.78	136.60	151.53
Age 12	Ma	2824	152.68	152.40	7.90	147.30	157.50
	CO	35	152.89	152.10	7.84	146.00	158.67
Age 13	Ma	2604	156.82	157.50	7.57	152.40	162.60
	CO	36	159.33	159.10	7.00	155.07	163.10
Age 14	Ma	2043	159.61	160.00	6.96	154.90	165.10
	CO	67	162.53	160.88	6.19	157.20	165.30
Age 15	Ma	1521	160.66	160.00	7.42	157.50	165.10
	CO	66	163.12	162.04	6.77	157.73	166.07
Age 16	Ma	1043	161.26	162.60	6.99	157.50	165.10
	CO	53	164.61	164.14	6.64	159.30	168.09
Age 17	Ma	474	161.98	162.60	7.67	157.50	167.60
	CO	47	165.13	164.07	5.69	159.56	168.56
Age 18	Ma	91	159.64	160.00	8.97	157.50	167.60
	CO	10	165.88	164.50	7.23	157.00	168.33

Table 29 Girls Weight

		Number	Mean	P50	S.D.	P25	P75
Age 6	Ma	2369	21.83	21.30	3.35	19.50	23.60
	CO	17	21.38	20.66	3.69	18.70	23.80
Age 7	Ma	3083	24.34	23.60	4.01	21.80	26.30
	CO	25	23.52	22.17	3.94	19.67	26.75
Age 8	Ma	3235	27.24	26.30	4.89	24.00	29.50
	CO	15	25.12	24.70	3.81	22.00	26.50
Age 9	Ma	3303	30.54	29.50	5.99	26.80	33.60
	CO	30	28.74	27.57	5.02	25.00	30.00
Age 10	Ma	3330	34.23	33.10	7.03	29.50	37.70
	CO	20	35.84	32.00	9.48	28.00	40.00
Age 11	Ma	3051	38.94	37.70	8.11	33.10	43.50
	CO	24	39.12	36.80	10.22	30.53	43.20
Age 12	Ma	2824	44.09	43.10	8.83	38.10	49.50
	CO	35	42.79	40.70	7.95	36.50	47.17
Age 13	Ma	2604	48.33	47.60	8.48	42.60	52.60
	CO	37	47.92	45.46	9.44	42.13	50.60
Age 14	Ma	2043	51.64	50.40	8.17	46.30	56.30
	CO	67	52.42	49.81	9.44	44.20	57.56
Age 15	Ma	1521	53.35	52.20	7.34	48.50	57.60
	CO	66	53.89	53.23	7.57	45.77	58.40
Age 16	Ma	1043	54.21	53.50	7.30	49.90	58.10
	CO	53	54.87	52.53	8.03	48.24	60.07
Age 17	Ma	474	54.99	54.40	7.35	49 90	59.00
	CO	47	55.76	54.06	6.79	50.40	57.73
Age 18	Ma	91	55.53	54.40	7.86	50.80	59.00
	CO	10	59.50	59.00	6.44	52.00	62.00

Table 30 Boys Height

		Number	Mean	P50	S.D.	P25	P75
Age 6	Ma	2429	119.15	119.40	6.45	114.30	121.90
	CO	17	117.04	116.30	6.30	111.40	119.90
Age 7	Ma	3129	124.23	124.40	6.86	119.40	127.00
	CO	22	122.80	121.95	5.07	117.93	125.40
Age 8	Ma	3381	129.71	129.50	7.09	124.50	134.60
	CO	22	129.64	128.95	6.01	125.40	131.40
Age 9	Ma	3455	134.98	134.60	7.21	129.50	139.70
	CO	27	133.35	131.77	7.37	127.27	137.90
Age 10	Ma	3629	140.11	139.70	7.14	135.90	144.80
	CO	21	140.14	137.97	6.99	134.10	143.70
Age 11	Ma	3327	145.47	144.80	7.54	139.70	149.90
	CO	26	143.68	141.85	6.98	137.20	146.68
Age 12	Ma	3079	151.13	149.90	8.41	144.80	157.50
	CO	33	149.25	147.92	6.45	143.80	153.04
Age 13	Ma	2845	157.89	157.50	9.55	152.40	165.10
	CO	35	159.20	158.17	6.94	152.00	162.80
Age 14	Ma	2175	163.85	165.10	9.02	157.50	170.20
	CO	76	165.52	163.48	8.64	159.49	171.07
Age 15	Ma	1701	169.82	170.20	8.74	165.10	175.30
	CO	77	170.46	168.94	8.73	162.36	175.87
Age 16	Ma	1103	173.00	172.70	8.00	170.20	177.80
	CO	56	174.59	173.80	8.37	167.91	178.60
Age 17	Ma	426	173.99	175.30	10.13	170.20	180.30
	CO	43	175.63	173.67	6.23	170.60	179.07
Age 18	Ma	148	174.40	175.30	9.14	170.20	180.30
	CO	21	179.04	179.30	7.66	173.20	182.35

Table 31 Boys Weight

		Number	Mean	P50	S.D.	P25	P75
Age 6	Ma	2429	23.06	22.20	5.63	20.40	24.50
	CO	17	21.75	20.91	2.98	19.70	21.97
Age 7	Ma	3129	25.06	24.50	4.92	22.70	27.20
	CO	22	23.92	23.11	2.85	21.36	25.20
Age 8	Ma	3381	27.92	27.20	4.55	25.00	30.00
	CO	22	27.50	26.54	4.53	23.60	28.40
Age 9	Ma	3455	31.12	30.40	5.54	27.20	34.00
	CO	27	28.80	27.26	5.15	24.56	30.95
Age 10	Ma	3629	34.45	33.60	6.41	29.90	37.20
	CO	21	33.23	31.72	5.90	29.10	33.88
Age 11	Ma	3327	38.14	36.70	7.51	33.10	41.70
	CO	26	37.21	33.80	7.95	30.73	39.20
Age 12	Ma	3079	42.66	40.80	9.52	36.30	47.20
	CO	33	42.18	41.43	8.61	33.30	45.46
Age 13	Ma	2845	48.07	47.20	9.48	41.30	53.50
	CO	35	48.00	46.75	7.46	41.00	52.33
Age 14	Ma	2175	53.95	53.50	9.96	47.60	59.40
	CO	76	52.60	52.08	9.69	44.07	58.48
Age 15	Ma	1701	60.13	59.00	9.78	54.40	65.80
	CO	77	58.63	56.33	11.23	49.36	61.45
Age 16	Ma	1103	64.16	63.50	9.65	59.00	69.00
	CO	55	62.16	61.88	8.86	54.00	67.00
Age 17	Ma	426	66.09	65.80	9.51	59.90	71.20
	CO	43	64.86	64.14	9.85	56.40	69.64
Age 18	Ma	148	68.61	68.00	8.47	62.70	74.80
	CO	21	68.82	67.63	7.70	60.40	74.35

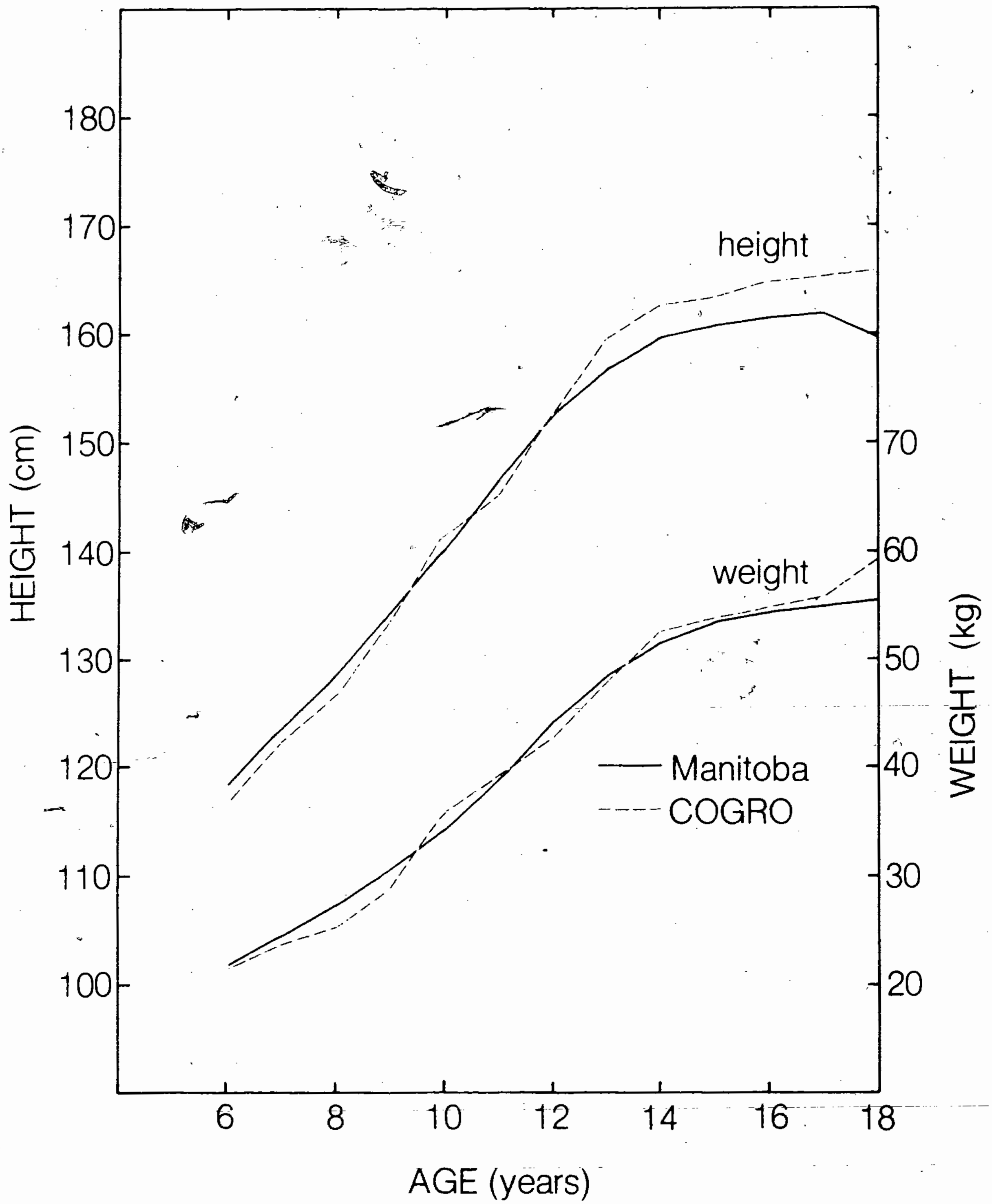
Observation revealed not only a marked similarity between the means of these samples, but there was also similarity between the standard deviations of the two samples, despite the very large differences in sample numbers. Likewise, differences between all other parameters were generally not marked.

A graphic display of means of height in Figures 14 and 15, reflects the similarity of the two groups. There appeared to be little difference in the data on height between girls age 6 - 13. Differences of the mean height values at age 13 was not significant whereas it was significant at age 14. Thus from age 14 to 18 , the COGRO girls sample appeared to be slightly taller than the Manitoba sample.

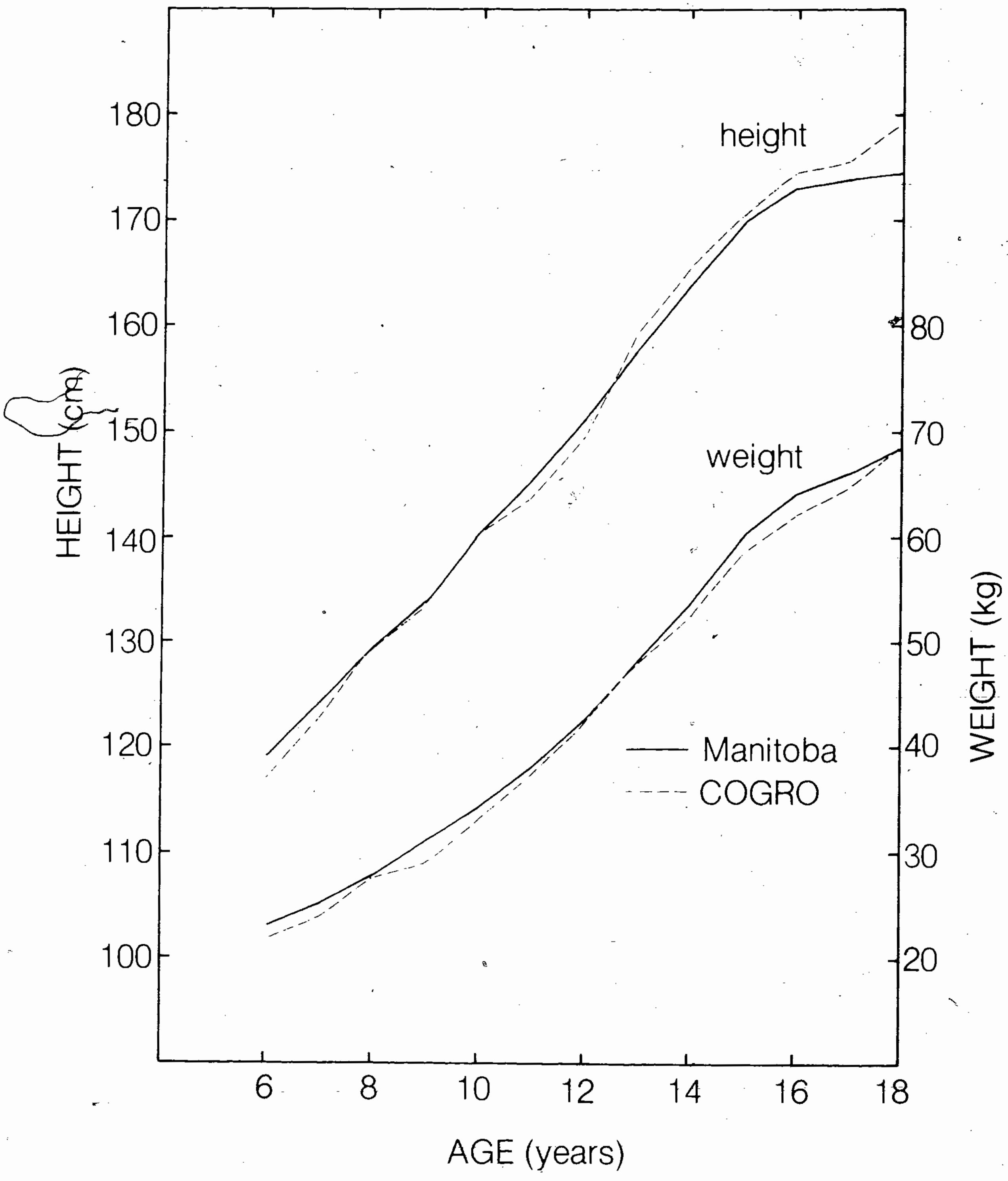
Girls aged 18 were markedly taller in the COGRO group than in the Manitoba study. However with only 10 subjects in this COGRO group it is also possible that this was too small a sample on which any valid conclusions should be drawn.

Investigation of boys height in Figure 15 showed the similarity of the two samples. The only major difference appeared at 18 years of age, with the COGRO boys being markedly taller than the Manitoba group.

Figures 14 and 15: Comparative means for height and weight for girls and boys in the Manitoba and COGRO studies.



Mean height and weight for COGRO and Manitoba girls aged 6-18 years



Mean height and weight for COGRO and Manitoba boys aged 6 - 18 years

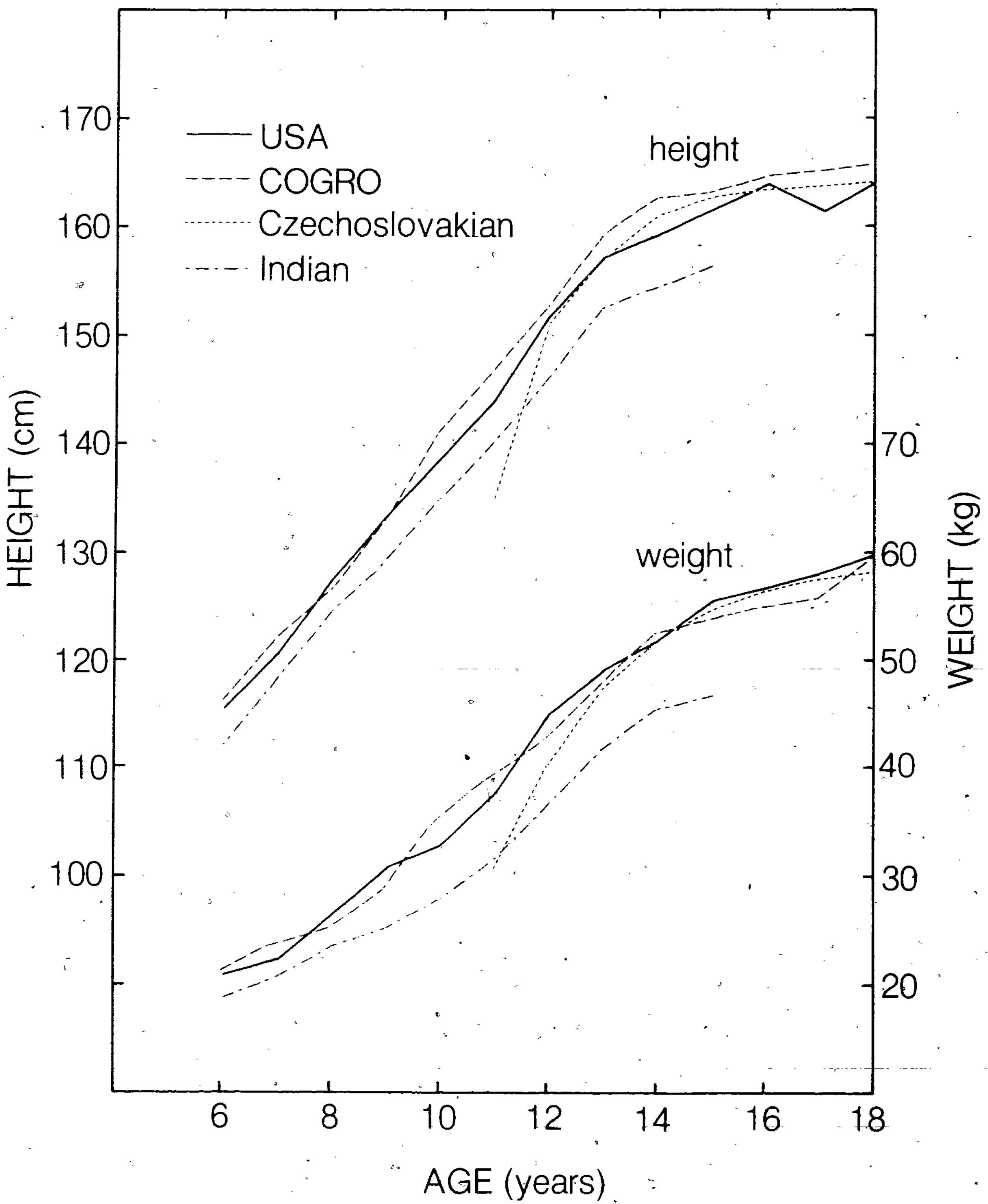
With regard to weight, shown in the lower sections of Figures 14 and 15, it was apparent that there were only small differences between the two groups, with the one exception of 18 year old girls which again might be explained by the size of the COGRO group.

COMPARISON OF INTERNATIONAL DATA WITH COGRO DATA

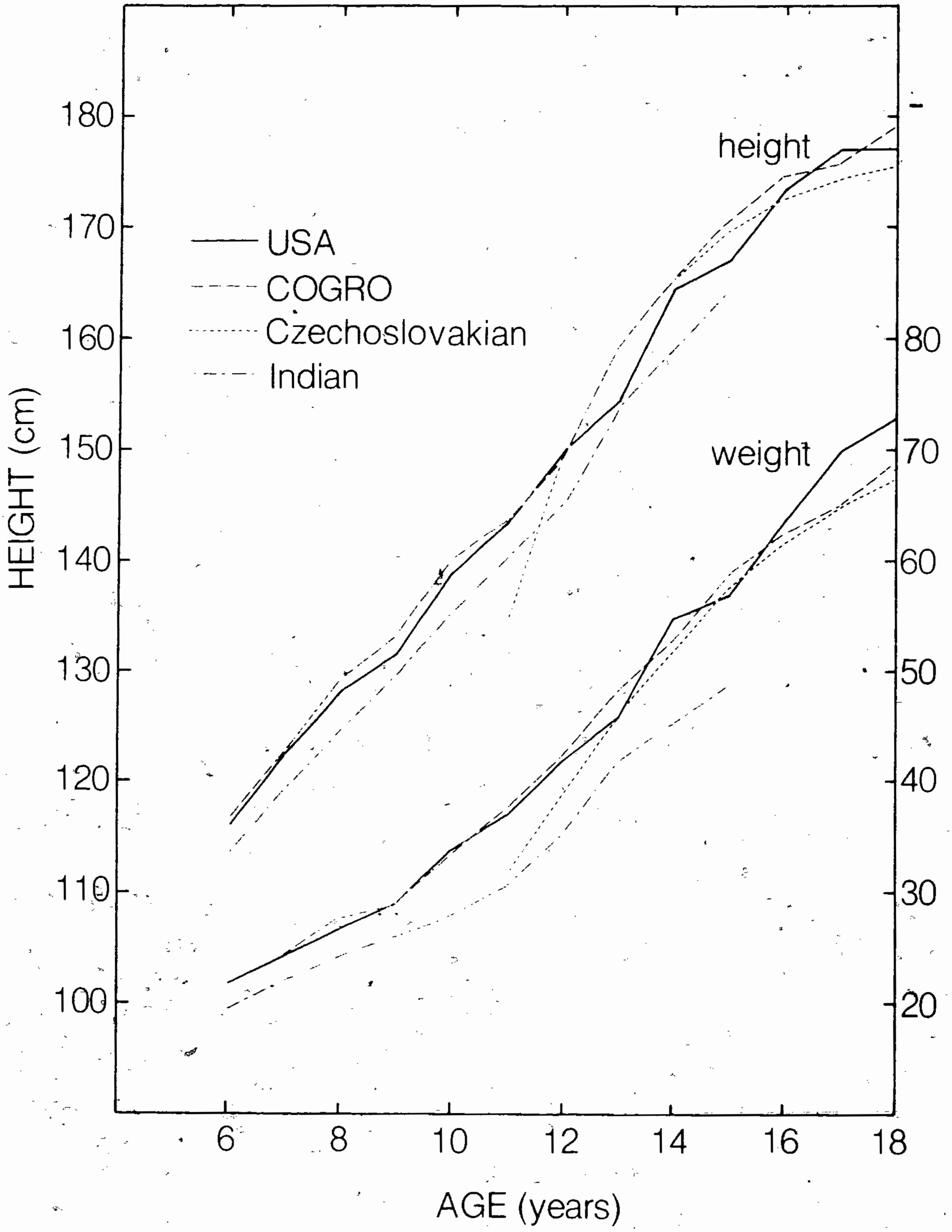
Figure 16 shows means of girls height and weight from age 6 to 18 as determined by COGRO and the National Center for Health Statistics (Hamill et al., 1977) from the U.S.A. in 1974, as well as data from Czechoslovakia (Seliger and Bartenuk, 1976) for ages 11 to 18 in 1976, and from Indian data (Ghani et al., 1971) for ages 6 to 15 in 1971.

Initial observation indicated similar mean values between the two sets of North American data i.e. U.S.A. and COGRO, and the Czechoslovakian data between 12 and 18 years of age. The very marked difference of the Czechoslovakian 11 year old girls was inexplicable since it was not found in other sample comparisons.

Figures 16 and 17: International comparisons of height and weight for girls and boys (U.S.A., Czechoslovakian, COGRO and India).

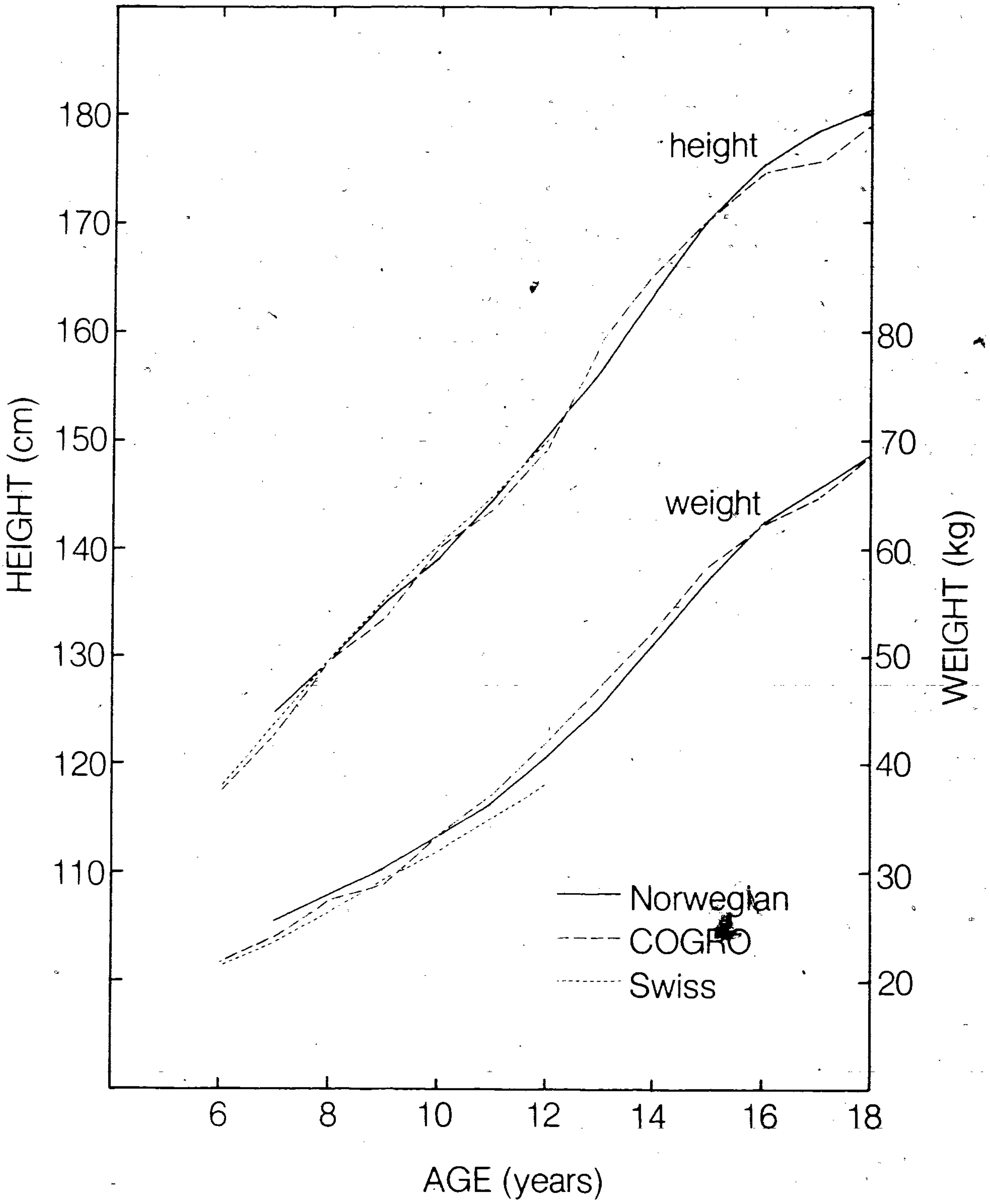


Mean height and weight for Czechoslovakian, Indian, USA and COGRO girls aged 6 - 18 years.

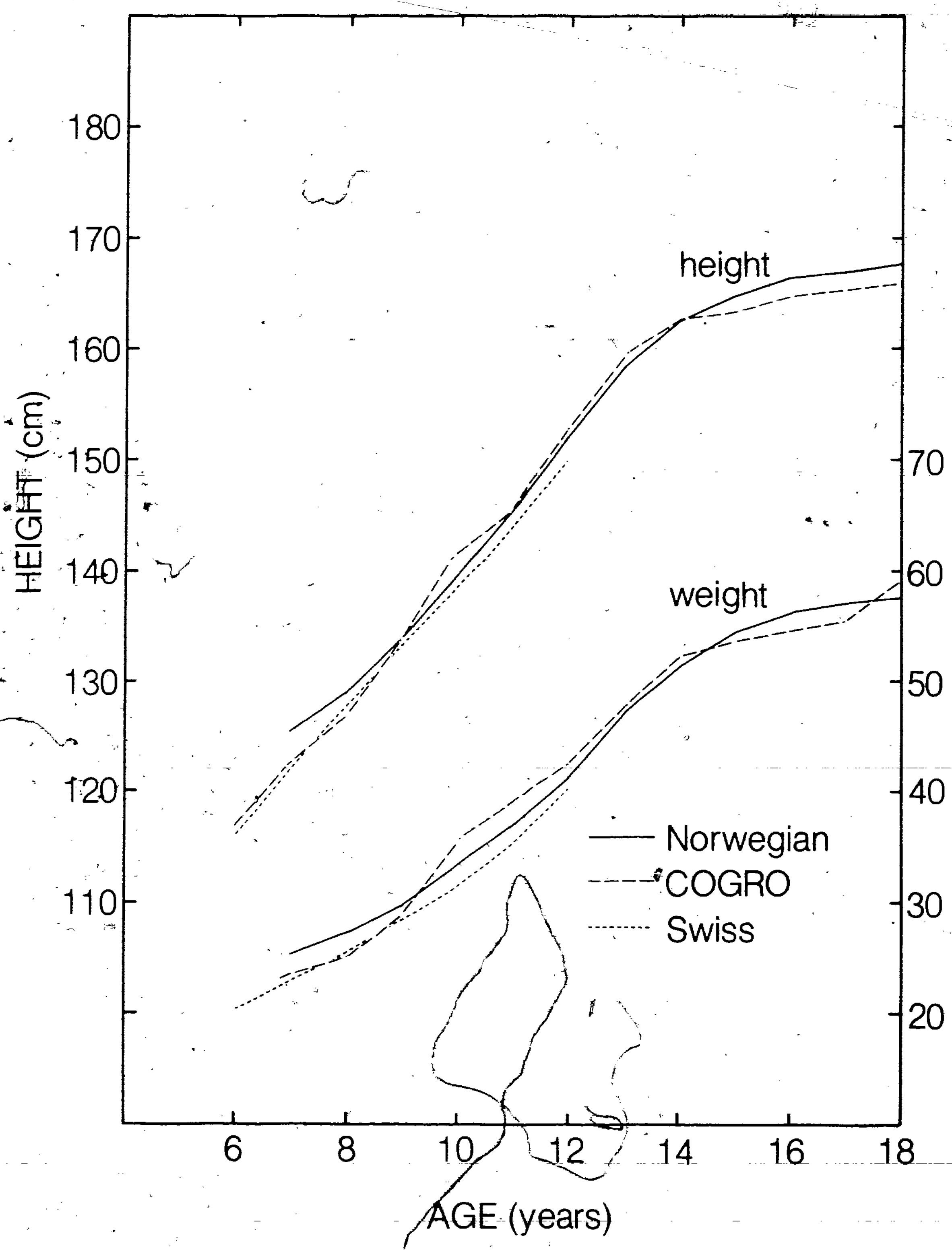


Mean height and weight of Czechoslovakian, Indian, USA and COGRO boys aged 6 - 18 years.

Figures 18 and 19: International comparisons of height and weight for girls and boys (Swiss, Norwegian, COGRO).



Mean height and weight of Norwegian, Swiss and COGRO girls aged 6 - 18 years



Mean height and weight of Norwegian, Swiss and COGRO boys aged 6 - 18 years.

Similar relationships were seen in Figure 17, boys height and weight, with similarities being observed between both the U.S.A., COGRO and the Czechoslovakian group. In general, Indian children of both sexes were found to be smaller and lighter at all age levels.

Further comparative data was summarized in Figures 18 and 19. The Swiss study (Prader and Budliger, 1977) was on longitudinal data of 207 girls and 206 boys born in 1954 and 1955. While it was limited to up to 12 years of age, mean values were similar to the COGRO data and to the longitudinal Norwegian data of 1975, (Bruntland et al.)

The most obvious limitation of longitudinal studies was illustrated here - namely, that a study begun in 1954 was reported in 1977, almost a quarter of a century later, by which time the growth norms may have changed quite noticeably.

The similarities were more marked in boys height and a little less marked in terms of weight. The Norwegian and COGRO data appeared not to differ appreciably.

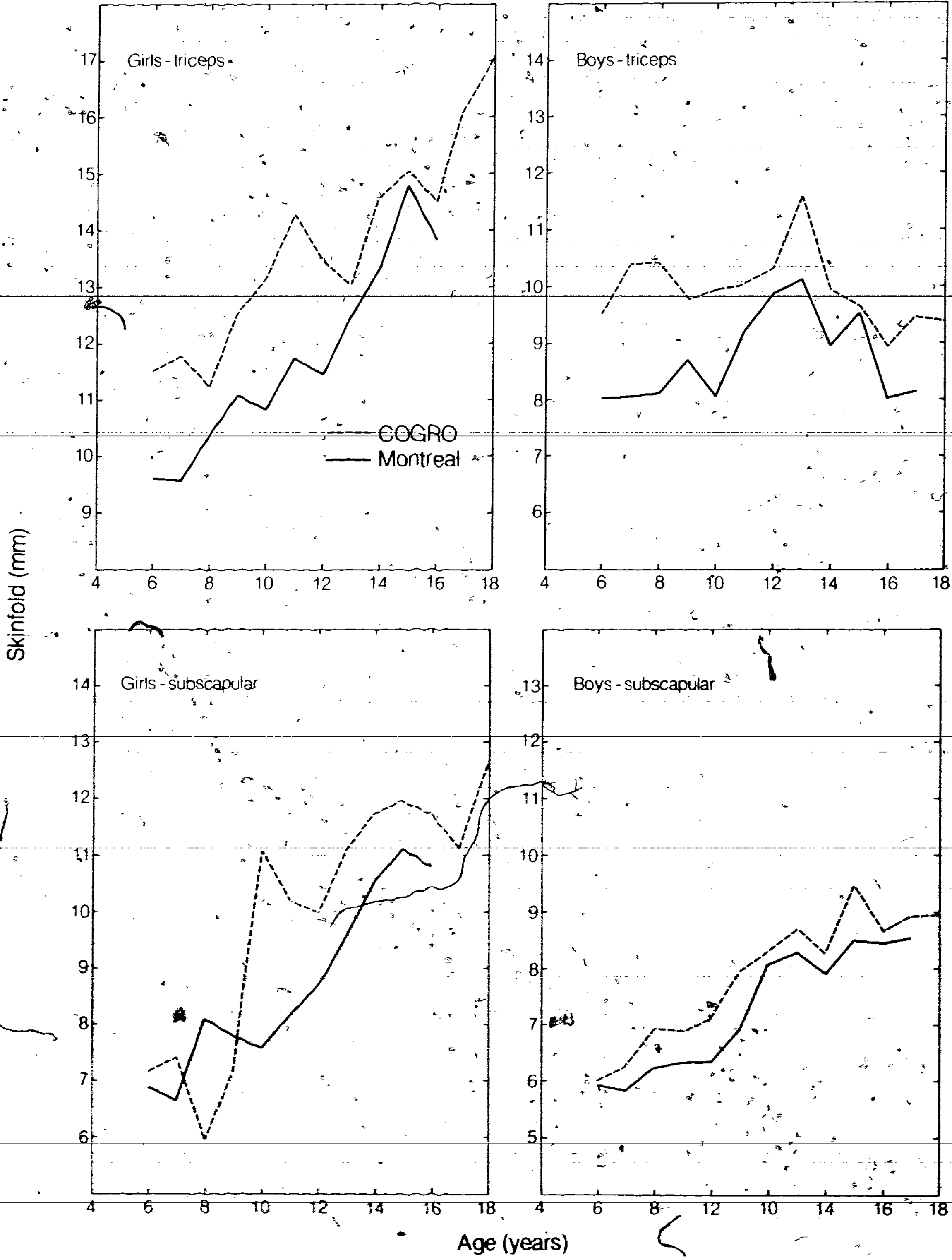
SKINFOLD DATA

Figure 20, indicated the relationship between the triceps and subscapular skinfolds for girls and boys in the COGRO study, compared with children from a French Canadian group (Demirjian et al., 1972) in Montreal.

In both studies there was a similar pattern of fat deposition with age. Girls triceps skinfolds showed a marked increase between the ages of 12 to 15, followed by a slight fall at 16. The COGRO data then indicated a marked increase in skinfolds to age 18. Boys triceps showed a maximum value at around 12 to 13 years of age followed by a gradual decrease to 16 years with a slight increase at 17. While both the COGRO and Montreal data showed a within sex pattern consistency, the pattern between sexes was noticeably different.

Subscapular skinfold results like wise showed a similarity of pattern within the sexes but a marked lack of similarity between the sexes, girls having much larger absolute values, with a maximum at 14 to 15 years, while the boys maximum occurred at 12 and 15, with a noticable decrease in values at 14 years of age.

Figure 20:Triceps and subscapular skinfolds for girls and boys from COGRO and Montreal.



Triceps and subscapular skinfolds of girls and boys from Montreal and COGRO

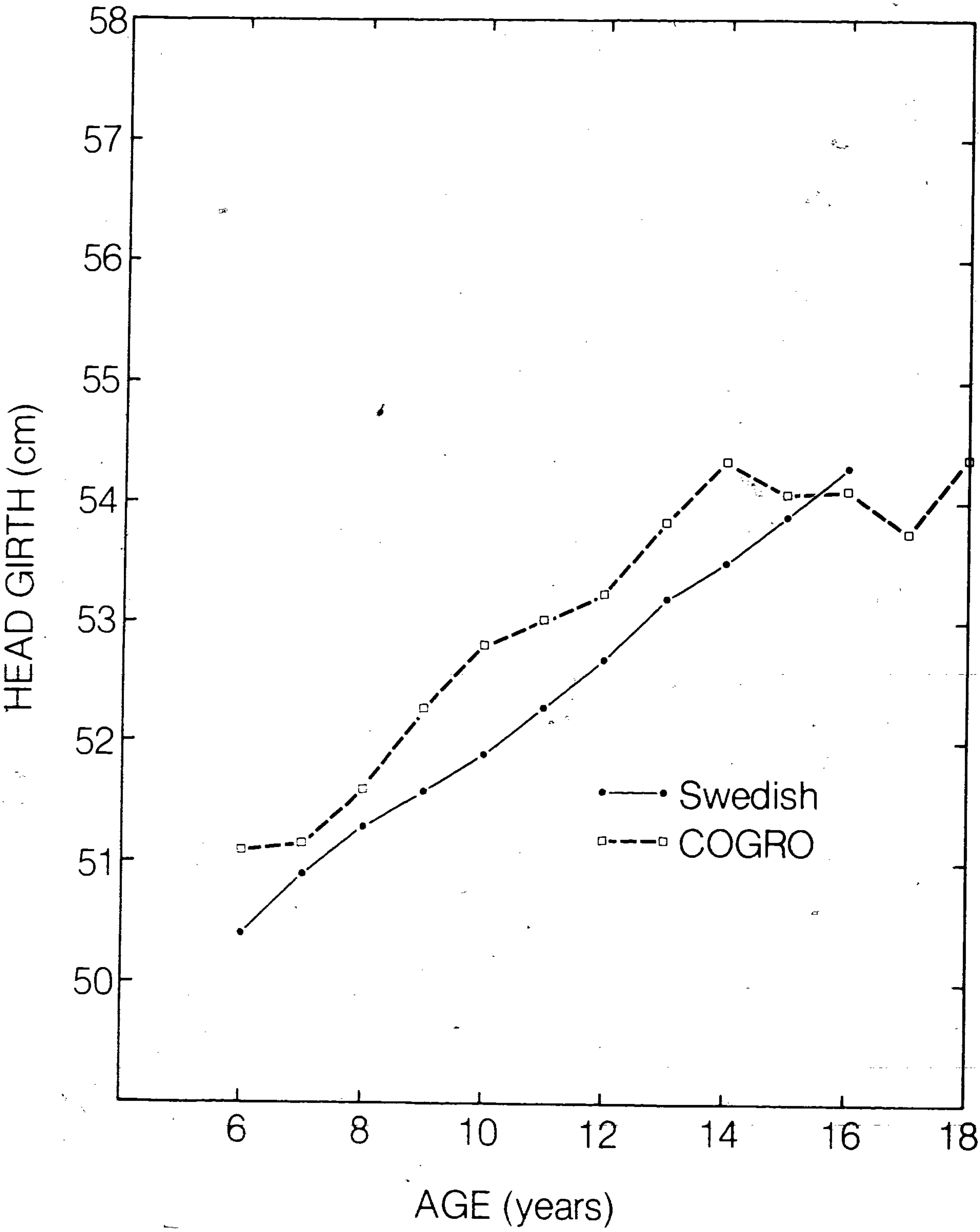
At all ages, with the exception of 8 year old girls' subscapular skinfolds, COGRO children had larger skinfolds than the 1972 sample at the same age.

HEAD CIRCUMFERENCE DATA

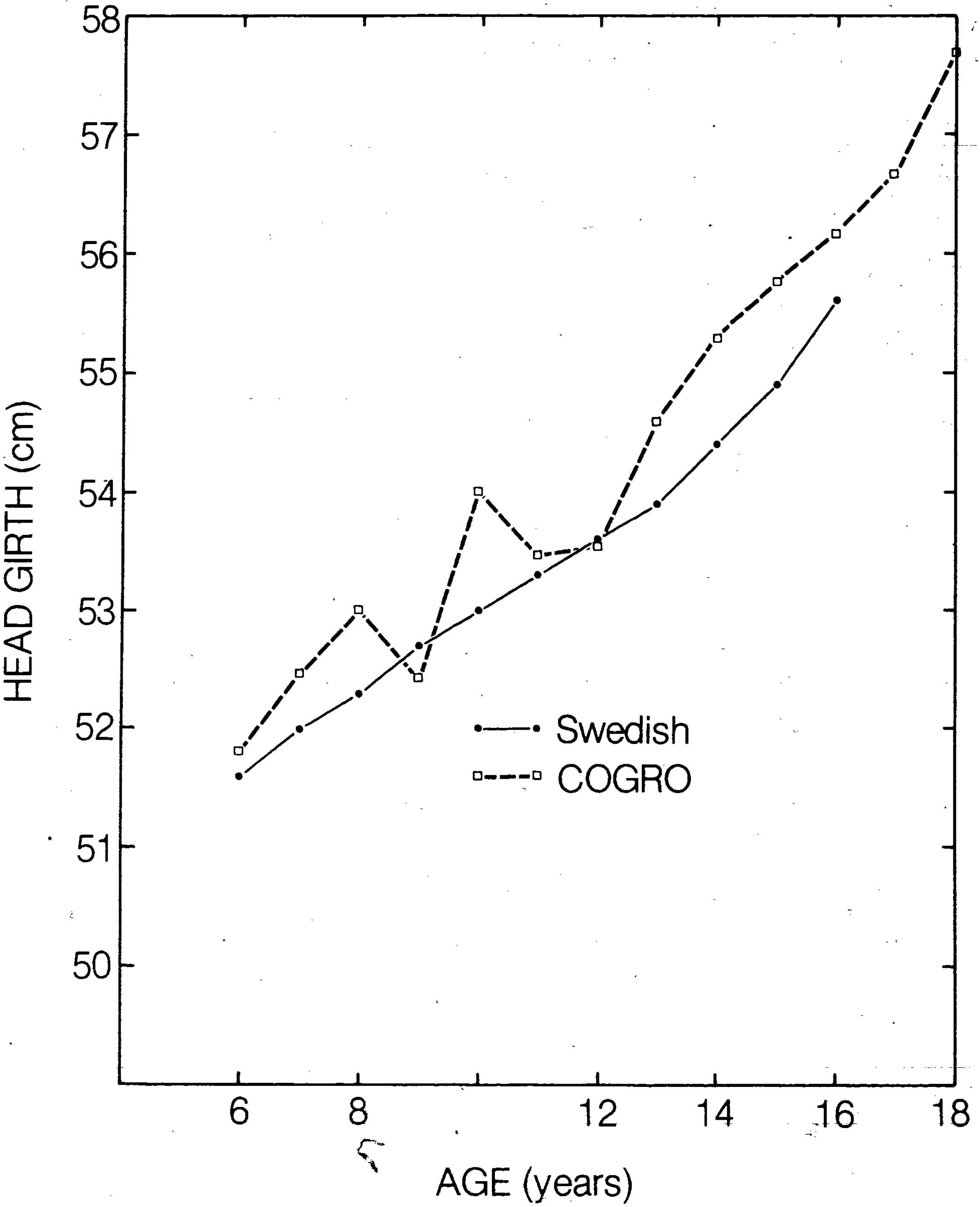
Mean head circumference data from Sweden (Karlberg et al., 1976) and for COGRO data were represented in Figures 21 and 22. While trends were similiar in both instances, there were noticeable absolute differences between the two samples, with the COGRO group exhibiting larger girths.

Notable differences also occurred in the stability of head circumference. This appeared to occur in COGRO girls at around 15 years of age, while a later age for stability was suggested by the Swedish study. Head growth in boys appeared not to have ceased at 18 years of age. Apparent smaller mean head circumferences than would be expected in COGRO boys age 9, 11, and 12 were noted.

Figures 21 and 22:Head circumference data for COGRO and Sweden girls and boys.



Mean head circumference for Swedish and COGRO girls aged 6 - 18 years.



Mean head circumference for Swedish and COGRO boys aged 6 - 18 years.

V A STUDY OF OUTSTANDING UNDER-12 GIRL FIGURE SKATERS

One of the questions to which administrators, in various sporting groups, have turned their attention is that concerning selection of young people who will best profit from coaching programs. In many instances such selection is purely subjective or at best based on the current performance level from which improvement is expected.

It has been shown in adults that certain physique characteristics are well correlated with some performance criteria, and this point will be discussed later. It has also been suggested that certain physique characteristics might be beneficial to a child athlete either in the learning of or performance in a skilled activity. While it has been possible to compare the child against a unisex adult phantom (Ross and Wilson, 1974), to this point there has been no way of comparing the child against prototypes for his own age which would specify those absolute or proportional differences which might be selective.

The purpose of this chapter is to indicate the way in which the prototypical data can be used in the assessment of selected groups of children.

INTRODUCTION

The question as to whether individuals become athletes because of their physique, or whether physique is determined by training in athletics, is largely unresolved. Carter (1973) concluded that both growth and training affect physique, some factors of which are selective for success, and that athletes are both born and made. Moreover he considered that while there is possibility for change, the magnitude of that change is probably limited by genetics.

The initial study on Olympic athletes by Kohlrausch (1929), followed by those of Cureton (1951), Correnti and Zauli (1964) Tanner (1964), Hirata (1966), and de Garay et al. (1974) found size and structural differences among athletes in different events and similarity in athletes successful in the same event.

Similarly it has been shown by (Carter, 1966, 1970, 1971, and Carter et al. 1971) that athletes in some sports are structurally different to the normal population. In all studies, however the subjects were mature adults.

Data which has been gathered from various sporting groups indicating the differences in particular physical traits, included those on swimmers (Behnke, 1968) and on long distance runners (Behnke and Royce, 1966). These differences were then proposed as having functional significance. The fatness of swimmers was seen as providing better bouyancy and, the small arm girths compared with leg and chest girths of the runners was seen as being advantageous for that activity.

A number of other studies, reviewed by Parizkova (1973) have investigated body composition, and its relationship with successful athletic performance, particularly in relation to fat and lean body mass, rather than the discrete anthropometric detail.

Using the traditional indices as specified by Montaigne, le Veau et al. (1974) showed U.S.A. gymnasts to have narrower hips and broad shoulders, short limbs, small thigh girths and narrower epicondylar widths than Japanese gymnasts- factors which were considered by them to provide a bio-mechanical advantage when controlling the movements of the body.

Similarly Carter (1976) concluded that a proportionally narrow pelvis and long arms were most characteristic of olympic runners and jumpers, particularly those who were described as racially 'black'.

While raw data gave no indication of differences or similarities between female track and field athletes, Eiben et al. (1976), using the phantom strategy of Ross and Wilson determined that different proportionality patterns were associated with different athletic events. They suggested that these differences might be associated with biomechanical factors specific to that event.

The availability of data for the mature athlete is more readily available and definite than that for children, where there are confounding factors of growth and maturation which must be taken into account when assessing the physical status of the individual, and where controls are difficult to apply.

Twelve outstanding under-12 female skaters were measured anthropometrically by Faulkner (1976). They were compared with other skating data, and with the adult unisex PHANTOM. At that time, Faulkner regretted the lack of normative data for this young age group, recognizing the need for prototypical comparison. Now with the comprehensive COGRO information available, a comparison can be made to identify how these skaters, or any other designated group, vary structurally from the reference standard of children of their own age.

The ability to identify the unique physical characteristics of children has particular application to the sports coach, parent and child, especially if it is found that some physical characteristics are never associated with major success in a given activity, whereas other characteristics are almost always associated with success. The coach is anxious for the child to be successful. He is concerned with the ability of the child to learn particular skills and may need to counsel the child in selecting an area of the sport appropriate to his physique and temperment. Both the parent and the child are likewise oriented towards the child's success, and set particular goals for him. From the point of view of all concerned, the attainment of these goals can be seriously disrupted when the physique of the child applies a structural constraint to higher achievement. Skating is a sport which involves mechanical constraints, and as an individual sport, rating as to proficiency is relatively simple, compared with team sports, when individual prowess may be confused with team success or failure.

Proportionality changes have been reported in boys aged 7 - 15 years (Ross et al. 1975). Principally the pattern was one suggesting an increase with age, of metabolically active tissue (muscle), in relation to the less active tissue (bone). Similarly maturation in girls has been associated with proportionality changes in a number of anthropometric variables. Malina (1975) and Harkness (1971) found early maturers to be heavier and taller at each age than late maturers. Likewise increasing fat levels have been associated with the maturation process (Rarick 1973, Malina and Johnston 1975).

Similarly the onset of menarche (an indicator of maturity) has been correlated with body build, in that linearity is typical of the late maturer (Skerlj et al. 1953, Kralj-Cercek 1956, McNeil and Levson 1963, and Young et al. 1963). The question as to whether low fat levels delay the onset of menarche, or whether the maturation event itself determines fat deposition, has not yet been resolved.

While the situation regarding the mature athlete is a matter of considering the nature and nurture factors and their interaction effects, the complication of maturity in children makes the task of examining body changes due entirely to sports participation, much more difficult. Nevertheless Parizkova (1968) in a well controlled study with 96 boys indicated that with higher levels of physical activity, there was a relative narrowing of the pelvis, and a decrease in fat mass which improved the economy of work.

It was the purpose of the present study to determine any absolute differences in selected anthropometric variables between skaters and their age peers and to ascertain any proportionality differences between these subjects, their peers, and the adult phantom.

The methods and procedures were those as specified by Faulkner.

The subjects were 12 outstanding under-12 female figure skaters, from British Columbia on the Canadian Pacific coast. The designation "outstanding" was based on a performance criterion from a strong competetive milieu.

RESULTS

Using the SPSS statistics program, (Nie et al. 1975) Faulkner calculated the means and standard deviations for 21 anthropometric variables which were assessed on the young skaters. From these parameters and those of the 11 year old girls prototypical data 't' ratios, as shown in Table 32, were calculated.

Table 32

ITEM	SKATERS		PROTOTYPE		't'
age	10.7	(1.1)	10.96	(0.31)	0.3
weight	31.2	(5.6)	39.12	(10.22)	3.0(s)
height	136.7	(9.4)	145.12	(7.78)	2.7(s)
sitting height	71.1	(3.4)	76.22	(4.28)	3.0(s)
foot length	21.5	(1.5)	21.75	(1.43)	0.5
triceps s f	10.2	(2.5)	14.28	(4.18)	3.7(s)
subscap s f	6.0	(1.7)	10.20	(4.5)	4.1(s)
suprail s f	4.0	(1.0)	10.00	(5.45)	4.2(s)
abdomin s f	5.2	(1.7)	13.14	(6.46)	5.6(s)
thigh s f	13.6	(3.4)	23.53	(8.16)	5.1(s)
calf s f	9.4	(2.5)	12.90	(5.45)	2.6(s)
tibial ht	35.6	(3.1)	37.97	(2.46)	2.2(s)
biiliocr wd	21.5	(1.6)	23.12	(2.53)	2.3(s)
epic hum wd	5.51	(0.35)	5.75	(0.42)	1.8(s)
epic fem wd	8.10	(0.54)	8.46	(0.53)	2.1(s)
thigh girth	44.4	(5.1)	45.89	(5.24)	0.83
calf girth	27.9	(1.9)	29.55	(3.14)	1.9(s)
chest girth	66.5	(3.8)	71.45	(6.05)	4.7(s)
up arm flex	21.3	(1.3)	23.59	(2.68)	3.4(s)
up arm len	25.7	(1.8)	27.07	(1.91)	3.2(s)
low arm len	19.1	(1.9)	20.62	(1.35)	2.4(s)

df=11; critical value at 5% level=1.782 for 1-tailed test.
(s) indicates significance at the 5% level.

The presentation of prototypical data from the COGRO study was reflective of the growth parameters at any one specific age, and with the small numbers involved, it would be presumptive to present these prototypes as population data. Nevertheless the marked similarity between the means and standard deviations of a very large population sample has already been pointed out. The appropiate APL computer program was used to calculate the required information.

The report by Faulkner concluded that the under-12 skaters were smaller than the general population and as this was the hypothesis to be tested, a 1-tailed test was applied. Inspection of Table 32 indicated that in every instance, the skaters raw data was less than that of the COGRO data, and supported the working hypothesis.

The Ross and Wilson phantom equation was applied to the COGRO data to calculate Z-values for each of the selected variables. Standard deviations of z-values for this data were also calculated. Thus the mean z-value and the standard deviation of the z-values were caluclated. This information was essential in studies of this kind to enable significance tests to be conducted. It has been common policy in anthropometric studies to report only means and standard deviations from the raw data. For full proportionality comparisons it is necessary to report the z-value mean and the z-standard deviation, both of which can only be determined from raw data using the Ross, Wilson proportionality formula.

Means and standard deviation z-values for the skaters, were those reported by Faulkner.

The z-value means and standard deviations for 13 selected variables of the skaters and COGRO data together with calculated 't' ratios were presented in Table 33.

Significance was detected in the two variables indicated (S) - foot length calf girth and lower arm length.

Figure 23, presents the proportionality Z-values for the 13 selected variables showing deviations of the 11 year old girls prototype and the skaters when compared with the adult phantom.

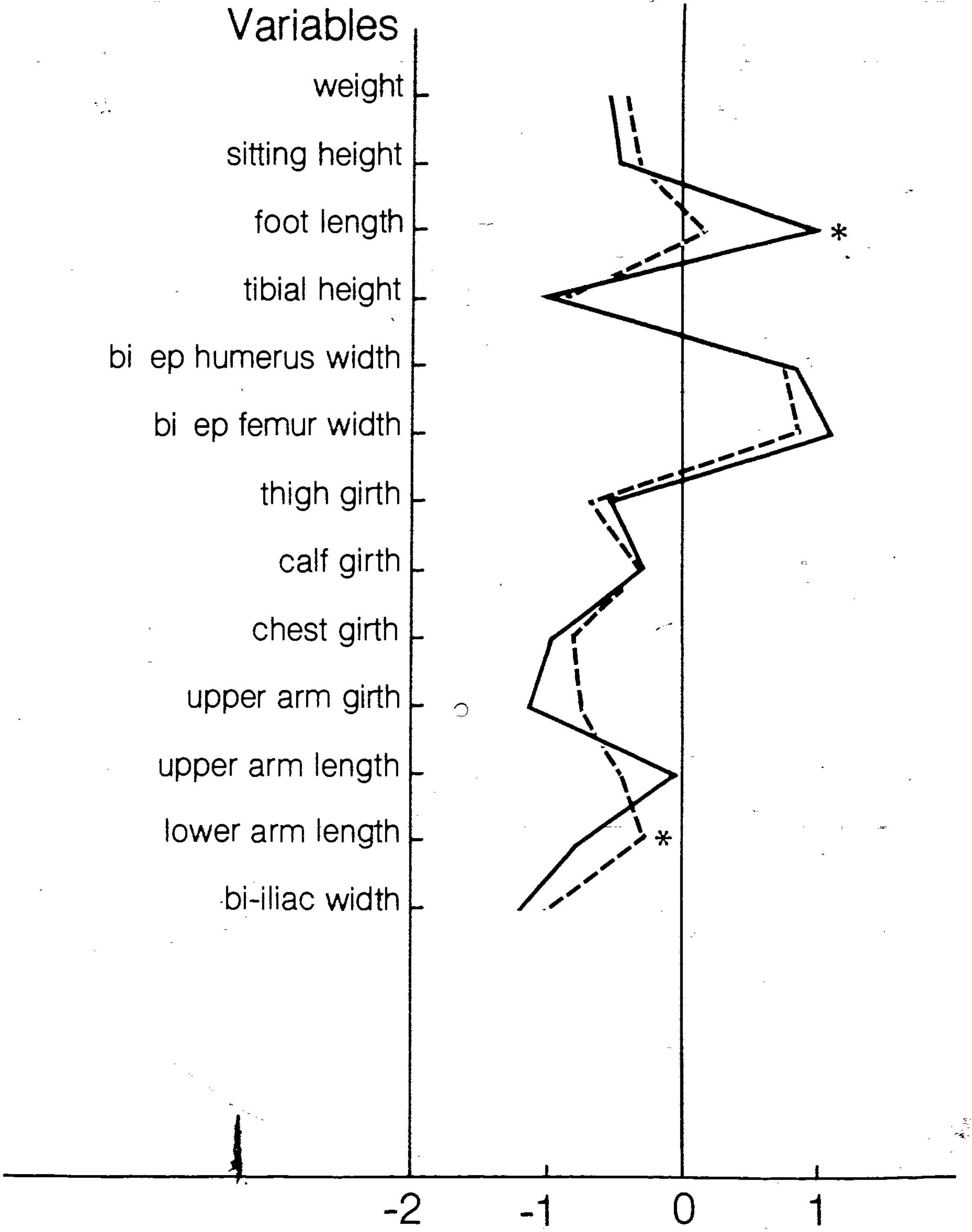
Table 33

ITEM	SKATERS	PROTOTYPE	't'
weight	-0.54(0.64)	0.41(0.93)	.42
sitting ht	-0.46(0.69)	-0.33(0.32)	.81
foot len	1.04(0.69)	0.16(0.80)	3.28(S)
tibial ht	-1.02(0.55)	-0.87(0.50)	.76
epi hum wd	0.84(1.08)	0.78(1.24)	.13
epi fem wd	1.13(0.67)	0.83(0.87)	1.02
thigh girth	-0.52(0.67)	-0.69(1.28)	.33
calf girth	-0.28(0.88)	-0.29(1.16)	.02
chest girth	-0.97(0.71)	-0.80(0.94)	.52
up arm flex	-1.12(0.62)	-0.74(1.09)	.95
up arm len	-0.04(0.83)	-0.44(0.76)	1.61
low arm len	-0.74(1.18)	-0.28(0.68)	2.23(S)
bi[illegible]ioc wd	-1.18(0.61)	-0.99(1.49)	.28

The level of significance in this case was appropriate for a two-tailed test since there was no testing hypothesis as to directionality. Thus the hypothesis was that the skaters were proportionately different to the prototypes.

With 34 d.f. in each instance, the critical value at the 5% level was 1.9.

Figure 23:Proportionality z-values of 13 selected variables for skaters and the appropriate prototype.



- - - - - Proportionality z values for 13 variables showing deviation of prototypical data for 11 year old girls from the phantom (0)

—— Proportionality z values for 13 variables showing deviation of under-12 outstanding skaters from the phantom (0)

The comparable CCGBC group was selected by considering the mean age of the skaters group. Hence the 11 year old data was chosen since the mean age for this prototype was closer than any other, to the mean age of the skaters. The small age difference was insignificant, as seen in Table 32.

In retrospect this was a recognized weakness in the study in that the skaters' group included some very young subjects which undoubtedly modified the results. This was a necessary compromise in that very little data is available on outstanding young performers in any sporting activity. In future comparative studies of this kind should not form groups of such a wide age range, but instead, comparisons should include single age groups compared with the appropriate prototype.

Although there was little absolute difference in foot length or epicondylar widths, raw measurements, generally indicated that the skaters displayed smaller dimensions than the prototype. They were lighter, shorter and had generally smaller girths. The low skinfold values were much lower, and linearity was subsequently assessed using the Heath - Carter (1975, a) method of somatotyping. This involved summing the triceps, subscapular and suprailiac skinfolds, then by application of this value to a rating form determining both relative relative leanness. This value for the means of the skaters was 20.2 i.e. (10.2 + 6.0 + 4.0) and 34.48 for the prototype. the respective degrees of linearity were 2.0 for the skaters and 3.5 for the prototype, where maximum linearity has the value of 0.5. thus the greater linearity of the skaters, as a group, compared with the prototype, was shown using this method.

Application of the 't' ratio to compare the means, indicated a significant difference at the .05 level between all measurements of the prototype and the skaters of the same age, with the exception of foot length and thigh girth.

Inspection of the proportionality profiles, when both samples were compared with the phantom, indicated a similar trend in deviation, with the skaters generaly showing greater proportional differences, as illustrated in Figure 23.

Comparison of the skaters with the protctype were displayed graphically in Figure 24, and proportionality differences between the two groups were found to be significant for foot length, and lower arm length. As seen in Table 33, the young skaters had significantly larger feet and shorter lower arms in proportion to their height when compared with the protctype for their age.

Other tendencies were marked though not statistically significant. Thus the skaters showed a tendency toward proportionately larger epicondylar femur widths and longer upper arm lengths.

DISCUSSION

Faulkner showed that there were a number of ways in which the outstanding young skaters differed from the senior elite prototype, and he suggested that the "size deviations were probably due to maturity differences as the young outstanding singles under-12 skaters were all prepubescent."

Now that it is possible to compare these children with their age peers, it is also possible to identify those variables where differences can be identified with performance, rather than with the growth phenomenon. The most noticeable result in this study, was the significantly low values for skinfolds in the young skaters (Table 32). This may be evidence of the effect of training on fat storage, as pointed out by Parizkova (1968), or evidence of late maturation.

The skaters in this study reportedly trained for up to 25 hours per week and could well be included in the heavy work category with which Parizkova associated low levels of fat and a greater proportion of lean body mass. Alternatively it might be suspected that the skaters were less mature than the prototype since with approaching maturity fat is deposited, thus late maturers have a tendency to smaller skinfolds than early maturers. As determined by Faulkner, there was an overall tendency to late maturation among female skaters, with a mean menarcheal age of 14.0 for the nationally elite senior and junior ladies. Faulkner proposed that excess fat associated with early maturation, would hinder the learning of skills, while proportional linearity would enhance same. Hence late maturers would be favoured as figure skaters.

This supports Espenschade (1940) who found that the better performing girls in motor tests were late maturers. If these two factors are causative it could be due to the economy of work found by Parizkova or to a minimal amount of bulk which might otherwise produce a restricting influence and interfere with the mechanics of movement.

Whether this relationship between maturation, fat and performance is causative or resultant, is not clear, i.e. does training reduce fat levels which produces a delaying effect on the appearance of menarche? or does a delayed menarche create a leanness which is conducive to skill learning and performance?

These questions and the interaction of these effects need more consideration. Furthermore most other variables showed a significant difference as determined by the 't'ratio, indicating that the skaters were, in general significantly smaller than the COGRO prototypes.

It appeared that the skaters were a selected sample, and that the factors which selected them were in part, those anthropometric variables which facilitated their learning and performance of skating skills.

Examination of the proportionality results of the prototype and the skaters compared with the adult phantom, indicated that in general, both samples deviated from the phantom unidirectionally. Thus it would seem that proportionality characteristics vary with age, but that more extreme differences may be selective for certain athletic activities. It is tempting to suggest on this meagre information, that on the basis of deviation from adult proportions, young girls are more suited anthropometrically to learn and perform skating skills.

While proportional foot length of the skater was significantly larger than the prototype, the ~~epi~~condylar widths showed a non-significant excess over the norms, although there was a tendency for larger values. Both these parameters were suggested by Faulkner as being beneficial to stability in providing a wider base.

One factor which should not be forgotten in this analysis is that the age range of the skaters was 8.2 to 12.0, whereas the age range of the COGRO group was 10.51-11.42. This difference in sampling could have influenced some of the results, in that the younger skaters would have contributed smaller values to that group, reducing the mean values and increasing the variance. Nevertheless, it is difficult to procure samples of outstanding athletes of sufficient size with a less varied age group range. While this appears as a problem, it is not sufficient justification to stop investigations of this kind, though age variation should be kept as small as possible. Futhermore this study was intended to illustrate only one of the possible ways in which the prototypes can be used.

A further problem in this type of analysis is the investigation of the status of the individual athlete. Subsequent treatment of the data and possibly the establishment of selected arbitary z-values to indicate a significant difference between an individual and prototypical data, will facilitate the extended use of prototypical data for use by the individual.

SUMMARY AND CONCLUSIONS

The data from Faulkner (1976) of twelve outstanding under-12 female skaters were compared with prototypes for their own age obtained from the COGRO study.

The study aimed to determine those anthropometric differences which might be identified with success in this activity and which might in turn lead to an assessment method for the selection of young skaters.

A plea was made for workers in the area of anthropometry to routinely report the mean and standard deviations of z-values.

From analysis of the data, the following conclusions were drawn:

1. The most outstanding result was the significantly low skinfolds of the young skaters when compared with the prototypical group. This was especially noticeable in subscapular, suprailiac, abdominal and front thigh skinfolds. It was proposed that these children were late maturers and they were able to take advantage of the lack of bulk, associated with the fat depostion occurring with maturation, which facilitated the learning and performance of figure skating skills, at the same time optimizing work output which is facilitated by low fat deposits.

It is possible that an interaction between maturity and training contributed to these lower skinfold values. Since the two groups were both prepubescent, the contribution of 25 hours training per week could not be under-estimated as a modifier of skinfold measurements.

The high values of fat in the prototypes would indicate that leanness is specific to the skaters.

2. In 18 of the selected variables, significant differences were found between the skaters and the prototypes. It was suggested that these differences were selective for young skaters. Thus a small body would appear to be advantageous in this activity. Whether this is a biomechanical advantage or whether the advantage stems from some other source needs further investigation.

3. When comparing proportionalities of the two samples with the phantom, it was noted in general, that deviation of both the prototype and the skaters were in the same direction. This was suggested as implying that much of the proportional differences were a function of age.

4. There were two variables where there was a significant difference between the Z-values of the skaters and those of the prototypical data. i.e. larger proportional foot length, and shorter lower arms (forearms). The longer The longer foot length was seen as contributing to better balance.

It was concluded that the proportionality differences which were found between skaters and the prototype were selective for young figure skaters.

Thus one of the proposals of Faulkner was verified, namely that there is a specificity of physique in figure skating which appears to accompany success in the young performer. This specificity was demonstrated as smallness, leanness, proportionately larger feet, proportionately , shorter lower arms, and possibly being a late maturer.

Questions which remain to be answered include whether or not after maturity, these young proteges are still in the outstanding class? Do these physique characteristics change? If so can the change be predicted and predetermine the performers success in adult competition? Is there a point in time during the adolescent growth spurt when conditions of changing physique enhance or inhibit the acquisition and performance of skill? Is heavy training accompanied by low skinfolds a critical factor in delaying puberty and the growth sequence, thereby extending the period of advantageous physique? Does this make the learning of complex skills, involving the manipulation of total body mass, easier?

Many of these types of questions can only be answered by the longitudinal study of performers as they pass from childhood to adulthood. Meanwhile the COGRO prototypes have provided the kinanthropometrist with an adequate tool by which specificity and generality of anthropometric measurement among selected groups can be identified. To this extent these prototypes can be used to identify those variables which might influence success and performance.

In this, they introduce an element of quantification in appraisal and guidance of the young athlete, which should eventually lead to improved service to children and their parents and those responsible for the conduct of youth sport programs.

VI DISCUSSION

In any study which has as its aim the establishment of normative data, the most reliable way to do this is to include all members of the required population. This is clearly not possible when dealing with the human population. For this reason compromises have to be made while at the same time attempting to maintain a condition which remains as close as possible to the ideal. Using small sample sizes and good technique, the compromises of the COGRO study led to the establishment, not of normative data, but of prototypes for girls and boys age 6 to 18.

Standard measuring conditions were maintained in COGRO with only trained kinathropometrists being responsible for measurements. While a larger number of schools would have given a more reliable assessment of data, time did not permit larger personal involvement and many other schools did not meet the criteria of selection. Restriction of the age range could have led to a prepubertal or mid-pubertal subgroup, and since it is generally accepted that the pubertal changes in growth are the most interesting, it was decided to cover the full school age range in order to gain a complete view of growth patterns.

From this study there have been several important outcomes in addition to achieving the primary objectives of the study:

It is now known that it is possible for an experienced team of anthropometrists to move into an institution and gather data quickly and reliably without severe disruption to that institution.

Staff and students in the schools showed a great deal of interest in the whole project. They were keen to participate, to discuss the methods and to know how they could use the results.

The basis for longitudinal study was established in these three schools which could provide further information, through both cross-sectional and longitudinal study, on the kinanthropometrical aspect of the growing child.

Since there is no general concensus on whether the 'best-off' or the middle-class groups should be used to establish normative data, the COGRO sample, which might be described as middle-class, was acceptable as a selection for the development of prototypical data. One of the problems of any survey of this nature is gaining the support, encouragement and the enthusiasm of administrators, without this, any survey is doomed before it starts. With the western world becoming more and more demanding of its private rights, the opportunities for this kind of data gathering could be seen to be decreasing. Indeed one part of the intended study included a menarche questionnaire, but the Coquitlam School Board refused its distribution. Thus denying the study group the possiblity of investigating the inter-relationship between maturation and growth attainment, or even of ascertaining whether menarche is occurring earlier or later than previously reported.

The COGRO study has not only established extensive prototypical data but it has also helped provide a source of information from a large sample of children which can be further elaborated upon as long as good will is maintained between educators and researchers, both groups being equally concerned with optimal growth and development of all children and youth. This, of course, is a basic responsibility for school administrators who see their role as creating an environment for happy, healthy, technically advanced and culturally enriched children, and a concern, shared with kinanthropometrists.

The selection of the three schools was done largely in consideration of the political situation, in that liaison with the public, including educational institutions, must be done with the support of the governing body. The Coquitlam area was considered to be principally middle-class with an observed mixed racial component, and it was assumed that factors positively influencing growth were maximized, and that those negatively influencing growth were minimized. It was also considered that the schools offered an atmosphere whch encouraged the expression of maximal growth potential. Thus it was felt that a group close to the 'best off', as suggested by Tanner, was used to establish the prototypes.

The use of the word prototype in this context is perhaps new, but its use in not new. A number of prototypical models have already been developed in kinanthropometry principally of athletic groups. The prototypes can be viewed as similar to the adult unisex phantom of Ross and Wilson, which is in fact a model with which adults of either sex, at any age, can be compared.

The word prototype is used to indicate a defined group where, for specified items, means and standard deviations are calculated and these are then taken as reference data against which other groups can be compared. Thus from the COGRO data, age-sex prototypes were developed for middle-class West Coast Canadian children against which other groups of children can be compared.

While there was concern as to the skewness, and to a lesser extent the kurtosis of some of the COGRO data it was also recognized that these factors were seldom reported by other similar studies. In the few where they were reported, similar degrees of deviation from generally accepted values (0.00 for skewness and 3.00 for kurtosis) were of a similar order as found in COGRO. Thus it appeared that growth data in general seems to vary somewhat from a true normal distribution.

Comparison of the COGRO data with Manitoba data showed a surpising degree of uniformity with respect to all variables considering the size of the two samples (N=923 for COGRO, N=59, 793 for Manitoba). It was suggested, therefore, that the prototypes were well representative of Canadian children.

THE SECULAR TREND

The principal reason for comparing COGRO data with Manitoba data was to ascertain if the smaller sample was characteristic of the larger one. Furthermore, if the COGRO children were taller, one might have speculated on a possible secular trend over the years 1970 to 1978. Most studies of this trend have occurred over a longer period, and it is indeed possible that if a secular trend is still occurring, it can only be statistically detected over a 10 - 20 year (or longer) period. This would explain why Karlberg and Taranger (1975) found a secular trend in Swedish children from 1883 and 1938-9 data compared with their modern study and why Blanksby et al. (1974) detected the trend in Australian children from 1940 to 1971 This might also explain why Damon first suggested that the trend was disappearing i.e. the time interval was insufficiently long for change to be detected. The other factor which could influence these results was also suggested by Damon, namely, that the trend was finished in the upper class only. Investigations of the secular trend must take this into account and ensure the equivalent socio-economic status of samples which are being considered.

From the comparison of COGRO and Manitoba means it was not possible to make any definite statement regarding the secular trend. In conducting 't' tests at the age where there was maximal difference between the two groups there was no significant difference in boy's weight, or height. In each instance, the 18 year old group was not included on the basis of innocent selection which occurred. After the study, in consultation with the Port Moody Senior school staff, it was found that the 18 year old boys from this school were principally a select basketball group which probably accounted for the greater height values and deviations from an otherwise smooth percentile curve. Thus while there were some absolute differences, the Manitoba group being heavier than the COGRO group, but being generally shorter, at the same time, these differences were not significant.

The girl's data was treated similarly and a significant difference was first detected in height in the 14 year old group. While this should have been followed up with an analysis of variance, this was not possible since sums of squares could not be calculated from the Manitoba date.

In addition there were distinct methodological differences, between the two studies. The aim of the Manitoba study was to establish norms for height, weight and performance and to achieve this, teachers were used to gather data. It is thus suspected that a large degree of inter-measurer and inter-equipment variability was involved in the results. While this variability may equally over- and under-estimate values, it was presumed to have been a very definite source of error.

Furthermore, in the assessment of height, in the Manitoba study, the non-stretched value was used (Corroll, 1978). In the COGRO assessment of this variable, stretch of 1 to 2 cm. was often observed, more consistently so later in the day. With the stretch stature technique used in COGRO one would assume maximal stature to be achieved with greater frequency than in Manitoba. Hence, if anything, from a technical point of view COGRO children should be slightly taller.

With the understanding and acceptance of the limitations of the Manitoba results, there would seem to be little justification to suggest that a secular trend is present between the two groups in the eight year period of 1970-1978. The only real difference between the two groups was in girls height with COGRO girls from 14 onwards being significantly taller than girls of the same age eight years ago.

It was mentioned on page 39 of this thesis that Van T' Hof criticized the results of cross-sectional studies as being adversely affected by cohort effects (i.e. the secular trend). Failure to determine a secular trend in this study should encourage the use of the cross-sectional method in the assessment of growth and the establishment of normative data.

Thus while a secular trend in height and weight was not demonstrated in boys aged 6-17, there appeared to be a secular trend in girls between 14 and 18, with girls becoming taller now than in 1970. The reason for this increase needs further investigation including sociological studies.

INTERNATIONAL COMPARISONS

Conditions for the growing child differ in various countries. Conditions which vary, do so according to the economic status of the family which influences nutrition, living conditions and freedom from illness: conditions also vary according to the economic stability and degree of technololgy of the country which determines the basic levels of family life. Other factors which are part of the complex socio-cultrual mileau influencing child growth include geographical area, child rearing practices and attitudes which are not independent of economics but which may not be as closely tied to economics as the previously itemized factors.

Comparisons of COGRO, U.S.A., Czechoslovakian, Swiss and Norwegian children within the 6 to 18 year age group, provided little evidence to suggest that within these countries there were any marked differences in height and weight of boys or girls. Thus while there may be marked socio-cultural dissimilarities in North American and European populations, there was little evidence of these differences affecting child growth.

However in countries where technology is less developed, as evidenced by India, there appeared to be marked differences in growth attainment at each age level, the children being shorter and lighter than European and North American children of the same age.

Variability of genotype might also be influencing child growth, since North America in particular, and also some of the European countries, have experienced a migration phenomenon which will have contributed to heterosis. This is not so in India where limited resources have seen an emigration rather than an immigration.

SKINFOLD CHANGES

Deposition of fat is associated both with nutrition and maturation. While it was unfortunate that menarche data could not be collected in the COGRO study, it could be reasonably assumed that the average age of menarche is approximately 13 years, based on 1975 data of Ross et al.

(1976). Thus in girls, the marked increase in skinfolds at 12 to 15 years could be accounted for in terms of the maturation event. There appeared to be no consistency in the pattern of skinfold thicknesses within the boy's data.

When compared with the Montreal skinfold data it was obvious that these measures were greater in the COGRO samples at all ages for boys in both triceps and subscapular sites as it was for girls at all ages except for the subscapular measure at age 8. As a nutritional phenomenon the implication was that the COGRO children were better nourished than those of the Montreal sample. However the dividing line between well nourished and over nourished is subjective and it might be considered that the COGO children were indeed over nourished.

Since there were no determined differences in the methods employed in the two studies, it would seem that real differences were detected over the whole age range. A similar situation i.e. increases in skinfold measurement, was observed by Karlberg et al. in their 1976 study when comparing their results with a 1971 study by Samuelson. It might seem that there is a world wide secular trend in skinfold thicknesses.

Overweight attributed to over fatness has been proposed as one of the present day health problems in that it has been linked to cardiovascular disease. On the assumption that skinfolds reflect the amount of subcutaneous fat, it would seem unwise for society to even tacitly encourage large skinfolds in children. There is little knowledge on how childhood fat content is related to adult content, and the question of whether hypertrophy or hyperplasia of fat tissue is involved in fat deposition is still largely unresolved. Intuitively it would seem wise to encourage low skinfolds,

HEAD CIRCUMFERENCE ASSESSMENT

On the basis of its use as a diagnostic tool in the detection of possible growth deficiencies of the brain or skull, the measurement of head circumference should always be made in routine examination, at least during childhood. There would however seem to be little data with which routine investigations can be compared. Indeed Epstein and Epstein (1978) could cite only four papers which in whole or part considered the relationship of head circumference and brain weight.

The results expressed in graphic form in figures 21 and 22 indicated differences between the head girths of the COGRO children and those of Swedish children of Karlberg and Taranger (1976) - an unexpected result since other parameters of bone growth appeared to be quite similar. However because of the scaling chosen for the graphs the differences appear somewhat magnified. Thus in reality head circumferences in girls from age 6 to 18 increased by only 3 centimeters in the COGRO sample and by 4 centimeters for girls aged 6 to 16 in the Swedish study. There was a maximum difference of 1 centimeter between the 10 year old girls of the two studies. Similar minor differences were seen in the boy's data.

There was no indication that a methodological factor was involved to explain the differences except that the use of a linen tape in COGRO may have led to under-estimations of this parameter if stretching of the tape occurred when strong pressure was applied in order to reduce the effect of hair and soft tissue.

The difference might however be due to differences in hair growth habits since without the "short back and sides" cut, boys head circumferences could be over estimated by the hair mass. Similarly girls' hair styles could account for the differences observed in those groups. There would appear to be no reason why one group should display larger head circumferences than the other, especially considering the relationship suggested by Epstein and Epstein (1978) that head circumference and brain weight are linearly related when expressed to the third power of a log - log relationship in both normal and marasmic children from birth to eighteen years. If brain size is constant between individuals of various origins, this would seem to suggest that differences are not to be anticipated between international groups.

VII SUMMARY AND CONCLUSIONS

From a comprehensive, cross-sectional anthropometric investigation of 923 children attending three schools in the Coquitlam District of British Columbia, Canada, 26 age-sex prototypes were presented as a reference for growth status of children aged 6 to 18.

Because of the paucity of numbers in several of the age groups, it was considered that the data was not a true population representation. Hence subsequent comparative studies should consider the COGRO data as a sample for the purpose of statistical evaluation.

Nevertheless, the closeness of the various parameters with a population of Manitoba children in the same age range, indicated that the inclusion of very large numbers in cross-sectional studies can be wasteful of resourses. The 'ideal' number of 100 subjects for both sexes or each age up to 4 years was recommended by the committee report of 1971 which would seem to be adequate to establish population parameters.

If the COGRO sample was indicative of the 1970 Manitoba data, there was no evidence of a secular trend. Proponents of the view that there is a secular trend in western Canada would have to argue that the 1970 Manitoba, children were advanced over the 1970 Coquitlam children or that to-day, the Manitoba children are larger than they were in 1970.

There appeared to be little variation in each age group between children from highly technological countries. However in less developed countries as indicated by India, it appeared that children were smaller and lighter than those from the countries which were chosen for comparison.

Skinfold measurements were seen to be much larger than in 1970 in both sexes and at nearly all age levels. The seriousness of this with regard to the increasing incidents of cardiovascular disease was considered. While the concern is genuine, one might question the evidence. Skinfold values obtained in Manitoba by virtually untrained personnel may indeed reflect a systematic difference over those obtained by an experienced anthropometrist whose technique was such that the calipers were applied correctly to the double fold skin. Novice anthropometrists often miss the true thickness and underestimate the value. Nevertheless, there is a possibility that the values do indeed indicate a move to over-nutrition and obesity and this, of course, must be subject tc further study. The routine monitoring of this measurement for the continual assessment of over nutrition was recommended.

The significance of head girth circumference was discussed in the light cf normal skull and brain development. Children in excess of 2 standard deviations from the mean should be more thoroughly screened to rule out the possibility of retarded mental development. While several studies use only height and weight in growth surveys, it should be recognized that other anthropometric data can be of value in assessing the physical status, thereby maintaining those factors which influence growth. The height, weight, skinfold and head size data perhaps could be used to pilot a health apprasial and counselling program. Certainly, such a follow up would be a lcgical expression of what appears to be a strong commitment to health and an active lifestyle which has been an emphasis in the school district for the last several years.

An ancillary study using data provided by Faulkner on under-12 outstanding female figure skaters was used to demonstrate the use of the COGRO data in comparing children with their age-sex protctypes.

To facilitate profile comparisons when means and standard deviations are presented for proportionality assessment, it was recommended that all anthropometric studies include means and standard deviations for z-values, as derived from the Ross, Wilson formula.

Significant differences using a paired 't' test of uncorrelated samples indicated absolute differences and specific proportionality characteristics of under-12 figure skaters when compared with the appropriate age-sex prototype.

It was considered that the prototypes developed in this study were suitable for use as the basis for child growth and in the assessment of structural differences and specific proportionality characteristics of athletic groups which can be used as basic information for the counselling of young athletes in their pursuit of excellence.

COGRO joins with similar types of surveys such as MOGAP (Montreal Olympic Games Anthropometrical Project) and CANSYN (Canadian Sychronized Swimmers Project) in providing a wealth of information regarding the human form. It was complementary to these surveys in that it dealt with the developing child and gave rise to prototypes which can be used in monitoring nutrition and the other factors which are known to influence growth, while at the same time furnishing the field of sports science with a means to identify those physical characteristics which are specific to young performers in various sporting endeavours.

APPENDIX A

COGRO

COQUITLAM GROWTH STUDY

Kinanthropometric Research Unit
Department of Kinesiology
Simon Fraser University

Children grow up only once. During the transition period from child to adult, they undergo many changes. Understanding these changes, whether they be physiological, emotional, or any other allows us to insure that the growing up process is as happy and satisfying as possible. There is much information available on the psychological aspects of child growth. However, there is far less known about the equally important area of physical and physiological growth. It is to help fill this void that we propose the Coquitlam Growth Study.

During the last two weeks of January approximately 2000 students in three Coquitlam schools (grade range from K to 12) will be put through a series of measurements and tests. The large number of students required is due to the cross-sectional, or "one time only" type of study which demands that an adequate sample in each age range be evaluated. The first part of the study will be anthropometric. Thirty body measurements (lengths, breadths, widths, girths, and skinfolds) will be taken on each student. The second part of the study will consist of a series of four physical performance tests, one for throwing, one for running, and two for jumping. In both parts of the study, all measurements will be taken by competent and experienced investigators and at no time will any student be subjected to a situation that he or she might find traumatic. Each student will be given a copy of his or her individual results with an accompanying explanation.

A number of important products will result. For example, the size data alone will give us one of the best anthropometrically evaluated norm groups in the world. Any school board wishing a vehicle with which to monitor the growth of its own students (for an obesity screening programme, for example) would be able to draw on the resources of this study for such purposes.

Please contact us in the Dept. of Kinesiology, S.F.U., if you have any questions.

APPENDIX B

COGRO

COQUITLAM GROWTH STUDY

Kinanthropometric Research Unit
Department of Kinesiology
Simon Fraser University

1	01. Subject ____ (Last Name) (Given Name)	1	
	02. Card Number ____	6	1
	03. Identity 7 Sex f = 0, m = 1; 8 checker number	7	
2	04. Date of observations Year ☐☐ mo. ☐☐ day ☐☐	9	
	05. Date of birth Year ☐☐ mo. ☐☐ day ☐☐	14	
	06. Body weight ☐☐☐.☐ kg -correction of ☐.☐	19	
	07. Height (cm)	23	
3	08. Triceps sf ____	27	
	09. Sub scapular sf ____	30	
	10. Suprailiac sf ____	33	
	11. Abdominal sf ____	36	
	12. Front thigh sf ____	39	
	13. Medial calf sf	42	
4	14. Acromial height ____	45	
	15. Radial height ____	49	
	16. Stylion height ____	53	
	17. Dactylion height ____	57	
	18. Tibial (lateral) height ____	61	
	19. Spinale height (anterior - superior spine) ____	64	
	20. Gluteale height (sacral-coccygeal)	68	
	21. Subject ____	1	
	22. Card Number	6	2
5	23. Arm girth relaxed ____	7	
	24. Arm girth flexed and tensed ____	10	
	25. Forearm girth (maximum relaxed) ____	13	
	26. Wrist girth (proximal styloid processed) ____	16	
	27. Chest girth (mesosternal) ____	19	
	28 Waist girth (min. circ) ____	23	
	29 Thigh girth (1 cm distal gluteal line) ____	27	
	30. Calf girth (max circ) ____	30	
	31. Ankle girth	33	
6	32. Biacromial breadth ____	36	
	33. Biilochristal breadth ____	39	
	34. Transverse chest ____	42	
	35. Foot length (akropodion pternion) ____	45	
	36. Bi-epicondylar humerus width ____	48	
	37. Bi-epicondylar femur width	52	
7	38. Sitting height ____	56	
	39. Anterior-posterior chest depth ____	60	
	40 Head girth ____	63	
	41 Neck girth ____	66	
	____		
	____		
	____		

APPENDIX C

```
COGRO FEMALES AGE 11                          WT

MEAN VALUE                39.12
SE(MEAN)                   2.09
VARIANCE                 104.35    THE DESCRIPTIVE STATISTICS
STANDARD DEVIATION        10.22    COMPUTED ARE ADJUSTED (n-1)
SE(SD DEVIATION)           1.47    SAMPLE STATISTICS.

MAXIMUM                   68.60
MINIMUM                   23.30
RANGE                     45.30

SYMMETRY---VETA 1          0.88
KURTOSIS---VETA 11         3.75
COEF. OF VARIATION        26.11%


NUMBER OF SUBJECTS 24

RAW PERCENTILES                  SMOOTHED PERCENTILES

99TH        69.04                99TH           72.20
98TH        68.56                98TH           66.54
97TH        55.60                97TH           63.20
95TH        49.60                95TH           58.96
90TH        48.40                90TH           53.08
85TH        47.20                85TH           49.51
80TH        46.00                80TH           45.92
75TH        43.20                75TH           44.81
70TH        42.40                70TH           43.04
65TH        40.80                65TH           41.48
60TH        39.20                60TH           40.08
55TH        38.00                55TH           38.79
50TH        36.80                50TH           37.57
45TH        35.20                45TH           35.40
40TH        33.40                40TH           35.28
35TH        32.20                35TH           34.17
30TH        31.33                30TH           33.06
25TH        30.53                25TH           31.91
20TH        29.60                20TH           30.69
15TH        28.40                15TH           29.36
10TH        26.40                10TH           27.79
 5TH        23.44                 5TH           25.64
 3RD        22.96                 3RD           24.34
 2ND        22.48                 2ND           23.42
 1ST         0.00                 1ST           22.00
```

```
    COGRO FEMALES AGE 11              HT

MEAN VALUE              145.15
SE(MEAN)                  1.59
VARIANCE                 60.56      THE DESCRIPTIVE STATISTICS
STANDARD DEVIATION        7.78      COMPUTED ARE ADJUSTED (N-1)
                                    SAMPLE STATISTICS
MAXIMUM                 155.40
MINIMUM                 131.50
RANGE                    23.90

SYMMETRY--VETA 1         -0.16
KURTOSIS---VETA 11        1.56
COEF. OF VARIATION        5.36%

NUMBER OF SUBJECTS 24

RAW PERCENTILES                     SMOOTHED PERCENTILES

99TH           156.68               99TH           156.02
98TH           156.52               98TH           156.97
97TH           156.20               97TH           157.16
95TH           155.40               95TH           156.97
90TH           154.40               90TH           155.73
85TH           153.20               85TH           154.34
80TH           152.33               80TH           152.99
75TH           151.53               75TH           151.66
70TH           150.20               70TH           150.37
65TH           147.80               65TH           149.10
60TH           146.47               60TH           147.85
55TH           145.67               55TH           145.61
50TH           142.87               50TH           154.35
45TH           142.07               45TH           144.09
40TH           141.27               40TH           142.81
35TH           140.20               35TH           141.50
30TH           139.00               30TH           140.14
25TH           136.60               25TH           138.72
20TH           134.73               20TH           137.22
15TH           133.93               15TH           135.62
10TH           133.13               10TH           133.90
 5TH           132.44                5TH           132.14
 3RD           131.96                3RD           131.63
 2ND           131.48                2ND           131.64
 1ST             0.00                1ST           132.39
```

BIBLIOGRAPHY

Bailey D.A., Malina R.M. and Rasmussen R.L. (In press). The influence of exercise, physical activity and athletic performance in the dynamics of human growth. In: Human Growth. Falkner F. and Tanner J.M. (Eds). Plenum Publishing Corporation. N.Y.

Bakwin H. and McLaughlin S.M. (1964). Secular increase in height is the end in sight? Lancet 2:1195-6.

Baltes P.B. (1968). Longitudinal and cross-sectional sequences in the study of age and generation effects. Human Dev. 11:145-171.

Barr G.D., Allen C.M. and Shinefield H.R. (1972). Height and weight of 7,500 children of three skin colours. Amer. J. Dis. Child. 24:866-872.

Behnke A.R. (1968). Physique and exercise. In: Exercise Physiology. H. Falls (Ed). Academic Press. New York.

Behnke A.R. and Royce J. (1966). Body size and composition of several types of athletes. J. Sports Med. Phys. Fitness. 6:75-88.

Billewicz W.Z. (1967). A note on body weight measurments and seasonal variation. Human Biology. 39(3):241-250.

Blanksby B.A., Freedman L., Barrett P. and Bloomfield J. (1974). Secular changes in the heights and weights of Western Australian primary school children. Annals of Human Biology. (3):301-309.

Borms J., Hebbelinck M. and Duquet W. (1974). On the variability of some physical fitness parameters in boys 6-13 years of age. J. Sports Med. 14:263-265.

Borms J., Hebbleinck M., Carter J.E.L., Ross W.D. and Lariviere G. Standardization of basic anthropometry in Olympic athletes- the MOGAP procedure. A paper presented at the International Symposium on "Methods of Functional Anthropology". Sept. 1977, Prague, Czechoslovakia.

Bowden B.D., Johnson J., Ray L.J. and Towns J. (1976). Height and weight changes of Melbroune children compared with other population groups. Australian Paediatric J. 12:281-295.

Boyne A.W., Aitken F.C. and Leitch T. (1957). Secular changes in height and weight of British children, including an analysis of measurments of English children in primary schools :1911-1953. Nutrition Abstracts and Reviews. 27(1):1-18.

Brock C.G.D. (1977). Prediction of adult stature. Developmental Medicine and Child Neurology. 19(1):78-80.

Brundtland G.H., Liestol K. and Walloe L. (1975). Height and weight of school children and adolescent girls and boys in Olso 1970. Acta Paediatrica Scand. 64:565-573.

Carter J.E.L. (1966). The somatotypes of swimmers. Swimming Technique. 3:76-79.

Carter J.E.L. (1970). The somatotypes of athletes - a review. Human Biology. 42:353-369.

Carter J.E.L. (1971). Characteristics of champion athletes. In: Anthropological Congress Dedicated to Ales Hrdlicka. V. Novotny (Ed). Czech. Acad. of Sci. Prague.

Carter J.E.L. (1973). Somatotype, growth and physical performance. Paper presented at The Fourth International Meeting of "Regulation of the Adipose Tissue Mass". Marseille.

Carter J.E.L. (1975, a) The Heath-Carter Somatctpye Method. 2/e Published by the author, San Diego State University.

Carter J.E.L. (1975 b). Proposed anthropometric measures for MOGAP. Personal communication.

Carter J.E.L. (1976). Proportionality characteristics of male Olympic black and white runners and jumpers. Paper presented at the American College of Sports Med. Anaheim.

Carter J.E.L., Sleet D.A. and Martin G.N. (1971). Somatotypes of male gymnasts. J. Sports Med. and Phys. Fitness. 11:2-11.

Choovivathanavanich P. and N. (1972). Arm circumference in Thai children. J. Med. Ass. Thailand. 55(7):400-405.

Clarke H.H. (1968). Characteristics of the young athlete: a longitudinal look. Kinesiology Review., AAHPER, Washington D.C. pp. 33-42.

Clauser C.E., Tucker P.E., McConville J.T., Churchill E., Laubach L.L. and Reardon J.A. (1972). Anthropometry of Air Force Women. AMRL - TR - 70 - 5. U.S. Air Force.

Clegg E.J., Parson I.G., Ashton E.H. and Flinn R.M. (1972). The growth of children at different altitudes in Ethiopia. Philisophical Transactions of the Royal Society of London. Series B Biological Sciences. 264:403-437.

Coan R.W. (1966). Child Personality and Developmental Psychology In: Handbook of Multivariate Experimental Psychology. Cattell R.B. (Ed). Rand, McNally and Co. Chicago.

Committee report: (1972). The Creation of Growth Standards. Amer. J. Clin. Nutrition. 25:218-210.

Condivi, A., The Life of Michelangelo. (1976). Louisiana State University Press.

Correnti V. and Zauli B. (1964). Olympionici 1960. Marves. Roma, Italy.

Corroll V.A. Personal communication. 1978.

Corroll V.A. and Dunfield J. (1973). Manitoba 'Fit for 70' height and weight norms. Physcial Education Branch, Manitoba Department of Education. Winnipeg, Manitoba.

Cumming G.R. (1976). The child in sport and physical activity - medical assesment. In: Child in Sport and Physical Activity. J.G. Albinson and G.M. Andrew (Eds). pp. 67-77. University Park Press Baltimore.

Cureton T.K. (1951). Phsycial Fitness of Champion Athletes. University of Illinois Press. Urbana, Ill.

Damon A. (1968). Secular trend in height and weight within old American families at Harvard, 1870-1965. Amer. J. Phys. Anthropol. 29(1):45-50.

Damon A. (1974). Larger body size and earlier menarche: The secular end may be in sight. Soc. Biol. 21(1):8-11.

Davenport C.B. (1927). Guide to Physical Anthropometry and Anthroscopy. Eugenics Research Association, Handbook Series, Cold Spring. Harbor, N.Y.

DeGaray A.L., Levine I. and Carter J.E.L. (Eds), (1974). Genetic and Anthropolagical Studies of Olympic Athletes. Academic Press. N.Y.

Dermirjian, A., Jenicek M. and Dubuc M.B. (1972). Les nommes statunc pendirales de l'enfant urbain Canadien Francais d'age scolaire. Canadian J. of Public Health. 63:14-30.

De Wijn J.F. (1968). Parameters of changing metabolism during growth from age 8 to 18, related to physique and body-composition. Acta Paedopsychiat. 35:301-317.

Douglas J.W.B., Ross J.M. and Simpson H.R. (1965). The relation between height and measured educational obesity in school children of the same social class, family size and stage of sexual development. Human Biology. 37:178-156.

Duquet W., Demeulenaere F. and Borms J. A method of detecting errors in data of growth studies. A paper presented at the fourth "Motor Development" symposium, May 1977, Darmstadt, Germany

Eiben O.G., Christensen W., Faulkner R.A. and Ross W.D. (1976). proportionality characteristics of female athletes. Anthropol. Kozl. 20:55-67.

Epstein, and Epstein,. Relationship between brain-weight and head circumference from birth to age 18 years. (1978). American J. Phy. Anthropl. 48(4);471-473.

Espenschade, E.A. Moter performance in Adolescence. (1940). Monog. Soc. His Child. Dev. No 24.

Faulkner R.A. (1976). Physique characteristics of Canadian figure skaters. Unpublished masters thesis, Simon Frazer University. B.C.

Furusho T. (1974). An estimate of the number of gene loci respons- ible for stature in the growth period. Jap. J. Human Genetics. 18(4):311-355.

Ganguly P. (1974). Variation in physique in North India in relation to urbanization and economic status. Bull. et Mem. De La Soc D'An- throp. De Paris. Series x111:3-43.

Garn S.M. (1972). The measurment of obesity. Biology of Food and Nutrition. 1:333-335.

Garn S.M., Clark D.C. and Guire K.E. (1974). Level of fatness and size attainment. Amer. J. Phys. Anthrop. 40:447-450.

Ghani A.R., Verma I.C., Ghai C.P. and Seth V. (1971). Physical growth of school children in Delphi. Indian J. of Paediatrics. 38(286):411-423.

Greulich W.W. (1976). A comparison of the physical growth and development of american born and native Japanese children. Amer. J. Phys. Anthropol. 45(3):553-568.

Greulich W.W., Crismon C.S. and Turner M.L. (1953). The physical growth and development of children who survived the atomic bombing of Hiroshima or Nagasaki. J. of Pediatrics. 43(2):121-145.

Habicht J.P., Martcrell R., Varbrough C., Malina R.M. and Klein R.E. (1974). Height and weight standards for preschool children. How relevent are ethnic differences in growth potential. Lancet 34(1):611-615.

Hamill P.V.V. (1977). National Centre for Health Statistics: Growth curves for children. U.S. Department of Health, Education, and Welfare. DHEW Publication : (PHS) 78-1650.

Harkness M. (1971). A comparison of early and late maturing 12 year old girls. N.Z. Dent. J. 6.

Harnett J.J., Bailey K.G. and Hartley C.S. (1977). Body height, position, and sex as determinants of personal space. J. of Psychology 87(May):129-136.

Hirata K. (1966). Physique and age of Tokyo Olympic champions. J. of Sports Med. and Phys. Fitness. 6:207-222.

Hrdlicka A. (1952). Practical Anthropometry. 4th ed Philadelphia, Wistar Institutes of Anatomy and Biology.

Hulse F.S. (1963). The Human Species. Random House N.Y.

Irwig L.M. (1976). Surveillance and in developed countries with particular reference to child growth. International J. of Epidemology. 5:57-61.

Jenicek M. and Dermirjain A. (1972). Triceps and subscapular skin- fold thickness in French - Canadian school-age children in Monteral. Amer. J. Clin. Nutrition. 25(June):576-581.

Jokl E., Frucht A.H., Karvon M.J., Seaton D.C., Simon E. and Jokl P. (1966). Sports Medicine. Ann. N.Y. Acad. Sci. 134:908-937

Jordan J., Ruben M., Hernandez J., Bebelagua A., Tanner J.M. and Goldstien H. (1975). The 1972 Cuban national child growth study as an example of population health monitoring : Design and methods. Annals of Human Biology. 2(2):153-171.

Karlberg P., Taranger J., Engstrom T., Lichtenstein H. and Svennberg -Redegcen T. (1976). The somatic development of children in a Swedish urban community. A prospective longitudinal study. Acta Paediatrica Scand. Suppl. 258.

Ketcham W.A. (1960). Relationship of physical traits and mental traits in intellectually gifted and mentally retarded boys. Merrill- Palmer Quarterly. 6(5):171-177.

Klugh H.E. (1970). Statistics : The Essentials for Research. John Wiley and Son, Inc. N.Y.

Kohlraush N. (1929). As cited on page 1 in: The Physique of the Olympic Athelete. J.M. Tanner. (1964). George Allen and Unwin Ltd. London.

Kralj - Cercek, L. The influence of food, body build and social origin on the age of menarche. (1956). Hum. Biol. 28:406.

Krogman W.M. (1955). Biological growth as it may affect pupil's sucess. Merrill-Palmer Quarterly.

Lundman B. (1972). Anthropological, sociological and psychological investigations of Swedish school children. Mankind Quarterly. 12(4):189-212.

Lavelle C.L.B. (1972). Secular trends of the face and stature. Angle Orthod. 42(3):221-226.

Le Veau B., Ward T. and Nelson R.C. (1974). Body dimensions of Japanese and American Gymnasts. Med. Sci. Sports. 6(2): 146-160.

Lowenstein F.W. and O'Connell D.E. (1974). Selected body measur- ments in boys ages 6-11 years from six villages in Southern Tunisia: An International Comparison. Human Biology. 46(3):471-482.

McNeil, D. and Livson, N. (1963). Maturation rate and body build in Women. Child. Devel. 34:25-32

Mala H. (1973). Anthroplogy of Gypsy school-youth in Czec Folia Morphologica. 21(3):311-313.

Malina R.M. (1972). Comparison of the increase in body size between 1899 and 1970 in a specially selected group with that in the general population. Amer. J. Phys. Anthrop. 37:135-142.

Malina R.M. (1969). Growth and physical performance of Amercian negro and white children. Clin. Pediatr. 8:476-483.

Malina R.M. (1975). Anthropometric correlates of strength and motor performance. Ex. and Sports Science Review. 3.

Malina R.M. and Johnston F.E. (1967). Relations between bone, muscle and fat widths in the upper arms and calves of boys and girls studied cross sectionally at ages 6 to 16 years. Human Biology. 39(3):211-233.

Malina R.M., Harper A.B. and Holman J.D. (1970). Growth status and performance relative to parental size. R.Q. 41:503.

Malina R.M. and Rarick G.L. (1973). Growth, physique and motor performance. In: Physical Activity : Human Growth and Development. G.L. Raweh (Ed). Academic Press. N.Y. pp. 125-153.

Marshall W.A. (1971). Cross sectional anthropometric studies. Developmental Medicine and Child Neurology. 13:804-806.

Martin, R. and Saller, K., (1959). Lehrbuch der Anthroplogie. Band 2. Gustav Fischer, Stuttgart.

Massler M. and Suher T. (1951). Calculation of "normal" weight in children. Child Development. 22:75-94.

Meredith H.V. (1976). Findings from Asia, Australia, Europe and North America on secular change in mean height of children, youths and young adults. Amer. J. Phys. Anthropol. 44(2):315-326.

Montagu M.F. Ashley. (1960). A Handbook of Anthropometry. C.C. Thomas, Springfield. Ill.

Mueller W.H. and Titcomb M. (1977). Genetic and environmental determinants of growth of school age children in a rural Columbian population. Annals of Human Biology. 4(1):1-15.

Nellhaus G. (1968). Head circumference from birth to eighteen years. Pediatrics. 41(1):106-114.

Newton, D. (1967). New Guinea Art in the Collection of the Museau of Primitive Art. Publishers Printing Admiral Press, N.Y.

Nie, N.H., Hull, C., Jenkins, J.G., Stenbrunner, A., Bent, D.H., SPSS; (1975). Statistical package for the Social Sciences 2/e McGraw-Hill N.Y.

Olivier Georges. (1969). Practical Anthropology. C.C. Thomas, Springfield. Illinois.

Osbourne R.H. and DeGeorge F.V. (1959). Genetic Basis of Morphological Variation. Harvard University Press. Cambridge, Mass.

Owen G.M. (1973). The assessment and recording of measurments of growth of children. Pediatrics. 51:461.

Parizkova J. (1968). Longitudinal study of the development of body composition and body build in boys of various physical activity. Human Biology. 40:212-225.

Parizkova, J. (1973). Body composition and exercise. In Physical Activity: Human Growth and Development. G. L. Rarick (ed) Academic Press. N. Y.

Parizkova J. (1974). Particularities of lean body mass and fat development in growing boys as related to their motor activity. Acta Paediatrica Belgica. 28(suppl):233-243.

Parnell, R.W. (1958) Behaviour and Physique. An Introduction to Practical and Applied Somatometry. Arnold. London.

Pett L.B. and Ogilvie G.F. (1956). The Canadian weight - height survey. Human Biology. 28:177-188.

Prader A. and Budliger H. (1977). Body measurements, growth velocity and bone age of healthy children up to 12 years old. Helvetica Paediatrica Acta. Suppl 37:5-45.

Pryor H.B. (1966). Charts of normal body measurements and revised width - height tables in graphic form. J. Pediatrics. 68(4): 615-631.

Rarick, G.L. (1960). In : Science and Medicine of Exercise and Sports. Johnson, W.R. (ed) Harper-Row, N.Y.

Rarick, G.L. (1973). Competetive sports in childhood. In Physical Activity : Human Growth and Development. Rarick, G. L. (ed) Academic Press, N. Y.

Rarick G.L. (1974). Exercise and growth. In: Science and Medicine of Exercise and Sport. 2 ed. Johnson W.R. and Busbirk E.R. (Eds). Harper and Row, N.Y. pp. 206-321.

Roberts D.F. (1962). Body weight, race and climate. Am. J. Phys. Anthrop. 11:533-558.

Rode A. and Shephard R.J. (1973). Growth, development and fitness of the Canadian Eskimos. Medicine and Science in Sports. 5(3):161-169.

Rona R. J. and Altman D.G. (1977). National study of health and growth; standards of attained height, weight and triceps skinfold in English children 5 to 11 years old.

Ross W.D., (1975). A parallax - correcting stadiometer. Int. Symp. on Pediatric Work Physiology.

Ross W.D., Bailey, D.A., and Weese, C.H., (1975). Proportionality in interpretation of longitudinal metabolic function data on boys. Int. Symp. on Ped. Work Physiol. Trois Rivieres, Canada.

Ross W.D., Brown S.R., Faulkner R.A. and Savage M.V. (1976). Age of menarche of elite Canadian skaters and skiers. Can. J. App. Sports Science. 1(4):288.

Ross W.D. and Wilson N.C. (1974). A stratagem for proportional growth assessment. Acta Peadiatrica Belgica. Suppl 28:169-182.

Ross W.D., Brown S.R., Hebbelinck M. and Faulkner R.A. Kinanthropometry terminology and landmarks. In: Physical Fitness Assessment. Shephard R.J. and Laueiller H. (Eds). C.C. Thomas. Springfield, Illinois. (1977).

Ross W.D., Drinkwater D.T., Bailey D.A., Marshall G.W. and Leahy R. (1978). Kinanthropometry : Traditions and New Perspectives. Paper delivered at the IInd International Seminar on Kinanthropometry. July 10-13th, Leuven, Belgium.

Ruiz L., Colley J.R.T. and Hamilton P.J.S. (1971). Measurments of triceps skinfold thickness and investigation of scurces of variation. Br. J. of Preventive and Social Medicine. 25:165-167.

Schaie W.K. (1965). A general model for the study of developmental problems. Psychol. Bull. 64:92-107.

Seliger V. and Bartunek Z. (Eds). (1976). Mean Values of Various Indices of Physical Fitness in the Investigation of Czechoslovak Population Aged 12-55 Years. CSTV Praha, (CSSR).

Seltzer C.C. and Mayer J. (1965). A simple criterion of obesity. Postgrad. Med. 38:A101-A107.

Simon (1961). Morpholcgcal and Functional Development in Physical Education. In: Health and Fitness in th Modern World. Larson. Athletic Institute. Chicago, Illinois. pp. 31-41.

Simons J., Beunen G. and Reuson R. (1974). The Louvain Boys Growth Study. (Preliminary Report). Katholieke Universitat te Leuven, Departement Lichamecijke Opvoeding.

Skerlj, B.J., Brozek, J., Hunt, J., (1953). Subcutaneous fat and age changes in body build and body form in women. Am. J. Physical Anthropology. 11:577-600.

Sloan A.W. (1967). Estimation of body fat in young men. J. Appl. Physiol. 23:311-315.

Slotkin J.S. (Ed). (1965). Readings in Early Anthropology. Aldine Publishing Co. Chicago.

Smit P.J., Potgieter J.F. and Neser M.L. (1967). Sex, age and race variations in the body measurements of white, bantu, coloured and Indian children aged 7-15 years. S. A. Medical J. 41(April):422-426.

Stephenson J.N., Mellinger R.C. and Manson G. (1968). Cerebral gigantism. Pediatrics. 41(1):130-138.

Stuart H.C. and Meredith H.V. (1946). Use of body measurements in a school health program. Amer.J. Publ. Health. 36:1373.

Tan R.H., Guzman P.E. de., Lingao A.L., Rosario T.B. and del Curarderno F.C. (1974). Weight, height and arm skinfold measurements of high school students in metropolitan Manila. Phillipine J. of Nutrition. 27(1):27-33.

Tanner J.M. (1962). Growth at Adolescence. Blackwell Scientific Publications Ltd. Oxford.

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

Tanner J.M. (1976). Population differences in body size, shape and growth rate. A 1976 view. Archives of Disease in Childhood. 51:1-2.

Tanner J.M. and Whitehouse R.H. (1962). Standards for subcutaneous fat in British children. Br. Med. J. 11:446-450.

Tanner J.M., Hiernaux J. and Jarman S. Growth and physique studies. In: Human Biology: A guide to field methods. J.S.Weiner and J.A. Lourie (Eds). IBP Handbook #9, Philadelphia F.A. Davies Co. 1969.

Van'T Hof M.A. (1977). Some Statistical and Methodological Aspects in the Study of Growth and Development. Druk: Stichting Studentenpers Nijmeyen.

Vines R. (1977). Long and short. Medical J. of Australia. 1(15):534-536.

Walker R.N. (1963). Body build and behaviour in young children: II. Body build and parents ratings. Child Development. 34:1-23.

Weiner, J.S. Lourie, J.A., (ed) (1969). Human Biology. Blackwell Scientific Publications, Oxford.

Wingera J., Solcman I.L. and Schien. E.J. (1973). Parent specfic height standards for preadolescent children of racial/groups, with method for rapid determination. Pedeatrics. 52:555-560.

Wolanski N. (1974). The stature of offspring and the assortive mating of parents. Human Biology. 46(4):613-619.

Young H.B., Zcli, A., Gallagher, J.R., (1963). Events of puberty in ill Florentine girls. Am. J. Dis. Child. 106:320-322.