A STUDY OF INTER-DEVELOPMENTAL RELATIONSHIPS AMONG STANDING HEIGHT, SKELETAL AGE, AND MENTAL AGE FOR SIXTY-SIX BOYS SELECTED FROM THE HARVARD GROWTH DATA

by

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AN ABSTRACT

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The Problem

It was the purpose of this investigation to analyze longitudinal data for sixty-six school age boys with respect to growth in standing height, skeletal age, and mental age. The cases were selected from the Third Harvard Growth Study which was inaugurated in 1922 in the Psycho-Educational Clinic of the Harvard Graduate School of Education. The data consisted of annual measurements in standing height, skeletal age, and mental age for the boys from approximately seven through seventeen years of age, and were representative of those taken from a normally distributed population.

Specifically, the study attempted to determine (1) growth relationships among the three aspects of development with respect to beginning and end points of adolescent development; (2) other developmental relationships such as those inherent in growth constants of rate, incipiency, and maximum; and (3) correlative relationships of timing aspects of physical and mental growth of school-age boys.

Methods and Procedure

The determination of points of cycle break for each of the sixty-six cases in each developmental measurement was made by the utilization of normal probability paper. Using the points thus obtained, the Courtis technique for analysis of growth was then applied to each case to determine cycle growth constants of rate, incipiency, and

maximum. The use of the formula made it possible to reduce all variables to common maturation units known as isochrons, which could then be used to determine correlation coefficients among the three aspects of development. Coefficients of correlation were obtained by the use of the Pearson r formula.

Summary and Conclusions

The Courtis technique, which utilizes the Gompertz equation, was found to describe growth patterns of the sixty-six boys in standing height, skeletal age, and mental age with better than ninety-five per cent efficiency.

Correlation coefficients were computed among the cycle growth constants of maxima, rates, and incipiencies as well as times of occurrence of cycle break, time of ninety-nine per cent of achieved adult maturity, and per cents of development of first cycle maxima and adult maxima at the time of cycle break. Mean annual increments were also compared to determine the degree of relationship in patterns of growth in physical and mental aspects of development among the sixty-six boys.

The pattern of growth for each of the boys was that of a two-cycle curve in standing height, skeletal age, and mental age, with the cycle breaks occurring between mean ages of ten and twelve years.

Correlation coefficients between equation constants of rate, incipiency, and maximum were not statistically significant.

Correlation coefficients between times at which cycle breaks occurred were positive but too low to be stated as reliably significant.

Growth is so variable from one individual to another, and from cycle to cycle, that a comparison of equation constants within a given cycle (because they are dependent upon each other) does not provide a sufficient basis on which to compare growth relationships.

Significant relationships between physical and mental aspects of growth of the boys were revealed when all equation constants were analyzed as a composite whole. The correlation between all aspects of growth was positively significant when mean annual increments obtained from equation constants were compared.

The use of a multi-cyclic regression equation for describing growth of the boys in standing height, skeletal age, and mental age predicted growth with good efficiency, provided a means of smoothing the growth curves and tended to reduce testing errors.

The degree to which ethnic and cultural influences affected the growth patterns of the sixty-six boys was not known. However, for these sixty-six boys who lived in the vicinity of Boston, patterns of growth in standing height, skeletal age, and mental age were significantly related as indicated above.

Correlation coefficients between and among the mean annual increments of the sixty-six boys were much higher than those obtained in previous studies where growth aspects were analyzed on a cross-sectional basis.

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CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS USED

Testimony to the fact that man has long been seeking to discover the mysteries of growth among his own species is borne out in the voluminous literature to be found. Many of the early studies which dealt with aspects of growth in the human organism were cross-sectional in nature, and in their quest to find the "normal" person they actually obscured traits of growth within the individual.[1] It is to Gueneau de Montbeillard[2,3] that present day investigators are indebted for his pioneering work (1759-1776) in the individual method of analyzing growth data, which today has come to be known as the "longitudinal" method of studying human growth and development. Since Montbeillard's time, data collecting methods have improved vastly, new techniques of growth analysis have been continuously applied, and the

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[1]Franz Boas, "Observations on the Growth of Children," Science, LXXI (July, 1930), pp. 44-48.

[2]R. E. Scammon, "The First Scriatim Study of Human Growth," American Journal of Physical Anthropology, X, No. 3 (1927), p. 333.

[3]Count de Buffon, "Sur l'accroissement successif des enfants, Gueneau de Montbeillard mesure de 1759 a 1776," Oeuvres Completes, Paris: Furne and Pie, 1873, Vol. III, 174-176.

search for the answer to the nature of human growth has come more and more into a science of its own.

I. THE PROBLEM

Statement of the Problem

It was the purpose of this investigation to analyze longitudinal data for sixty-six boys of school age with respect to growth in standing height, mental age, and skeletal age. The sixty-six cases were selected from the Third Harvard Growth Study which was inaugurated in 1922 in the Psycho-Educational Clinic of the Harvard Graduate School of Education.[4] The major problem was to determine growth relationships in the three aspects of development with respect to beginning and end points of adolescent development.

Statement of Hypotheses

The statement of the major purpose led to the formulation of four major hypotheses. The hypotheses were (1) that growth is multi-cyclic in nature, and that two major cycles of growth would be evident from the data which were analyzed, inasmuch as no data were available for the early childhood cycle; (2) that the use of suitable statistical tests would reveal positive correlative relationships among

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[4]W. F. Dearborn, J. W. Rothney, and F. K. Shuttleworth, "Data on the Mental and Physical Growth of Children," _Monographs of the Society for Research in Child Development_, III, No. I (1938), pp. 1-136.

the three aspects of development, i.e., standing height, mental age, and skeletal age; (3) that physical aspects of growth in the individual show relationships to the mental growth data; and (4) that the correlation among the three aspects of development at the time when the adolescent cycle of growth begins would be positively significant.

Secondary Problems

In the analysis of longitudinal data for the purpose of investigating related aspects of growth at beginning and end points of adolescent development, a number of pertinent secondary problems arose. Such problems, which may be regarded as essential to the investigation of the major problem, included (1) the selection of a suitable mathematical formula which would reduce the observed measurements to common units which could then be used for comparative purposes; (2) the consideration of other growth variables which may be compared in order to investigate growth relationships, such as extra- and intra-growth relationships among the growth constants, represented by rates of growth within cycles of development, and beginning and end points of cycles; and (3) the consideration of ethnic and cultural influences upon growth and development.

II. IMPORTANCE OF THE STUDY

The fundamental tenets which underly this study and influence its approach, its method, and its recommendation should be pointed out as having profound implications for those who are concerned with the nature of human growth and development and for education and learning. The need for such research and the value of the longitudinal approach to the study of human growth and development was recognized by Boas. He stated that:

> The general growth curve of man has long been known, but we have little evidence in regard to the growth of individuals who ultimately reach various statures. For this purpose it is necessary to follow the individual growth from childhood to the adult stage. Some material of this kind has been collected but not enough to give adequate insight into the phenomena.[5]

Adkins noted the importance of using results of longitudinal research for increased understanding of child growth and development when she stated that:

> Although the "wholeness" of each child, in its developmental aspects is best revealed by individual case studies, the fact remains that if no generalizations can be extracted from such records they cannot have the greatest of practical scientific value.[6]

Probably the first investigator to provide conclusive evidence to the effect that cross-sectional studies do not produce the same results as longitudinal studies was Stewart, whose pioneering efforts were reported in 1916.[7]

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[5]Franz Boas, "Studies in Growth," A Journal of Human Biology, IV (1932), p. 307.

[6]Margaret M. Adkins, et al, "Physique, Personality and Scholarship," Monographs of the Society for Research in Child Development, VIII (1943), p. 5.

[7]S. F. Stewart, "Physical Growth and School Standing of Boys," Journal of Educational Psychology, VII (1916), pp. 414-426.

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Subsequent investigations by other researchers have lent substance to Stewart's findings.[8,9,10,11] This investigation was designed with the purpose of providing another link in the chain of longitudinal investigations which have been cited as providing a more adequate basis on which to evaluate the growing organism as a dynamic whole. It is neither the process nor the cold facts of growth relationships which lend value to such a study, however, but rather the implications of the findings for increased understanding of the "whole" child. Courtis has made a significant statement in this regard:

> The most recent book on Educational Measurement (American Council on Education, 1951) in its 819 pages gives ample proof that measurement gets one nowhere in education; that the dry rot of meaningless juggling of statistical symbols has taken the place of critical thinking and productive experiment.[12]

In a society in which more and more emphasis is being placed upon the guidance of individuals for the utilization

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[8]Ethel Abernethy, "Relationships Between Mental and Physical Growth," Monographs of the Society for Research in Child Development, I, No. 7 (1936), pp. 66-70.

[9]H. Gray and T. G. Ayres, Growth in Private School Children (Chicago: University of Chicago Press, 1931).

[10]H. Gray and A. M. Walker, "Length and Weight," American Journal of Physical Anthropology, IV (1921), pp. 231-238.

[11]Arthur R. DeLong, "The Relative Usefulness of Longitudinal and Cross-Sectional Data," Paper presented at a meeting of the Michigan Academy of Science, Arts, and Letters, March 26, 1955.

[12]S. A. Courtis, Toward a Science of Education (Ann Arbor, Michigan: Edwards Bros., 1951).

of potential abilities to the highest possible degree, it seems essential that those who hold the responsibility for such guidance be apprised of all possible knowledge of the nature of growth of the individual in order to perform the task efficiently. With this purpose in mind this investigation was undertaken.

III. LIMITATIONS OF THE STUDY

The greatest single limitation of a longitudinal study of this type lies in the fact that the collection of longitudinal data is necessarily so time consuming that often more precise methods of data collection are discovered before any analysis can take place. This is a weakness in the case of the skeletal age measurements. At the time that the Harvard Growth data were collected, the best available standards for the assessment of skeletal age were those which had been presented by Todd[13] and which he later published in his Atlas of Skeletal Maturation (Hand).[14] Until 1950, his Atlas and the radio-graphic standards of Flory[15] were the only scales available for the assessment

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[13] W. F. Dearborn, et al, op. cit., p. 9.

[14] T. Wingate Todd, Atlas of Skeletal Maturation (Hand) (St. Louis: C. V. Mosby Company, 1937).

[15] Charles D. Flory, "Osseous Development in the Hand as an Index of Skeletal Development," Monographs of the Society for Research in Child Development, I, No. 3 (1936).

of the skeletal age of a child during the entire postnatal osseous stage as based upon sequence of appearance of the intermediate skeletal maturity indicators of bones.[16] Since 1950, three additional standards have been published.[17] A more detailed report of the study by Pyle as to the effect of the difference in standards in interpreting skeletal age of infants will be included in Chapter II of this thesis. It is sufficient to note here that current research has raised serious questions in reference to earlier studies dealing with the assessment of skeletal age.

Time is a factor not only in the collection of the data, but also in the analysis of each case. Because of this, often too few cases are selected to make it possible to subject the data to parametric statistical analysis. It is for this reason that the Harvard Growth data represents probably the most complete set of longitudinal data on school age children which is currently available.

IV. DEFINITION OF TERMS

Growth

The term growth, as used throughout this thesis, shall refer to a phase of the total development of the organism.

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[16] S. Idell Pyle, "Effect of the Difference in Standards in Interpreting Skeletal Age of Infants," Merrill-Palmer Quarterly, IV, No. 2 (Winter, 1958), p. 75.

[17] Ibid.

Development

The term <u>development</u> will be used to describe the general organization of the individual and organismic change in the total organism.

Growth Curve

The <u>growth curve</u> for the individual represents the total pattern of development in a given trait or in total organismic structure.

Growth Cycle

A <u>growth cycle</u> is the representative growth curve for a given trait within a given developmental period.

Organismic Growth

The concept of <u>organismic growth</u>, as used in this paper, holds that the human individual is a biological organism whose growth takes place as a complex organismic whole and not as segmented parts.

Rate

<u>Rate</u> refers to the increment of growth in a particular aspect of development. It is variable from individual to individual and from one stage or cycle of development to another.

Incipiency

<u>Incipiency</u> represents the beginning point of growth in a given developmental aspect, within a given growth cycle.

Maximum

The term maximum refers to the maturity point toward which an individual is growing in a given trait in a given cycle of growth. The term is also used to indicate the maturity points of total development of a given trait.

Isochron

Isochron is the name given to the lolog value of a per cent of total development in a given aspect of growth. A more detailed discussion of the isochron as a maturation unit will be presented in Chapter III, Section II, which deals with methodology.

Growth Constant

A growth constant represents a variable which characterizes the elements by which growth may be analyzed. The three constants involved in the Courtis technique, using the Gompertz equation, are: incipiency, rate, and maximum.

Courtis Technique

The Courtis technique is a method of growth analysis which was devised by S. A. Courtis[18] and utilizes the Gompertz formula for describing a simplex growth curve.

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[18] S. A. Courtis, "Maturation Units for the Measurement of Growth," School and Society, XXX (1929), pp. 683-690.

CHAPTER II

REVIEW OF THE LITERATURE

Extensive research into the related aspects of various growth processes of the child has been reported in the research literature pertaining to child growth and development. Several authors have presented exhaustive reviews of the literature at various times.[1,2,3,4] Comprehensive bibliographies have also been compiled.[5,6] Scammon noted

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[1] Richard E. Scammon, "The Literature of the Growth and Physical Development of the Fetus, Infant, and Child: A Quantitative Summary," Anatomical Records (1927), pp. 241-267.

[2] Howard V. Meredith, "Physical Growth of White Children: A Review of American Research Prior to 1900," Monographs of the Society for Research in Child Development, I, No.2 (1936).

[3] Review of Educational Research. Vol. III (April,1933); Vol. VI (February, 1936); Vol. IX (February, 1939); Vol. X (Dec. 1941); Vol. XIV (Dec. 1944); Vol. XX (Dec. 1950); Vol. XXII (Dec. 1952); and Vol. XXVI (June, 1956).

[4] Wilton M. Krogman, "The Physical Growth of Children: An Appraisal of Studies 1950-1955," Monographs of the Society for Research in Child Development, XX, Serial No. 60, No. 1 (1955).

[5] Children's Bureau of the United States Department of Labor, References on the Physical Growth and Development of the Normal Child, 1927, No. 179.

[6] Bird T. Baldwin, "Physical Growth of Children from Birth to Maturity," University of Iowa Studies in Child Welfare, I, No. 1 (1921).

that "the research literature pertaining to human physical growth is literally voluminous."[7] The present review will, therefore, confine itself to a sampling of the studies pertinent to the problem.

Anthropometric Studies

Much of the early anthropometric research was of a cross-sectional nature and revealed little information as to the individual nature of growth. Baldwin reports, however, that,

> as early as 1700 Sir Joshua Reynolds called attention, in an address delivered before the Royal Academy of Fine Arts, to the differences in the measurements of the human form from childhood to adult life. But it was to M. Quetelet, who coined the word anthropometry, that credit should be given for the first scientific study of physical growth in 1836.[8]

Longitudinal Data

In 1873 Buffon[9] reported the studies of Geneau de Montbeillard which were actually the first records of a longitudinal study as it is known today.

In America, Dickson[10] is credited with having been the first person to collect anthropometric data on children.

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[7]R. E. Scammon, *op. cit.*

[8]Bird T. Baldwin, "Physical Growth and School Progress," Bulletin 10, United States Bureau of Education, Washington, D. C., 1941, p. 142.

[9]Buffon, *op. cit.*

[10]Samuel Henry Dickson, "Some Additional Statistics of Height and Weight," *Charleston Medical Journal and Review*, XIII, No. 4 (1858).

Although the data which he collected and reported in 1858 were analyzed cross-sectionally, it is of significance to describe here since it represented a pioneering effort in collection and analysis.

The first American study employing the longitudinal method was that undertaken by the Harvard Medical School and reported by Bowditch.[11] In his 1872 report, he exhibited a diagram showing the rate of growth in height in the two sexes. The curves of growth in height and the abscisses gave the age in years and the ordinates in height in feet and inches. These curves represented the average measurements of thirteen girls and twelve boys. He reports that:

> An examination of the curves shows the following facts:
> 1. Growth is most rapid during the early years of life.
> 2. During the first twelve years boys are from one to two inches taller than girls of the same age.
> 3. At about twelve and a half years of age girls begin to grow faster than boys and during the fourteenth year are about one inch taller than boys of the same age.
> 4. At fourteen and a half years of age boys again become taller, girls having at this period nearly completed their growth, while boys continue to grow rapidly till nineteen years of age.[12]

This report represented the first of many later studies reported by Bowditch. In 1877 he reported a study, the purpose of which was "to determine the rate of growth of the

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[11] H. P. Bowditch, "Comparative Rate of Growth in the Two Sexes," Boston Medical and Surgical Journal, X (1872), pp. 434-435.

[12] Ibid.

human race under the conditions which Boston represents."[13] The subjects were 24,595 Boston school children of both sexes, aged five to nineteen years. Stature was measured without shoes, body weight in ordinary clothing was recorded, and the nationality of the parents as well as the birth place of the children was reported.[14]

In a paper read at the thirty-second annual meeting of the American Medical Association in 1881,[15] he indicated further research in his pioneering efforts to analyze growth longitudinally. At that time Bowditch presented a graph showing the rate of growth of a girl between two and three years and the relationship between growth and disease.[16] It was obvious that Bowditch recognized the value of longitudinal records in determining growth relationships when he said:

> It must not be supposed that loss of weight in a growing child is in every instance a percursor of actual disease. The weight of a healthy child is liable to oscillations within limits which have yet

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[13]H. P. Bowditch, "The Growth of Children," Eighth Annual Report, Massachusetts State Board of Health (1877), 276.

[14]Ibid.

[15]H. P. Bowditch, "The Relation Between Growth and Disease," Transactions of the American Medical Association, XXXII (1881), 371-377.

[16]Ibid., p. 375.

> to be determined. It is only by systematic observations on an extensive scale that the real importance of this branch of preventive medicine can be ascertained.[17]

Following the example set by Bowditch, Peckham,[18] in 1881 reported a study of Milwaukee school children in which he pointed out similarities in rate of growth to Bowditch's findings, but pointed out differences which may have been due to environment and ethnic origin. In 1882 he reported body weight means for young children based on measurements of one hundred boys and one hundred twenty girls.[19]

An attempt to compare the rate of growth of normal and feeble-minded children was reported by Tarbell[20] in 1883. In this report he concluded that growth of the two sexes of feeble-minded children follows a similar course to that of the two sexes of public school children except that the adolescent acceleration is delayed about two

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[17] Ibid., p. 376.

[18] George W. Peckham, "The Growth of Children," Sixth Annual Report, State Board of Health of Wisconsin (1881), pp. lxxiv-146.

[19] George W. Peckham, "Various Observations on Growth," Seventh Annual Report, State Board of Health of Wisconsin, Public Document No. 14 (1882), 185-188.

[20] G. G. Tarbell, "On the Height, Weight and Relative Rate of Growth of Normal and Feeble-Minded Children," Proceedings of the Association of Medical Officers of American Institutions of Idiotic and Feeble-Minded Persons, Philadelphia, Pa.: Lippincott (1883), 188-189.

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years.[21] Thus, Tarbell, at this early date implied the relationship between patterns of physical and mental growth. It is significant that this first American study of the physical growth of feeble-minded children contributed its findings with the caution that they "may be proved to be erroneous by a larger number of observations."[22]

Several of the early studies noted the difference in patterns of growth in the two sexes, as well as evidence which pointed to the "adolescent spurt" which today's researchers recognize as the adolescent cycle of growth.[23,24,25] Stephenson noted that, "the well-marked retardation of growth in the ninth and eleventh years is a fact to which attention has not previously been drawn, but will doubtless be found to have important clinical bearings."[26] Bowditch noted that the growth curves showed marked differences between

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[21] *Ibid.*, p. 188. [22] *Ibid.*, p. 189.

[23] William Stephenson, "On the Rate of Growth in Children," Translated from International Medical Congress Ninth Session, Washington, III (1887), 446-452.

[24] H. P. Bowditch, "The Growth of Children, Studies by Galton's Method of Percentile Grades," *Twenty-Second Annual Report, State Board of Health of Massachusetts*, Public Document No. 34 (1891), 479-522.

[25] L. M. Greenwood, "Heights and Weights of Children," *Twentieth Annual Report of the Board of Education of the Kansas City Public Schools, Kansas City, Missouri, 1890-1891*, Kansas City, Missouri: Electric Printing Co., 1891.

[26] Stephenson, *op. cit.*, p. 452.

sexes at the adolescent period, but were found to be similar for each measurement on a given sex.[27] Greenwood found that for all groups studied, girls exceeded boys in both stature and weight at thirteen and fourteen years, further evidence of the "adolescent spurt."[28]

Another of the pioneers in studying growth longitudinally was Franz Boas. In 1892, commenting on the value of longitudinal data for the study of physical and mental growth, he observed that:

> In order to carry out such a plan, it would be necessary to organize a bureau with sufficient clerical help to carry on the work. The questions underlying physical and mental growth are of fundamental importance for hygiene and education, and we hope the time may not be far distant when a work of this character can be undertaken.[29]

Mental Growth

Thus the search for understanding growth of the human individual was launched, by pioneers who were primarily interested in anthropometric measurements. The turn of the century found psychologists and educators becoming more and more interested in the mental growth of the child, and in particular, the relationships of physical and mental traits.

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[27]Bowditch, "The Growth of Children Studied by Galton's Method of Percentile Grades," op. cit.

[28]Greenwood, op. cit.

[29]Franz Boas, "Growth of Children," Science, XX:516 (1892), 351-352.

Conventional correlation techniques applied to mental and physical traits revealed positive but low relationships. Whipple, in 1914, reported that:

> The apparent correlation between height and mental ability raises an important question which reappears whenever we discuss the correlation between any physical trait, e.g., weight, strength, vital capacity, etc., and mental ability. The trend of evidence is to the effect that all such correlations, where found, are largely explicable as phenomena of growth, i.e., as correlations with relative maturity. . . . This makes intelligible the fact that, in general, the positiveness of all such correlations lessens with age, and that many of them, indeed, become difficult or impossible of demonstration in adults.[30]

Credited as the pioneer investigator of the relationships between intelligence of school children and indices of physical growth, however, was Porter,[31] who in 1893, reported the first investigation of this sort.

Baldwin,[32] in 1914, described his work as the "first attempt to follow consecutively some groups of children through the elementary and high school, either in physical growth and school standing or the relation of the two."

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[30]Guy Montrose Whiplle, Manual of Mental and Physical Tests, Part I (Baltimore: Warwick and York, 1914), p. 71.

[31]William Townsend Porter, "The Physical Basis of Precocity and Dullness," Transactions of the Academy of Sci. of St. Louis, VI, No. 7 (1893), 161-181.

[32]Baldwin, "Physical Growth and School Progress," op. cit., p. 7.

The first height-weight norms to receive general attention in this country were those published by Wood in 1910.[33]

As more research was undertaken, others began to realize the value of the longitudinal approach and pointed out limitations of cross-sectional studies. One of the first to recognize that the pattern shown by averaging the growth of a group of children had little relationship to the pattern of individual growth was Stewart, who recorded some interesting conclusions in 1916.[34] He pointed out that:

> 1. When we consider averages of groups of the same age, the group one year ahead of the normal grade averages both heavier and taller than the group of the normal grade. In some cases the group one year below the normal average both heavier and taller than the group of the normal grade.
>
> 2. When individual curves and correlations are considered without reference to the size of the boy or to his stage of development, it is difficult to see any relation between physical growth and school standing.
>
> 3. When individual curves and correlations are considered, together with the size of the body at fourteen years of age and his stage of development, the following are suggested:
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>   a. Heavy or tall boys of early development rank better than light boys of early or medium development.

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[33]T. D. Wood, "Health Examination," Ninth Yearbook, National Society for the Study of Education, IX, Part I (1910), 34-25.

[34]S. F. Stewart, "Physical Growth and School Standing of Boys," Journal of Educational Psychology, VII (1916), 426.

b. Light boys of late development rank better than light boys of early or medium development. Short boys of late development do not rank high.

c. Boys of medium size or of medium period of development are hard to classify, though a majority of them appear to be doing school work of medium rank.[35]

Attempts to correlate measurements of mental capacity with those of physical growth have been numerous. Abernethy-- summarizes the studies by observing that the general conclusion indicates that mental and physical measurements of children are to some extent positively related.[36]

In 1920, Professor Frank N. Freeman protested the -- customary identification of mental maturity with superiority in intellectual capacity and stated that the only means of distinguishing between the leval of capacity which the individual will ultimately reach and the rate of maturing of that capacity is through repeated measurements up to maturity.[37]

As the search for relationships between mental and physical aspects of growth progressed, several investigators employed techniques which showed the growth curves of

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[35] Ibid.

[36] Ethel Abernethy, "Relationships Between Mental and Physical Growth," Monographs of the Society for Research in Child Development, I, No. 7 (1936), p. 1.

[37] Ibid., p. 2.

individuals in the two aspects of development and the relationship of mental and physical growth as a function of the total organism.[38,39,40,41] Stolz and Stolz in presenting a detailed case history of one boy showed the relationship between physical and social development.[42]

In 1955, Greenshields[43] presented some interesting data which raised another serious question as to the reliability of I Q. test scores when other aspects of growth are not considered, and pointed out that "it is of necessity . . . to know something of the individual's total development before adequate appraisal can be made in a specific area of growth."[44]

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[38]Bird T. Baldwin, "Relation Between Mental and Physical Growth," Journal of Educational Psychology, XIII (April, 1932), 193-203.

[39]Donald G. Paterson, Physique and Intellect (New York: The Century Co., 1930).

[40]Charles D. Flory, "The Physical Growth of Mentally Deficient Boys," Monographs of the Society for Research in Child Development, I, No. 6 (1936).

[41]W. F. Dearborn, J. W. M. Rothney, Predicting the Child's Development (Cambridge, Massachusetts: Sci-Art Publishers, Harvard Square, 1941).

[42]H. R. Stolz and L. M. Stolz, Somatic Development of Adolescent Boys (New York: Macmillan Co., 1951).

[43]C. M Greenshields, "The Relationship Between Consistent I.Q.Scores, Decreasing I.Q.Scores, and Reading Scores Compared on a Developmental Basis" (unpublished M.A. thesis, Michigan State University, East Lansing, Michigan, 1955).

[44]Ibid., p. 30.

Skeletal Maturation

Numerous studies have also been presented in the analysis of skeletal maturation. Probably the most complete set of skeletal growth standards up until 1950, was that presented by Todd.[45] He selected the hand and knee as points which are most stable as indices. An exact reproduction of the original roentgenograms permits a direct comparison between the standards and the roentgenograms to be assessed. Many other studies have revealed the nature of skeletal growth.[46,47,48,49,50,51,52] The very close

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[45] T. Wingate Todd, Atlas of Skeletal Maturation (Hand) op. cit.

[46] H. D. Stuart, P. Hill, and C. Shaw, "Growth of Bone, Muscle, and Overlying Tissues as Revealed by Studies of Roentgenograms of the Leg Area," Monographs of the Society for Research in Child Development, V, No.3 (1940), Serial 26.

[47] S. Idell Pyle and Camille Menino, "Observations on Estimating S eletal Age from the Todd and the Flory Bone Atlases," Child Development, X, No. 1 (March, 1939), 27-34.

[48] W. M. Krogman, W. W. Greulick, D. Wechsler, and S. M. Wishik, "The Concept of Maturity from the Anatomical, Physiological, and Psychological Point of View," Child Development, XXI (1950), 25-60.

[49] Vernette S. Vickers Harding, "Time Schedule for the Appearance of Fusion of a Secondary Accessory Center of Ossification of the Calcaneous," Child Development, XXIII, No. 3 (1952), 181-184.

[50] Charles D. Flory, "Osseous Development of the Hand as an Index of Skeletal Development," op. cit.

[51] Psyche Cattell, "Preliminary Report on the Measurement of Ossification of the Hand and Wrist," Human Biology, VI (1934), 454-471.

relationship between skeletal and sexual maturity has been amply demonstrated.[53,54,55] Seils[56] found, also, a slight relationship between skeletal maturity and motor performance.

Bailey, using the Todd standards for skeletal age norms, concluded that:

> It appears that growth in size is closely related to the maturing of the skeleton. As a given skeletal age we may say that a child has achieved a given proportion of his eventual adult body dimensions. Consequently, mature size can be predicted with fair accuracy if a child's present size and skeletal age are known.[57]

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[52]Bird T. Baldwin, "Physical Growth of Children from Birth to Maturity," op. cit.

[53]W. W. Greulich, "The Rationale of Assessing the Developmental Status of Children from Roentgenograms of the Hand and Wrist," Child Development, XX (1950), 33-34.

[54]Katherine Simmons, "The Brush Foundation Study of Child Growth and Development II--Physical Growth and Development," Monographs of the Society for Research in Child Development, IX, Serial No. 37 (1944), 1-87.

[55]Frank K. Shuttleworth, "Sexual Maturation and the Skeletal Growth of Girls Age Six to Nineteen," Monographs of the Society for Research in Child Development, III, No. 5, Serial No. 18 (1938).

[56]Leroy Seils, "The Relationship Between Measures of Physical Growth and Gross Motor Performance of Primary Grade School Children," Research Quarterly of the American Association of Health, XXII (May, 1941), 244-260.

[57]Nancy Bayley, "Skeletal Maturing in Adolescense as as Basis for Determining Percentage of Completed Growth," Child Development, XIV, No. 1 (1943), pp. 44-45.

These conclusions were further corroborated in a later study.[58]

In spite of the many scientific efforts to adequately assess the nature of skeletal maturity in the growing organism, much more research is still needed. In evaluating skeletal X-rays as indicators of skeletal maturity, Bailey, in 1940, noted that:

> Little is known as yet concerning individual differences in the pattern of skeletal maturation. The prediction of individual maturing . . . must wait upon the further study of longitudinal data.[59]

She concluded that:

> All clinical norms now available for skeletal development have the same defect as mental age scales, in that they are dependent on chronological age. This forces the average curve of growth into a straight line, failing to distinguish the period of rapid and slow development.[60]

Since 1950, however, three additional standards for the assessment of skeletal age have been published. They

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[58] Nancy Bayley, "Size and Body Build of Adolescents in Relation to Rate of Skeletal Maturing," Child Development, XIV, No. 2 (1943), 47-89.

[59] Nancy Bayley, "Skeletal X-Rays as Indicators of Maturity," Journal of Consulting Psychology, IV (1940), 72.

[60] Ibid., pp. 70-71.

are those of Greulich and Pyle,[61] Speijer,[62] and Mackay.[63] The different components of the scales of Todd, Flory, Greulich and Pyle, Speijer, and Mackay is pointed out by Pyle as being that of temporal spacing.[64] On this point she writes:

> In 1939, differences in the temporal spacing of the osseous features in the Flory and Todd standard were analyzed according to assessments of the films of the Fels Research Institute Children who were less than six years old. From that study and the present one it would seem necessary to include an analysis of the temporal spacing of the standards of reference used for population studies with the skeletal age assessments before conclusions about differences in calcification rates or skeletal ages of groups of children are made.[65]

Growth Analysis

Many analytical and mathematical methods have been employed to determine the nature of growth. The multicyclic nature of the human growth curve is a phenomenon of

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[61]W. W. Greulich and S. I. Pyle, Radiographic Atlas of Skeletal Development of the Hand and Wrist (Stanford, California: Stanford University Press, 1950).

[62]B. Speijer, Betekenis En. Bepaling Van De Skeleteeftyd (Leiden, Holland: A. W. Sijthoff's Uitgevers Moatschappij, 1950).

[63]D H. Mackay, "Skeletal Development in the Hand: A Study of Development in East African Children," Transactions, Royal Society of Tropical Medicine and Hygiene, 46:135 (1942).

[64]S. Idell Pyle, "Effect of the Difference in Standard's in Interpreting Skeletal Age of Infants," Merrill-Palmer Quarterly, IV, No. 2 (Winter, 1958), p. 86.

[65]Ibid., p.87.

[illegible]

[illegible]

growth which has challenged investigators during this century. Davenport pointed out that there is at least more than one cycle.[66] One of the earliest presentations of the cyclic pattern of growth was that of Scammon[67] in 1927. Using Montbeillard's data, he indicated that the growth curve showed four phases. The theory that growth shows a pattern of four phases was supported by Shuttleworth[68] and he demonstrated very striking differences in growth patterns of early and late maturing girls in aspects of physical growth.[69] the concept of a single cycle of growth was also challenged by Wallis,[70] Meredith,[71] Gray,[72] and Count.[73]

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[66] C. B. Davenport, "Human Growth Curve," loc. cit.

[67] R. E. Scammon, "The First Scriatim Study of Human Growth," op. cit.

[68] Frank K. Shuttleworth, "The Physical and Mental Growth of Girls and Boys Age Six to Nineteen in Relation to Age at Maximum Growth," Monographs of the Society for Research in Child Development, IV, No. 3 (1939).

[69] Frank K. Shuttleworth, "Sexual Maturation and the Physical Growth of Girls Age Six to Nineteen," Monographs of the Society for Research in Child Development, II, No. 5 (1937).

[70] Ruth Wallis, "How Children Grow," University of Iowa Studies in Child Welfare, V, No. 1 (1930).

[71] H. V. Meredith, "The Rhythm of Physical Growth," University of Iowa Studies in Child Welfare, XI (1935),1-128.

[72] Horace Gray, "Individual Growth Rates from Birth to Maturity for Fifteen Physical Traits," Human Biology, XIII (1941), 306-333.

[73] Earl W. Count, "Growth Patterns of the Human Physique--An Approach to Kinetic Anthropometry," Human Biology, XV (1943), 1-32.

The nature of growth curves was described by Freeman and Flory in 1937:

> These curves severally and jointly show, first, a slight acceleration in pre-adolescence, second a moderate decline in rate of growth beginning in early adolescence, and third, a continuance with very little further decline in rate to the end of the adolescent period, or nineteen or twenty years.[74]

A critical evaluation of current literature dealing with growth curves may be found by referring to Shock,[75] Tanner,[76] and Jensen.[77] Several equations have been utilized with the purpose of determining the cycles of growth. These include those of Pearl and Reed,[78] Huxley

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[74] Frank N. Freeman and Charles D. Flory, "Growth in Intellectual Ability as Measured by Repeated Tests," Monographs of the Society for Research in Child Development, II, No. 3, Serial No. 9 (1937), 88.

[75] Nathan S. Shock, "Growth Curves," in Handbook of Experimental Psychology, edited by S. S. Stevens (New York: Wiley and Sons, 1951), p. 336.

[76] J. M. Tanner, "Some Notes on the Reporting of Growth Data," Human Biology, XXIII (1951), 93-159.

[77] Kai Jensen, "Physical Growth," in Review of Educational Research, XXII (December, 1952), 391-420.

[78] R. Pearl and L. J. Reed, "Skew Growth Curves," Proceedings of the National Academy of Science, XI (1925), 16-22.

and Thissler,[79] Jenss and Bayley,[80,81] Davenport,[82] Gray,[83] and Courtis.[84] Other methods have also been presented. Burgess presented a height chart using percentile curves in 1937.[85] Norms of growth variability were utilized by others.[86,87,88,89]

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[79]R. Huxley and S. Thissler, "Standardixation of Growth Formula," Nature, Vol. 137 (May 9, 1936), 780-781.

[80]R. M Jenss and N. Bayley, "A Mathematical Method for Studying Growth of a Child," Human Biology, IX (1937), 556-563.

[81]Nancy Bayley, "Predicting Height of Children," Paper presented at the annual meeting of the Society for Research in Child Development, 1955.

[82]C. B. Davenport,"Interpretation of Certain Infantile Growth Curves," Growth, I (December 1937), 279-283.

[83]Horace Gray, "Individual Growth Rates," Human Biology, XIII (1941), 306-333.

[84]S. A. Courtis, "Maturation Units for the Measurement of Growth," School and Society, XXX (1929), 683-690.

[85]M. A. Burgess, "The Construction of Two Height Charts," Journal of the American Statistical Association, XXXII (1937), 290-314.

[86]Meinhard Robinow, "The Variability of Weight and Height Increments from Birth to Six Years," Child Development, XIII, No. 2 (1942), 159-164.

[87]Read D. Tuddenham and Margaret M. Snyder, "Physical Growth of California Boys and Girls from Birth to Eighteen Years," University of California Publications in Child Development, I, No. 2 (1954), 183-364.

[88]K. Simmons and T. W. Todd, "Growth of Well Children: Analysis of Stature and Weight, Three Months to Thirteen Years," Growth, II (1938), 93-134.

One of the most widely known and used methods for plotting relationships of height and weight was that presented by Wetzel.[90] The method utilizes a "channelwise grid" sheet for plotting height and weight relationships in such a manner that normal growth should follow a straight line. This method has since been challenged as one which truly describes normal growth by Garn[91] who showed that channelwise progression is not common in girls, and that the grid construction does not fully correct for changes in body form during growth and development. Krogman[92] also concluded that:

> Height and weight alone (and hence the Grid) cannot substitute for basic skeletal age in assessing the maturation of the child in terms of "advanced" or "retarded."[93]

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[89] L. W. Sontag and E. L. Reynolds, "The Fels Composite Sheet: A Practical Method for Analyzing Growth Progress," Journal of Pediatrics, XXVI (1945), 327-335.

[90] Norman C. Wetzel, The Treatment of Growth Failure in Children (Cleveland: N.E.A. Services, Inc., 1948), and "The Motion of Growth--Theoretical Foundations," Growth, I (April, 1937).

[91] Stanley Marion Garn, "Individual and Group Deviations from 'Channelwise' Grid Progression in Girls," Child Development, XXIII, No. 3 (September, 1952).

[92] W. M. Krogman, "A Handbook of the Measurement and Interpretation of Height and Weight in the Growing Child," Monographs of the Society for Research in Child Development, XIII, No. 3, Serial No. 48 (1950).

[93] Ibid., p. 63.

A method of graphically plotting growth of children from one to nineteen years of age was devised by Bayer and Gray.[94] The chart showed the relation of the individual to the average of the group. Meredith[95] devised a method of predicting stature through the use of T-scores.

Another widely used method of growth analysis known as the "Organismic Age" was devised by Olson and Hughes.[96] They developed growth ages in months for physical growth such as dental, carpal, height, weight, and grip. The average of such growth measurements was then plotted as the total "organismic age" of the growing child. Olson and Hughes pointed out the inefficiency of cross-sectional analyses of growth data as is indicated in Figure 1.[97] If line A represents growth in height of one boy and line B represents growth in height of another individual, then the dotted line would represent the average for the two,

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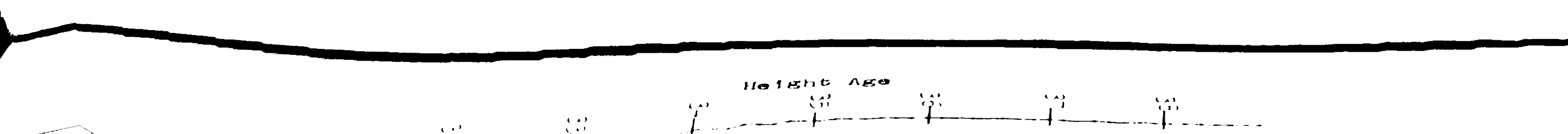
[94]L. M Bayer and H. Gray, "Plotting of a Graphic Record of Growth for Children Aged One to Nineteen Years," American Journal of Diseases of Children, L (1935), 1408-17.

[95]H. V. Meredith, "The Prediction of Stature," Human Biology, VIII (1936), 279-283.

[96]W. C. Olson and Byron O. Hughes, "Growth of the Child as a Whole," in Barker, Kounin and Wright, Child Behavior and Development (New York: McGraw-Hill Book Company, 1943).

[97]W. C. Olson and Byron O. Hughes, Manual for the Description of Growth in Age Units (Ann Arbor, Michigan: University of Michigan Elementary School, 1950), p. 22.


Height Age

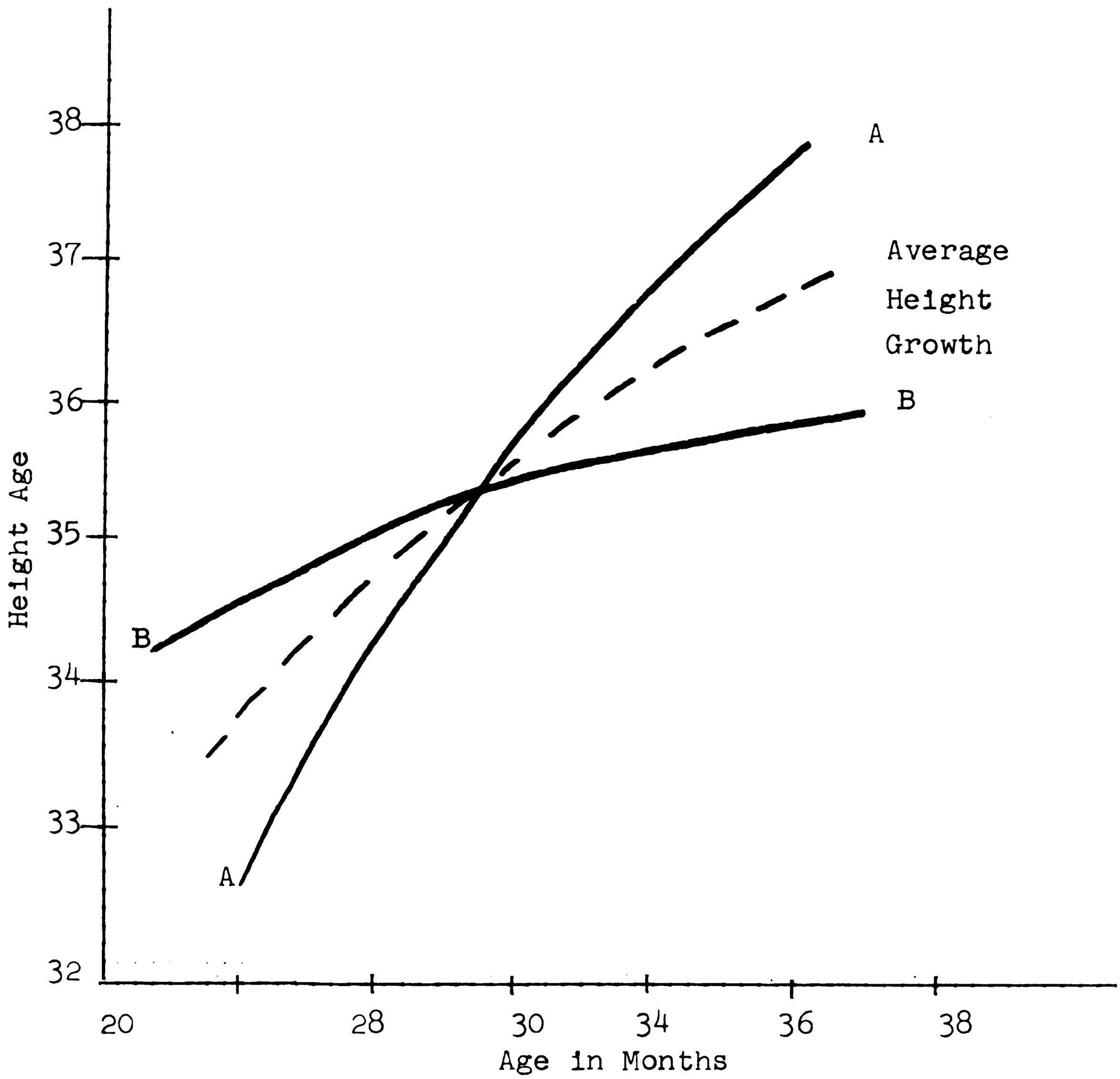


Figure 1. Variation in Rate of Individual Height Growth

and does not truly represent growth in height of either boy. The "organismic age" method, they feel, holds real value for the field of education in that it represents a means of studying growth relationships longitudinally.[98] Bloomers[99] applied the "organismic age" concept to selected data and noted "some relatedness in rate of growth among various physical measures." He obtained a correlation coefficient of .57 between height age and weight age.

The most serious criticism aimed at the organismic age theory was that of Tyler.[100] He utilized Cattell's P-Technique[101] to study the interrelatedness of growth among physical characteristics during adolescence, and concluded that there was no common factor of relatedness of growth in twelve areas. In a later article, however, he admits that:

> No doubt there are important relationships among growth of testes and certain aspects of growth or development of learning. These related characteristics are more likely to be in the realm of physical

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[98]W. C. Olson, Child Development (Boston: D. C. Heath and Company, 1949), pp. 19-29.

[99]P. Bloomers, et al, "The Organismic Age Concept," Journal of Educational Psychology, XLVI (1955), 142-148.

[100]Fred T. Tyler, "Concepts of Organismic Growth--A Critique," Journal of Educational Psychology, XLIV (1953), 321-342.

[101]R. B. Cattell, "P-Technique, A New Method for Analyzing the Structure of Personal Motivation," Transactions of the New York Academy of Science, XIV (1951), 29-34.

> growth, and possibly in social and emotional learning than in academic learning . . .[102]

The work of S. A. Courtis[103] in presenting a formula for the analysis of maturation and the prediction of growth has represented one of the most valuable contributions to the field. In presenting his formula, he notes the efforts of Verhulst (1838), Mitscherlich (1909), Robertson (1913), Thurston (1919), Pearl and Reed (1920), Spillman (1924), and Brody (1926), each of whom had derived a mathematical formula for analysis of growth.[104]

The Courtis method is based on the Gompertz equation which was reported by Benjamin Gompertz in 1825.[105] A detailed description of the Courtis method will be made in Chapter III of this thesis under Methodology.

Courtis describes the Gompertz formula as being simple, subject to direct experimental verification of the meaning of the various constants; having rational, objective explanation; and one which represents a universal relationship

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[102] Fred T. Tyler, "Organismic Growth: Sexual Maturity and Progress in Reading," Journal of Educational Psychology, XLVI (1955), 85-93.

[103] S. A. Courtis, "Maturation Units for the Measurement of Growth," op cit., p. 686.

[104] S. A. Courtis, Maturation Units and How to Use Them (Ann Arbor, Michigan: Edwards Bros., 1950), pp. 179-180.

[105] Benjamin Gompertz, "On the Nature of the Function Expressive of the Law of Human Mortality," Philosophical Transactions of the Royal Society of London for the Year 1825, Part I (St. James Pall Mall: W. Nicol, Printers to the Royal Society, CXV (1825), Ch. XXIV), pp. 513-585.

between the factors involved in all biologic maturations.[106] His research substantiates this statement and points out the multi-cyclic nature of growth by use of the formula.[107,108,109]

Millard's use of the Courtis method has shown three cycles of growth.[110] In 1940 he presented a study which showed the extent to which the Gompertz function adequately describes growth.[111] At that time he noted that:

> The conclusion must be made that the concept of norms needs revision. Evidence such as that shown in this study illustrates the injustice done many children by comparing their performances with so-called norms which so inadequately describe the true nature of growth.[112]

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[106]S. A. Courtis, loc. cit.

[107]S. A. Courtis, The Measurement of Growth (Ann Arbor: Michigan: Brumfield and Brumfield, 1952).

[108]S. A. Courtis, "The Prediction of Growth," Journal of Educational Research, XXVI (1933), 481-492.

[109]S. A. Courtis, "Maturation as a Factor in Diagnosis," Thirty-Fourth Yearbook of the National Society for the Study of Education (1935), 169-187.

[110]Cecil V. Millard, Child Growth and Development in the Elementary School Years (Boston: D. C. Heath and Company, 1951), p.65.

[111]Cecil V. Millard, "The Nature and Character of Pre-Adolescent Growth in Reading Achievement," Child Development, XI, No. 2 (1940), 71-114.

[112]Ibid., p. 105.

An early evaluation by Winsor of the Gompertz curve as a growth curve has provided a valuable critique on the function. He reported that:

> The Compertz curve and the logistic possess similar qualities which make them useful for the empirical representation of growth phenomena. It does not appear that either curve has any substantial advantage over the other in range of phenomena which it will fit. Each curve has three arbitrary constants, which correspond essentially to the upper asymptote, the time origin, and the time unit or "rate constant." . . . It has been found in practice that the logistic gives good fit on material showing an inflection midway between the asymptotes. No such extended experience with the Gompertz curve is yet available, but it seems reasonable to expect that it will give good fits on material showing an inflection when about thirty-seven per cent of the total growth has been completed. Generalizations of both curves are possible, but here again there appears to be no reason to expect any marked differencein the additional freedom provided.[113]

The sort of extended experience with the use of the Gompertz curve to which Winsor referred has been reported by several researchers. Millard[114] has shown the extent to which the Gompertz function adequately describes growth. Other studies which have contributed to the verification of the method are those by Nally,[115] Kowitz,[116]

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[113]C. P. Winsor, "The Gompertz Curve as a Growth Curve," Proceedings of the National Academy of Science, XVIII (1932), 7.

[114]C. V. Millard, op. cit.

[115]Thomas P. F. Nally, "The Relationship Between Achieved Growth in Height and the Beginning of Growth in Reading" (unpublished Ph.D. thesis, Michigan State College, East Lansing, Michigan, 1953).

Rusch,[117,118] Udoh,[119] Greenshields,[120] Holmgren,[121] and Wolferd.[122]

Meredith attempted to apply the Courtis method to test its usefulness on six cases ages seven to nine years, nine months, using three measures each.[123] He made a critical evaluation of the Courtis "universal law" method of prediction of individual growth and reported that it is "considered unsuited to the prediction of individual growth in stature for white males between six and eleven

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[116]Gerald T. Kowitz, "An Exploration into the Relationship of Physical Growth Pattern and Classroom Behavior in Elementary School Children" (unpublished Ph.D. thesis, Michigan State College, East Lansing, Michigan, 1954).

[117]Reuben R. Rusch, "The Relationship Between Growth in Height and Growth in Weight" (unpublished Master's thesis, Michigan State College, East Lansing, Michigan, 1954).

[118]Reuben R. Rusch, "The Cyclic Pattern of Height Growth from Birth to Maturity" (unpublished Ph.D. thesis, Michigan State University, East Lansing, Michigan, 1956).

[119]Ekanem (Benson) Akpan Udoh, "Relationship of Menarche to Achieved Growth in Height" (unpublished Ph.D. thesis, Michigan State University, East Lansing, Michigan, 1955).

[120]C. M. Greenshields, op. cit.

[121]Gordon E. Holmgren, "A Study of Relationship of Certain Developmental Measures to Maturity of Boys as Indicated by Measures of Height" (unpublished Ph.D. thesis, Michigan State University, East Lansing, Michigan, 1957).

[122]Gerald H. Wolferd, "An Evaluation of the Courtis Method in the Study of Growth Relationships" (unpublished Ph.D. thesis, Michigan State Universit, East Lansing, Michigan, 1957).

[123]H. V. Meredith, "The Rhythm of Physical Growth," op. cit.

years."[124] Nally and DeLong, however, reworked the Meredith material, and found errors in the computations. From their analysis, it was their conclusion that "Courtis' law of growth is applicable for the prediction of growth in stature with an accuracy that is within rigorous scientific limits. . . ."[125] In general, this conclusion was confirmed by Dearborn and Rothney.[126]

Thus, as the literature was reviewed, an atmosphere of critical analysis seemed to pervade. Krogman stated that "as one views the literature in this field in the past five years one is struck by an atmosphere of ferment and discontent."[127] This atmosphere he noted,

> has engendered a positive rather than a negative attitude. . . . The work now going on, the constructive criticism being levelled, all permit one to hope, and to expect, that 1955-1960, and thereafter will see remarkable reorientation and considerable progress.[128]

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[124] _Ibid_., p. 120.

[125] Thomas P. F. Nally and A. R. DeLong, "An Appraisal of a Method of Predicting Growth," _Child Development Laboratory Publications_, Series II, No. 1, East Lansing, Michigan (1952).

[126] W. F. Dearborn and J. W. M. Rothney, _Predicting the Child's Development_, _op. cit_., pp. 218-220.

[127] Wilton M. Krogman, "The Physical Growth of Children: An Appraisal of Studies 1950-1955," _op. cit._, p. iii.

[128] _Ibid_., p. 76.

He observed that "a major issue centers around the cross-sectional versus longitudinal, or serial, philosophies . . . [and] only from the second can we derive any idea of growth progress."[129]

It was with such a philosophical frame of reference, and with an earnest desire that a contribution could be made to the scientific approach to longitudinal growth studies, that the present study was undertaken.

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[129] *Ibid.*, p. 72.

CHAPTER III

PROCEDURE

The Data

The cases selected for analysis in this study were sixty-six boys whose measurements were reported in the Harvard Growth Study which was inaugurated in the fall of 1922.[1] Some thirty-five hundred children were included in the original study which was conducted by the Psycho-Educational Clinic of the Harvard Graduate School of Education. They represented a population of first grade school children who were entering school in three cities in the vicinity of Boston. Twelve annually repeated measurements were recorded for each subject. The measurements included standing height, body weight, sitting height, sternal height, iliac diameter, head length, head width, dental age, skeletal age, mental age, chest depth, and chest breadth.

The completed measurements represent longitudinal data for 747 boys and 806 girls, from first grade through senior high school.

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[1]W. F. Dearborn, J. W. Rothney, and F. K. Shuttleworth, "Data on the Mental and Physical Growth of Public School Children," Monographs of the Society for Research in Child Development, III, No. 1 (1938).

In appraising the Harvard Study, Shuttleworth points out the classic nature of the data.[2] He states that:

> It is the considered judgment of the writer that the materials of the Harvard Growth Study represent easily the finest collection of longitudinal records available for the study of physical growth during the adolescent period. Better data, in the sense of more data and longer records, will probably never be available. Better data, in the sense of half as many cases followed over as long a period together with either more measurements or more accurate measurements or more supplementary data, will not be available for analysis within a period of at least fifteen years.[3]

The sixty-six cases selected for this study represent a random sampling from the 1553 completed cases on whom measurements in standing height, skeletal age, and mental age measurements were available. A Chi-Square test of "Goodness of Fit" was used to test the sampling distribution of the measurements at age eight for the sixty-six cases. Table I gives the computed values of Chi-Square for the sampling distribution as well as the critical value of Chi-Square at the ninety-five per cent level of confidence. Examination of the figures in Table I indicates that for all three measurements, the sampling distribution can be assumed to be that of one taken from a normally distributed population, at the ninety-five per cent level of confidence.

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[2]Frank K. Shuttleworth, "The Physical and Mental Growth of Girls and Boys Age Six to Nineteen in Relation to Age at Maximum Growth," Monographs of the Society for Research in Child Development, IV, No. 3 (1939).

[3]Ibid., p. 6.

TABLE I

COMPUTED AND CRITICAL X^2 VALUES OF OBSERVED MEASUREMENTS IN STANDING HEIGHT, MENTAL AGE, AND SKELETAL AGE OF THE SIXTY-SIX BOYS AT AGE 8

Measurement	Computed X^2	Critical $X^2_{.95}$
Standing Height	3.68	11.07
Mental Age	10.89	15.51
Skeletal Age	2.67	7.81

In the case of the distribution of observed measurements in standing height at age eight, for instance, it can be noted that an observered $X^2 = 11.07$ would need to be obtained before the hyopthesis that the observed measurements were those taken from a normally distributed population could be rejected. The observed value of $X^2 = 3.68$ led to the assumption of normal distribution at the ninety-five per cent confidence level, and represents a value well within the acceptable area. Further observation of Table I leads to the same assumption for all three aspects of development.

The observed measurements for each case in standing height, mental age, and skeletal age, as well as the computed percentages of total development in each aspect of growth, ethnic origin and socio-economic status may be found in Appendix A of this thesis. Examination of this data revealed that the ethnic origin and the socio-economic status in regard to the occupation of the boys' fathers were distributed as indicated in Table II.

TABLE II

ETHNIC ORIGIN AND SOCIO-ECONOMIC STATUS OF THE SIXTY-SIX BOYS

Ethnic Origin	Frequencies	Socio-Economic Status*	Frequencies
Jewish	2	I	4
North European	44	II	7
Mixed Stock	2	III	25
Italian	17	IV	18
Negro	1	V	4
		Unknown	8

*I--Professional
II--Semi-professional, large business, important managerial
III--Skilled labor, small business, small managerial
IV--Semi-skilled labor
V--Unskilled labor

Methodology

In order to analyze longitudinal growth data for the purpose of determining coorelative relationships among beginning points and end points of the adolescent cycle of maturation, it was necessary first of all to employ a suitable mathematical method for determining the multi-cyclic nature of growth in the three developmental aspects of standing height, skeletal age, and mental age. This section will present the mathematical method which was utilized as well as the test used to determine the efficiency of the method for prediction of growth in the three aspects, and correlative techniques which were employed.

Determination of cycles. The determination of the number of cycles of growth which were present in the measurements for each of the sixty-six cases in each of the three developmental aspects (height, skeletal age, and mental age) was made by the utilization of normal probability paper. To do this, each measurement was first reduced to a per cent of maximum development. The measurement taken as that representing maximum development in each case was the largest observed measurement in a particular aspect of growth. By way of example, the data for Case 343M is presented in Table III. The observed measurements and computed per cents of development in each developmental aspect for all of the sixty-six cases may be found in Appendix A of this thesis.

Figure 2 shows the per cents of development in standing height, mental age, and skeletal age after they have been plotted on normal probability paper and determined by the resulting lines of best fit through the plotted points. It can be noted that the lines of best fit in each of the three aspects of growth indicate a two cycle pattern of growth.

TABLE III

OBSERVED MEASUREMENTS AND COMPUTED PER CENTS OF DEVELOPMENT IN STANDING HEIGHT, MENTAL AGE, AND SKELETAL AGE FOR CASE 343M

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.11	85.32	1160	68.96	81.90	36.25	78	34.36
8.07	96.84	1207	71.75	117.17	51.87	90	39.64
9.09	109.08	1273	75.68	121.14	53.63	102	44.93
10.08	120.96	1317	78.29	119.14	52.74	113	49.77
11.10	133.20	1363	81.03	146.52	64.86	126	55.50
12.08	144.96	1403	83.41	160.18	70.91	140	61.67
13.08	156.96	1441	85.67	160.80	71.18	151	66.51
14.08	168.96	1491	88.64	174.02	77.04	167	73.56
15.07	180.84	1571	93.40	184.45	81.65	178	78.41
16.09	193.08	1641	97.56	207.56	91.88	198	87.22
17.09	205.08	1664	98.92	213.28	94.42	214	94.27
18.10	217.20	1682*	100.00	225.88*	100.00	227*	100.00

*Represents the measurement taken as maximum for computation of per cents of development.

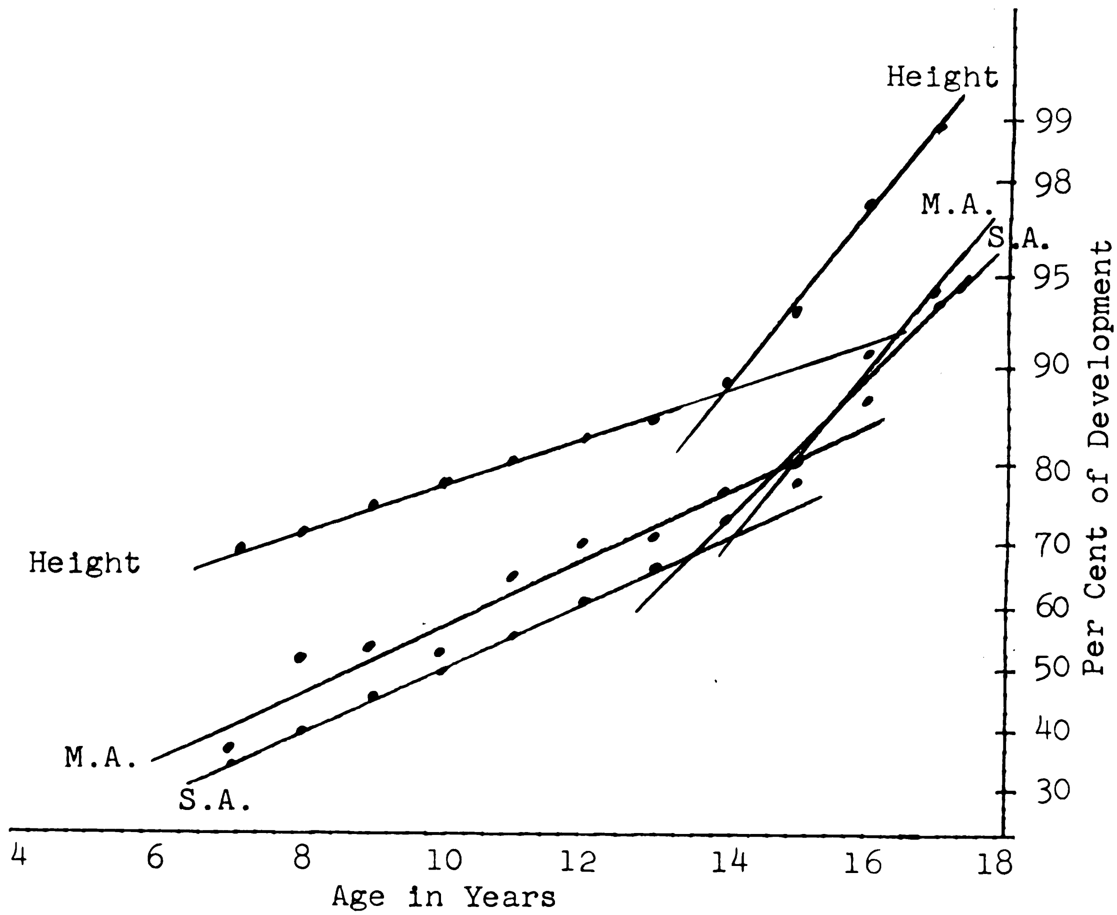

Figure 2. Composite normal probability graph of per cents of total development in standing height, mental age, and skeletal age, for Case 343M, indicating measurements within a given cycle of growth.

The usage of normal probability paper for the determination of points which lie within a given cycle is not a new idea. Cornell and Armstrong[4] utilized the method with good success in determining end of childhood and beginning of adolescent cycles of growth. Their conclusions, after plotting the percentage of development in mental age for each individual at yearly intervals, was that the resulting lines consisted of a straight line between the ages of six or seven, usually up to a point varying for different individuals from about age eleven to age fourteen or fifteen, followed by another straight line at a steeper slope toward maturity.[5]

Similar conclusions to those of Cornell and Armstrong were drawn from the observations of the probability lines in the present study. A more detailed report of the findings will be included in Chapter IV of this paper.

The Courtis Method. After the measurements to be included in each of the two cycles of growth were determined by use of the normal probability paper, the Courtis technique for analysis of growth was applied to determine (1) the maximum amount of development in each cycle of

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[4] E. L. Cornell and C. M. Armstrong, "Forms of Mental Growth Patterns Revealed by Reanalysis of the Harvard Growth Data," Child Development, XXVI, No. 3 (September 1955), 169-204.

[5] Ibid., pp. 173-175.

growth for a given developmental aspect; (2) the rate of growth in a given cycle; (3) the incipiency, or amount of growth at the beginning of a cycle; (4) the predicted growth at a given age within a cycle; and (5) the deviation of the observed score or measurement at a given age from the predicted score.

A brief historical review of the development of the Courtis technique seems necessary at this point before a detailed explanation of the method is presented. The method was first presented by Courtis in 1929.[6] He defined the method as a simplex growth equation and noted that the laws of growth, and the effect of any one factor upon growth, are most easily determined in simple situations, characterized by (1) progress toward a defined maturity which takes place in (2) the immature organism of constant nature when it reacts to (3) constant nuture under (4) constant conditions.[7] He noted further that all simplex curves may be described by the formula $y = k_g c^x$[8] which was deduced by Gompertz[9] in 1825, from mortality statistics. Other

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[6]S. A. Courtis, "Maturation Units for the Measurement of Growth," *School and Society*, XXX (1929), 683-690.

[7]Ibid., p.685.

[8]*Ibid.*, p. 686.

[9]Benjamin Gompertz, "On the Nature of the Function Expressive of the Law of Human Mortality," *Transactions of the Royal Society of London, for the Year 1825, Part I,* Vol. 115, Chapter 24, pp. 513-585.

references to the Gompertz formula may be found in Prescott[10] as well as Croxton and Cowder.[11]

In the equation, g, c, and k represent three constants, x the time variable and y the measurement of growth at time x.

The use of isochrons, or maturation units, reduces the exponential equation to a simple linear equation:

$$Y_1 = r_1 t + s_1$$

where Y_1, s_1, and r_1 are the isochrons of y, g, and c; and t represent units of time.[12] An isochron is defined as the time required for the ordinate at the point of inflection to increase to one-tenth of its own power of itself. It is one per cent of the total time required for the growth curve to change from development of 0.000,000,189 per cent to a development of 99.90917 per cent, or (practically) from zero to complete maturity. Courtis has published a table which gives the percentages of the period of maturation corresponding to each tenth percentage of development.[13]

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[10] R. D. Prescott, "Law of Growth in Forecasting Demand," Journal of the American Statistical Assn., XVII, No. 140 (1922), 471-479.

[11] F. E. Croxton and D. J. Cowder, Applied General Statistics (New York: Prentice Hall, Inc., 1939), pp.447-452.

[12] S. A. Courtis, "Maturation Units for the Measurement of Growth," op. cit., p.686.

[13] S. A. Courtis, Natural Isochrons, Linear Maturation Units for Use in Computations Involving Measurements of Growth (Ann Arbor, Michigan: private publication).

He states that, "The use of isochrons, or time scores, . . . reduces the complex phenomena of biologic growth to the simplicity of physical phenomena and makes possible the setting up of standards and comparable units of measurement in all biological fields."[14]

In later writings, Courtis presented detailed explanations of the method which explain the technique for the analysis of growth.[15,16,17,18] It was from these sources that the method was taken for use in the current study. The explanation of the use of the method in this study follows.

After the points which were to be included in the childhood cycle of growth were determined by use of the normal probability paper, these measurements were then plotted on semi-logarithmic paper in order to determine first-cycle maximum in each of the three aspects of growth for every one of the sixty-six cases. Figure 3 illustrates the resulting curve for the childhood cycle for Case 343M

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[14] S. A. Courtis, "Maturation Units for the Measurement of Growth," op. cit., p. 690.

[15] S. A. Courtis, The Measurement of Growth (Ann Arbor: Brumfield and Brumfield, 1932).

[16] S. A. Courtis, "The Prediction of Growth," Journal of Educational Research, XXVI (1933), 481-492.

[17] S. A. Courtis, Toward a Science of Education (Ann Arbor, Michigan: Edwards Bros., 1951).

[18] S. A. Courtis, Maturation Units and How to Use Them (Ann Arbor, Michigan: Edwards Bros., 1950).

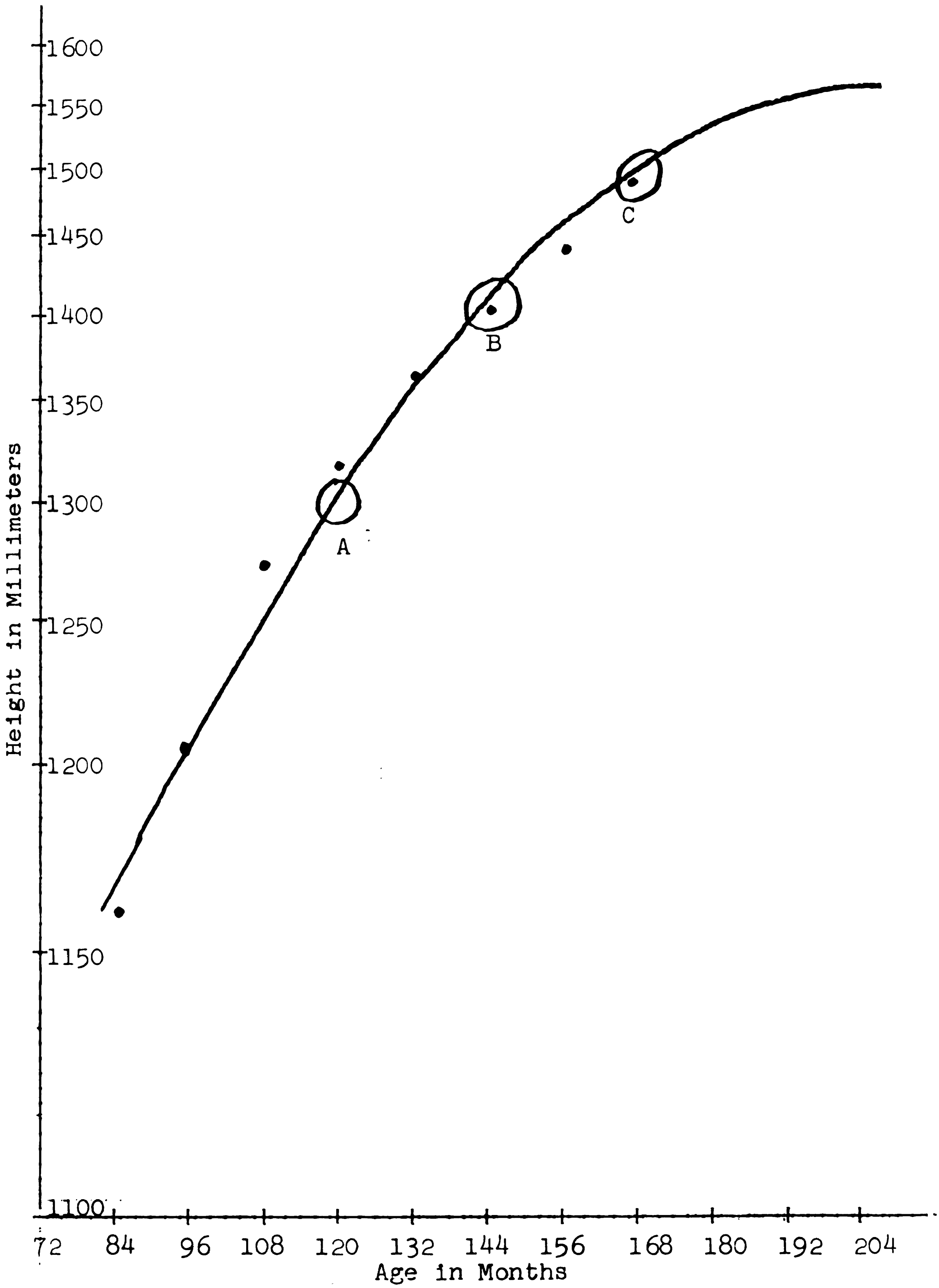

Figure 3. Semi-logarithmic curve showing childhood cycle development in standing height, Case 343M.

in standing height. Courtis original method then selected three equally spaced points from the resulting curve, indicated by A, B, and C in Figure 3. The cycle maximum was then computed by the following formula, which is the Freedman Method For Computing Maximum of a growth cycle.[19]

$$A \div B = \text{a per cent} = \text{isochronic value} = A_1$$

$$B \div C = \text{a per cent} = \text{isochronic value} = B_1$$

$$C \div B = \text{a per cent}$$

$$(A/B)\ (C/B) = \text{a per cent} = \text{isochronic value} = C_1$$

$$\text{Maximum } K = B \left(\frac{1}{\not[\ B_1 + A_1 - C_1\ ]} \right)$$

where the notation $\not[\ ]$ directs one to change the value obtained to a per cent before multiplying by B.

In the present study, however, it was found that the maximum could be read graphically from the semi-logarithmic curve and the resultant maximum did not differ significantly from that which was computed by the formula.

The next step in the process was the computation of the _rate_ of growth in isochrons within the cycle. Once the cycle maximum had been obtained, per cents of cycle maximum were computed for each measurement within the cycle. These per cents, which are presented in Table IV for childhood

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[19]Devised by Seymour Freedman, a student of S. A. Courtis; reported in C. V. Millard, _Problems of Pupil Growth and Development_ (Ann Arbor, Michigan: Edwards Brothers, Inc., 1948), p. 63.

TABLE IV

PER CENTS OF CHILDHOOD CYCLE MAXIMUM FOR MEASUREMENTS IN STANDING HEIGHT, CASE 343M

Chronological Age Years	Mos.	Observed Measurement	Per Cent of Maximum	Childhood Cycle Maximum = 1568 m.m.
7.11	85.32	1160	73.97	
8.07	96.84	1207	76.97	
9.09	109.08	1273	81.19	
10.08	120.96	1317	83.99	
11.10	133.20	1363	86.92	
12.08	144.96	1403	89.47	
13.08	156.96	1441	91.90	
14.08	168.96	1491	95.08	
15.07	180.84	1571	---	

cycle for Case 343M, were then plotted on an Isochronic Graph Sheet. The line of best fit for the points was then determined, and two arbitrary points were selected as indicated by X and Y on the line in Figure 4, which illustrates the line for the childhood cycle in standing height for Case 343M. The computation of cycle rate was then made by the following process:

Age Y - Age X = age difference

per cent of development at Y converted to isochronic value minus per cent of development at X converted to isochronic value = Isochronic difference

Isochronic difference ÷ age difference = rate of growth in isochrons for one month in a given cycle.

After the two growth constants of maximum and rate had been obtained, the third constant, that of incipiency, or acquired growth at the beginning of the cycle, was computed. This was done by multiplying the computed rate times age Y, and subtracting the observed isochronic value at Age Y from the product to obtain the accrued growth at the beginning of the cycle which must be added into the equation. Table V presents the data for determination of rate and incipiency for Case 343M in standing height.

When the three growth constants for the childhood cycle had been thus obtained they were substituted in the equation: $Y = K [rt \pm i]$, where y = estimated growth, K = cycle maximum, r = rate; t = a given time; and i = incipiency.

Figure 4. Line of best fit for per cents of development of childhood cycle in Standing Height, Case 343M.

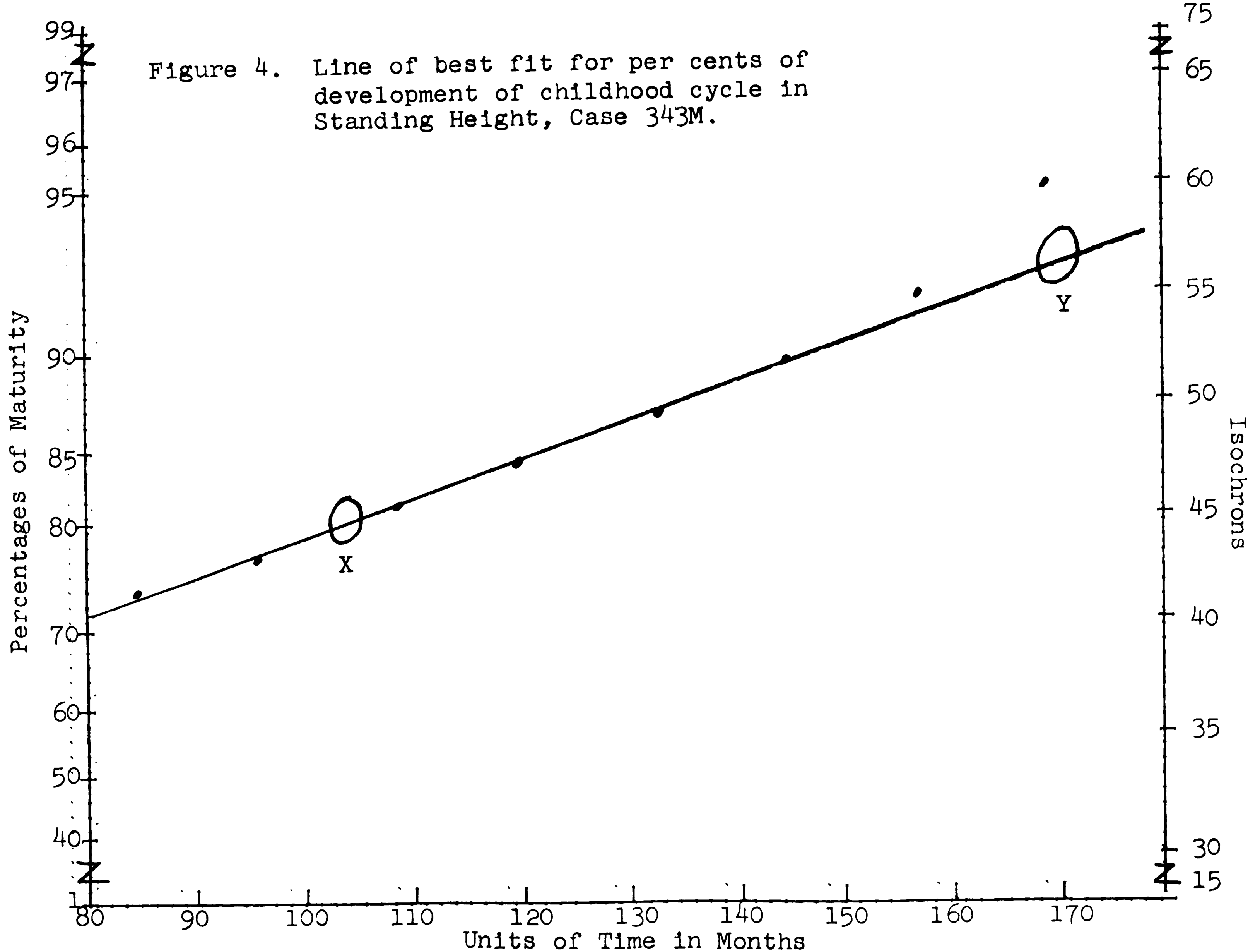


TABLE V

COMPUTATION OF FIRST CYCLE RATE AND INCIPIENCY IN STANDING HEIGHT FOR CASE 343M

Max. 1568

Ages	Per Cents	Isoc.	Rate Is.Diff ÷ Age Diff.
170	93	56.23	
104	80	45.00	.1701
Diff. 66		Diff.11.23	

(A) (Rate) x Age (2) 17.69; (B) Isoc.Value at Age (2) 45.00

Diff. Between A and B 27.31; Sign +

Equation: $y = \frac{1568}{\text{max}} \left[\frac{.1701}{\text{rate}} t + \frac{27.31}{\text{diff.(B-A)}} \right]$

The expression ǂ] directs one to change the isochronic value thus obtained to a per cent of development before multiplying by the maximum. Substituting the computed values of childhood cycle constants in standing height for Case 343M, the resultant equation reads:

$$y = \underline{1568} \;\; \text{ǂ} \; .\underline{1701}\; t + \underline{27.31}]$$

Table VI shows the ages at which measurements were taken, the observed measurements, predicted measurements, and deviation of the estimated measurements from the observed measurements in standing height for Case 343M. Examination of the table indicates that the negative values of the deviations increase in magnitude from age 156.96 months to age 217.20 months, the last observed measurement. These negative values were then plotted on semi-logarithmic paper in order to compute the <u>maximum</u> <u>residual</u> <u>growth</u> in the adolescent cycle.

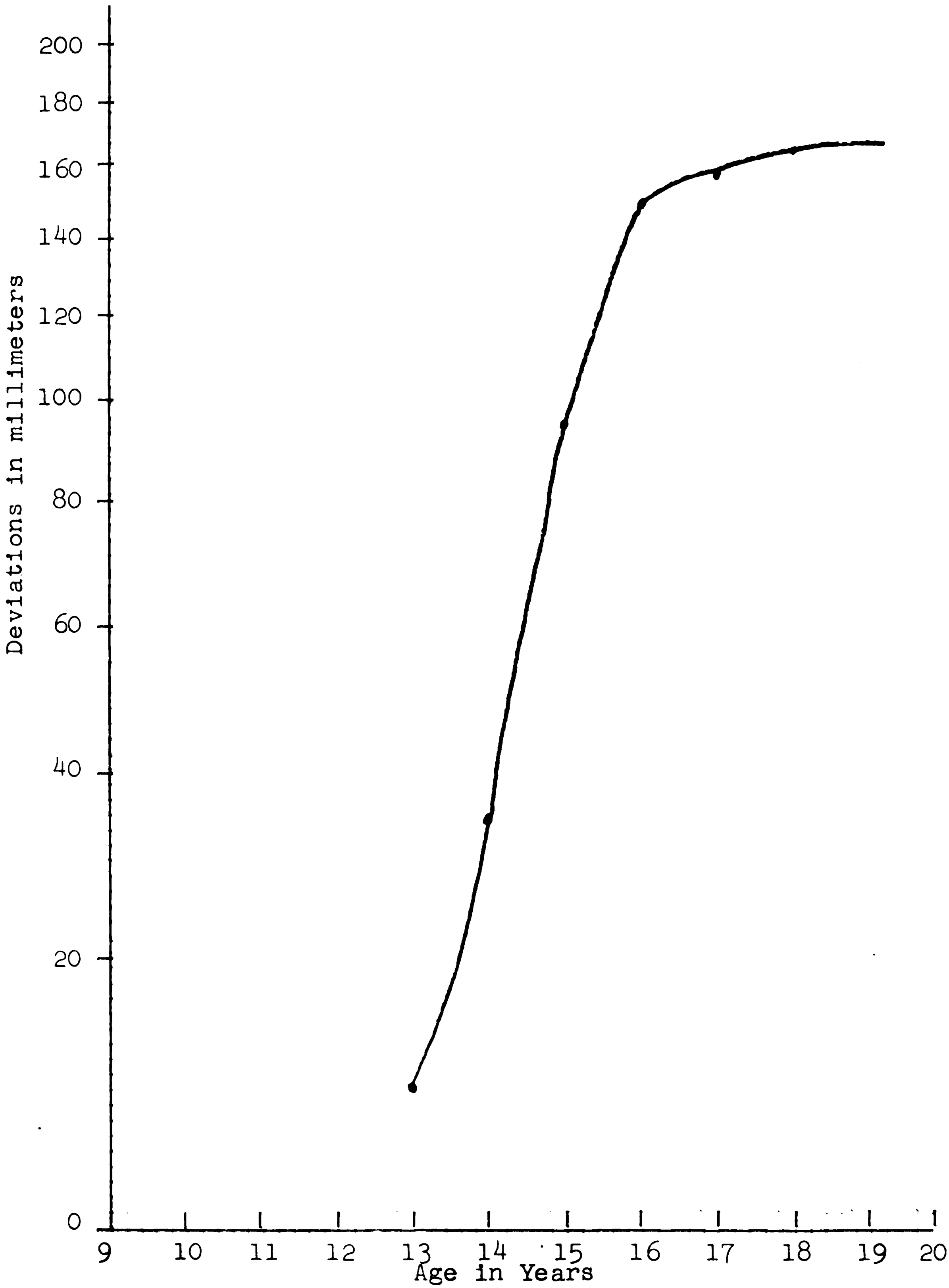
The same processes for obtaining the three cycle constants of maximum rate and incipiency as those described for the childhood cycle, were employed to obtain the residual elements of growth in the adolescent cycle. Figure 5 shows the adolescent cycle curve which resulted from the plotting of the residual negative deviations from the first cycle equation for standing height for Case 343M. From this, an adolescent cycle residual maximum of 166 millimeters was obtained, and per cents of maximum development

TABLE VI

OBSERVED AND PREDICTED MEASUREMENTS IN STANDING HEIGHT, CASE 343M, AND DEVIATIONS OF THE TWO MEASUREMENTS

Age in Months	Observed Measurement	Predicted Measurement	Difference
85.32	1160	1154.04	- 5.96
96.84	1207	1218.33	+ 11.33
109.08	1273	1277.92	+ 4.92
120.96	1317	1326.52	+ 9.52
133.20	1363	1368.86	+ 5.86
144.96	1403	1403.36	+ 0.36
156.96	1441	1431.58	- 9.42
168.96	1491	1456.67	- 34.33
180.84	1571	1475.48	- 95.52
193.08	1641	1492.73	-148.27
205.08	1664	1506.84	-157.16
217.20	1682	1517.82	-164.18

Figure 5. Semi-logarithmic curve of second cycle residuals obtained from first cycle equation constants in Standing Height, Case 343M.



of adolescent cycle were computed as for the childhood cycles. These percentages, as shown in Table VII, were then plotted on an Isochronic graph sheet (see Figure 6) and two arbitrary points were selected from the line of best fit for the purpose of computing cycle rate and incipiency. The equation constants for the adolescent cycle are shown in Table VIII. The resulting equation of residuals for the adolescent cycle in standing height for Case 343M was as follows:

$$y = 166 \text{ ⨍ } .9299\ t - 131.66]$$

Using this formula, the estimated second cycle residuals were then obtained and added to the estimates which were obtained from the first cycle equation. These results, as well as the deviations from the observed measurements may be found in Table IX. Total estimated maximum to which Case 343M was growing in Standing Height was obtained by the formula:

$$K_3 = K_1 + K_2,$$

$$K_3 = 1568 + 166 = 1734 \text{ millimeters}$$

where K_3 = total maximum development in a given growth aspect; K_1 = first cycle maximum, and K_2 = second cycle maximum, representing a residual of K_1.

A complete listing of all cycle constants, average error of equations, time of cycle breaks and estimated time of adult maturity in each of the three aspects of growth (standing height, mental age, skeletal age), for each of

TABLE VII

DATA FOR ISOCHRONIC GRAPH SHEET--PERCENTAGES OF TOTAL DEVELOPMENT IN STANDING HEIGHT FOR CASE 343M

Maximum--166 mm.		
C.A. in Months	Observed Measurement	Per Cent of Maximum
168.96	34.33	20.68
180.84	95.52	57.54
193.08	148.27	89.31
205.08	157.16	94.67
217.20	164.18	98.90

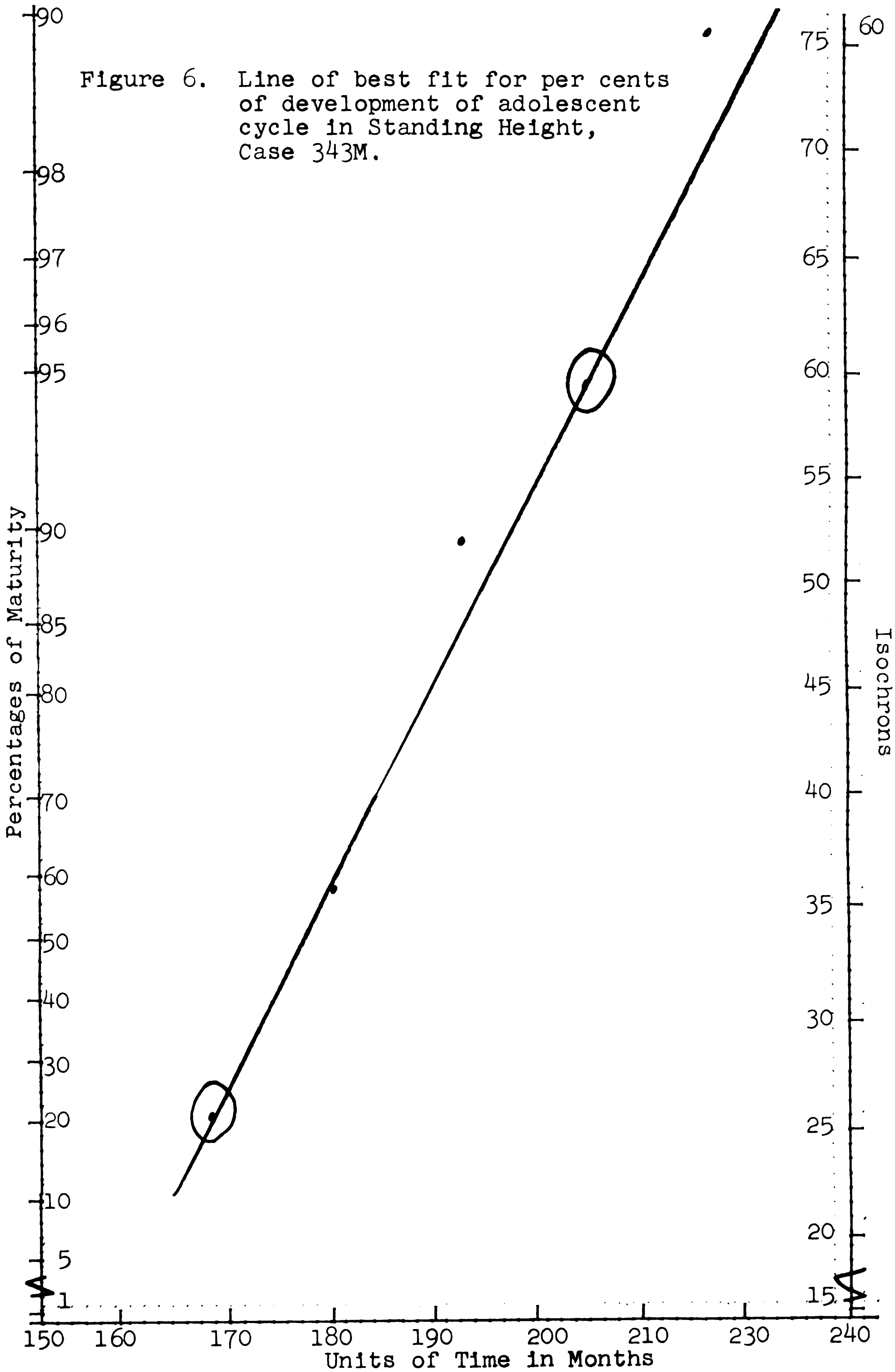


Figure 6. Line of best fit for per cents of development of adolescent cycle in Standing Height, Case 343M.
Percentages of Maturity
90
98
97
96
95
90
85
80
70
60
50
40
30
20
10
5
1
Isochrons
60
75
70
65
60
55
50
45
40
35
30
25
20
15
150 160 170 180 190 200 210 230 240
Units of Time in Months

TABLE VIII

COMPUTATION OF ADOLESCENT CYCLE RATE AND INCIPIENCY

Max.166

Ages	Per Cents	Isoc.	Rate Is.Diff. ÷ Age Diff.
205.08	94.67	59.04	
168.96	20.68	25.45	.9299
Diff. 36.12		Diff.33.59	

(A)(Rate) x Age (2) 157.11; (B) Isoc.Valve at Age (2) 25.45

Diff. Between A and B 131.66; Sign -

Equation: $$y = \frac{166}{max}\left[\frac{.9299}{rate}\, t \;-\; \frac{131.66}{diff.(A-B)}\right]$$

TABLE IX

PREDICTED MEASUREMENTS FOR CHILDHOOD AND ADOLESCENT CYCLES OF GROWTH IN STANDING HEIGHT, CASE 343M

Age in Months	Observed Measurement	Predicted Measurements K_1	K_2	$K_1 + K_2$	Diff.
85.32	1160	1154.04	--	1154.04	- 5.96
96.84	1207	1218.33	--	1218.33	+11.33
109.08	1273	1277.92	--	1277.92	+ 4.92
120.96	1317	1326.52	--	1326.52	+ 9.52
133.20	1363	1368.86	--	1368.86	+ 5.86
144.96	1403	1403.36	--	1403.36	+ .36
156.96	1441	1431.58	13.44	1445.02	+ 4.02
168.96	1491	1456.67	42.66	1499.33	+ 8.33
180.84	1571	1475.48	98.43	1573.91	+ 2.01
193.08	1641	1492.73	140.43	1633.16	- 7.84
205.08	1664	1506.84	157.03	1663.87	- .13
211.20	1682	1517.82	163.34	1681.16	- .84
		Average error of equation			5.09

the sixty-six boys included in this study may be found in Appendix B of this thesis.

By substituting computed growth constant values in the equations thus obtained, it was possible to determine the age at which the childhood cycle had reached the point of maturity. This age represented the computed age of cycle break and is indicated at t_2 in the tables in Appendix B. Age of reaching adult maturity was computed in the same manner and is reported as t_3 for each aspect of growth for all sixty-six individuals in Appendix B.

Correlative techniques. The statistical method which was employed to obtain the various correlations which will be reported in Chapter IV of this thesis is known as the Pearson r.[20] The partial correlations were obtained by the formula:

$$r_{xy} = \frac{N\Sigma XY - (\Sigma X)\ (\Sigma Y)}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2]\ [N\Sigma Y^2 - (\Sigma X)^2]}}$$ [21]

and will be referred to as the zero-order coefficient of correlation. First order partial correlations were obtained by the formula:

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[20] Helen M. Walker and Joseph Lev, Statistical Inference (New York: Henry Holt and Company, 1953), p. 233.

[21] Ibid., p. 234.

$$r_{xy.z} = \frac{r_{xy} - r_{xz}\ r_{yz}}{\sqrt{(1 - r_{xz}^2)\ (1 - r_{yz}^2)}}$$

The multiple correlation coefficient of any three factors was obtained by the formula:

$$1 - R^2_{x.yz} = (1 - r^2_{xy})\ (1 - r^2_{xy.z})$$

A discussion of the various partial and multiple correlations which were computed from the data which was analyzed by the use of the Courtis technique as well as the findings which resulted from the computations will be reported in the chapter which follows.

CHAPTER IV

ANALYSIS OF THE DATA

It is generally agreed that multiple relationships among the various aspects of human growth and development are best revealed through analysis of individual longitudinal data. In order to examine relationships among phenomena of growth in standing height, skeletal maturity, and mental maturity during the school life of the child, it was necessary to select what represented the best available data for that purpose. The Harvard Growth Data of the Third Study was selected as meeting this requirement. Sixty-six boys were selected for whom annual measurements in standing height, skeletal age, and mental age were available from the approximate time of entrance into the first grade of three public schools in the vicinity of Boston until their graduation from senior high school. The measurements covered the years from seven through seventeen. Measurements were available for only three of the boys before six years of age. Measurements at age six were available for thirty-four of the cases. For twenty of the sixty-six cases, measurements were available through eighteen years of age. In four of the cases measurements were recorded through nineteen years, and in one case the recorded observations included the twentieth year. The annual measurements in standing height, skeletal age, and mental age for each of the sixty-six cases are to be found in Appendix A of this thesis.

After the cases had been selected, it was then necessary to determine whether the sampling represented one which could be assumed to be that of a random sampling from a normally distributed parameter. The test used to determine the nature of the distribution of the observations in the three developmental aspects was the Chi-Square test of "goodness of fit." The results of this test indicated that the distribution of the observations in each of the three aspects of growth could be assumed to be that of one representative of a normally distributed population.

Analysis of the data thus selected and tested with regard to the nature of the distribution, revealed some pertinent findings about the nature of physical and mental growth of school-age boys when such analysis was undertaken on an individual longitudinal basis. The utilization of the Courtis technique for the analysis revealed the multicycle nature of growth for each child in the three developmental aspects. It also made possible the observation of the individuality of growth in terms of times of cycle breaks, rates of growth within a cycle, beginning and end points of cyclic development, attained growth at the beginning of a cycle, and maxima toward which individuals were growing.

The cyclic nature of growth in the human organism is a phenomenon which has been recognized by many researchers whose studies were cited in Chapter II of this thesis. Earlier studies have also emphasized the fact that the study of growth relationships by the utilization of conventional cross-sectional techniques has tended to obscure the nature of individual growth patterns. The utilization of the Courtis technique made it possible to compute an individual growth curve from equation constants which revealed the magnitude of growth from one age interval to the next, the points of cycle break, and provided a method for predicting adult maturity which was consistent with the observed measurements.

The adequacy of the method for describing growth is revealed by the composite curvilinear regression line which was obtained from the average equation constants for the sixty-six cases for standing height, skeletal age, and mental age. The resultant composite equations were as follows:

1. Standing Height

   $$y = 1576 \, [.1778t + 26.96] + 197 \, [.8719t - 110.72]$$

2. Skeletal Age

   $$y = 158 \, [.2365t + 14.05] + 71 \, [.3433t - 26.85]$$

3. Mental Age

   $$y = 148 \, [.3163t + 11.62] + 60 \, [.5476t - 55.82]$$

It was possible to compute the magnitude of the error of the equations by computing predicted scores at annual intervals and then determining the deviation of the mean predicted score from the mean observed score at each age interval. These data are presented in Tables X, XI, and XII. From the observed deviations, it was then possible to compute a per cent of error of the predicted score from the observed measurement. These per cents of error revealed the efficiency of the curve of constants for describing growth at yearly intervals, and also provided a means of determining a composite efficiency percentage representative of the compound equations for each of the sixty-six cases in the three aspects of development.

The data in Table XIII indicates that the equation described growth with better than ninety-five per cent efficiency for all three aspects of development for the sixty-six cases.

The mean per cent of error for the three equations was 2.2 per cent. Thus it may be stated that the equation obtained by the use of the Courtis technique for describing growth in developmental aspects of standing height, skeletal age, and mental age for the sixty-six boys was 97.8 per cent efficient.

Figure 7 presents the percentages of error for each of the three composite equations in graphic form. From the graphic representation, it can be noted that the smallest

TABLE X

OBSERVED MEANS, COMPOSITE PREDICTED MEANS, DEVIATIONS AND PER CENT OF EQUATION ERROR AT ANNUAL INTERVALS FOR MEAN STANDING HEIGHT MEASUREMENTS OF SIXTY-SIX BOYS

Age in Months	Observed Measurement in Millimeters	Predicted Measurement in Millimeters	Deviations in Millimeters	Per Cent of Equation Error
89	1191.4	1183.5	- 7.9	.66
101	1247.5	1251.3	3.8	.30
113	1303.1	1308.0	7.9	.61
125	1352.8	1355.6	2.8	.20
137	1401.4	1394.8	- 6.6	.47
149	1454.7	1439.2	-15.5	1.06
161	1520.1	1526.1	6.1	.40
173	1590.8	1637.0	46.2	2.90
185	1649.2	1668.9	19.7	1.19
197	1687.2	1699.7	12.5	.74
209	1713.2	1717.8	4.5	.27

TABLE XI

OBSERVED MEANS, COMPOSITE PREDICTED MEANS, AND PER CENT OF EQUATION ERROR AT ANNUAL INTERVALS FOR MEAN SKELETAL AGE MEASUREMENTS OF SIXTY-SIX BOYS

Age in Months	Observed Measurement in Months	Predicted Measurement in Months	Deviations in Months	Per Cent of Equation Error
89	84.03	86.58	2.55	3.03
101	96.39	100.49	4.10	4.25
113	108.77	112.49	3.72	3.42
125	120.89	123.56	3.27	2.70
137	132.81	135.09	2.28	1.71
149	145.51	148.81	3.30	2.26
161	158.15	163.57	5.42	3.43
173	171.06	178.27	7.21	4.21
185	184.43	190.97	6.54	3.54
197	197.16	201.28	4.12	2.09
209	208.75	209.12	0.37	0.18

TABLE XII

OBSERVED MEANS, COMPOSITE PREDICTED MEANS, AND PER CENT OF EQUATION ERROR AT ANNUAL INTERVALS FOR MEAN MENTAL AGE MEASUREMENTS OF SIXTY-SIX BOYS

Age in Months	Observed Measurement in Months	Predicted Measurement in Months	Deviations in Months	Per Cent of Equation Error
89	97.75	101.52	3.77	3.85
101	109.21	114.40	3.79	3.47
113	118.21	124.02	5.81	4.91
125	128.72	131.32	2.60	2.02
137	143.43	140.52	-2.91	2.03
149	157.37	152.88	-4.49	2.85
161	165.68	169.55	3.87	2.33
173	175.80	183.99	8.19	4.65
185	186.41	193.81	7.40	3.97
197	193.15	199.98	6.83	3.52
209	200.23	203.45	3.22	1.61

TABLE XIII

AVERAGE COMPOSITE EQUATION ERRORS FROM OBSERVED MEAN SCORES AND PER CENTS OF EFFICIENCY OF EQUATIONS FOR STANDING HEIGHT, SKELETAL AGE, AND MENTAL AGE OF SIXTY-SIX BOYS

Measurement	Average Error of Composite Equation	Average Per Cent of Error of Equation	Average Per Cent of Efficiency of Equation
Standing Height	12.1 mm.	0.80	99.20
Skeletal Age	3.89 mos.	2.80	97.20
Mental Age	4.81 mos.	3.20	96.80

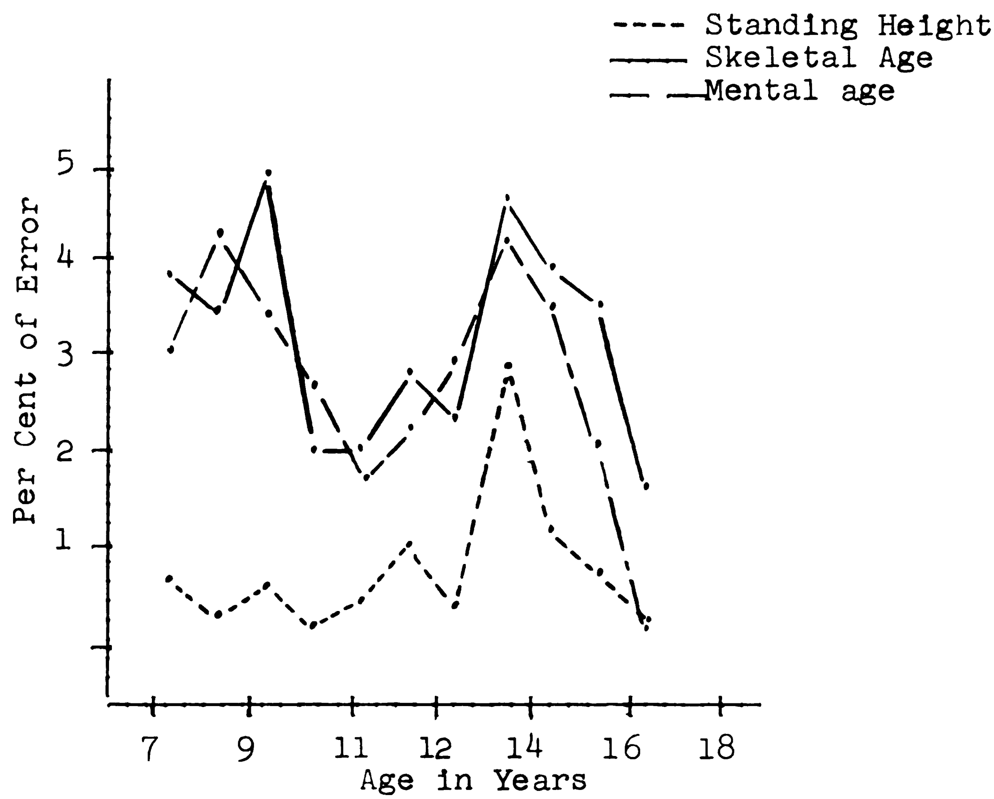

Figure 7. Graph of per cents of composite equation error for standing height, skeletal age, and mental age

deviation of predicted scores from the observed scores in terms of percentages of deviation occurred at ages ten to twelve, the termination of the childhood cycle, and again at ages sixteen to seventeen years of age, the termination of the adolescent cycle. The greatest deviations occurred at ages eight to nine and again at ages fourteen and fifteen years. These ages represent the periods of most rapid growth within the two cycles, as well as periods when growth is most variable from individual to individual.

The average annual increments in growth for the sixty-six boys which were computed from the equations are presented in Table XIV.

TABLE XIV

AVERAGE ANNUAL INCREMENTS IN GROWTH IN STANDING HEIGHT, SKELETAL AGE, AND MENTAL AGE FOR SIXTY-SIX BOYS, COMPUTED FROM COMPOSITE EQUATIONS OF GROWTH CONSTANTS

	Average Annual Increment		
Age in Years	Standing Height in Millimeters	Skeletal Age in Months	Mental Age in Months
7-- 8	70.92	14.69	14.21
8-- 9	59.89	12.85	11.10
9--10	52.00	11.13	8.03
10--11	44.13	11.24	7.14
11--12	36.83	12.63	10.92
12--13	67.58	14.54	16.10*
13--14	96.14*	14.84*	15.73
14--15	69.93	13.78	11.86
15--16	40.83	11.40	7.57
16--17	19.65	8.78	4.40

*Year of greatest average increment in growth

Figures 8, 9, and 10 show the fit of the composite curve of equation constants to mean observed measurements at annual intervals, and demonstrate the curvilinear regression line for the mean annual measurements in standing height, skeletal age, and mental age.

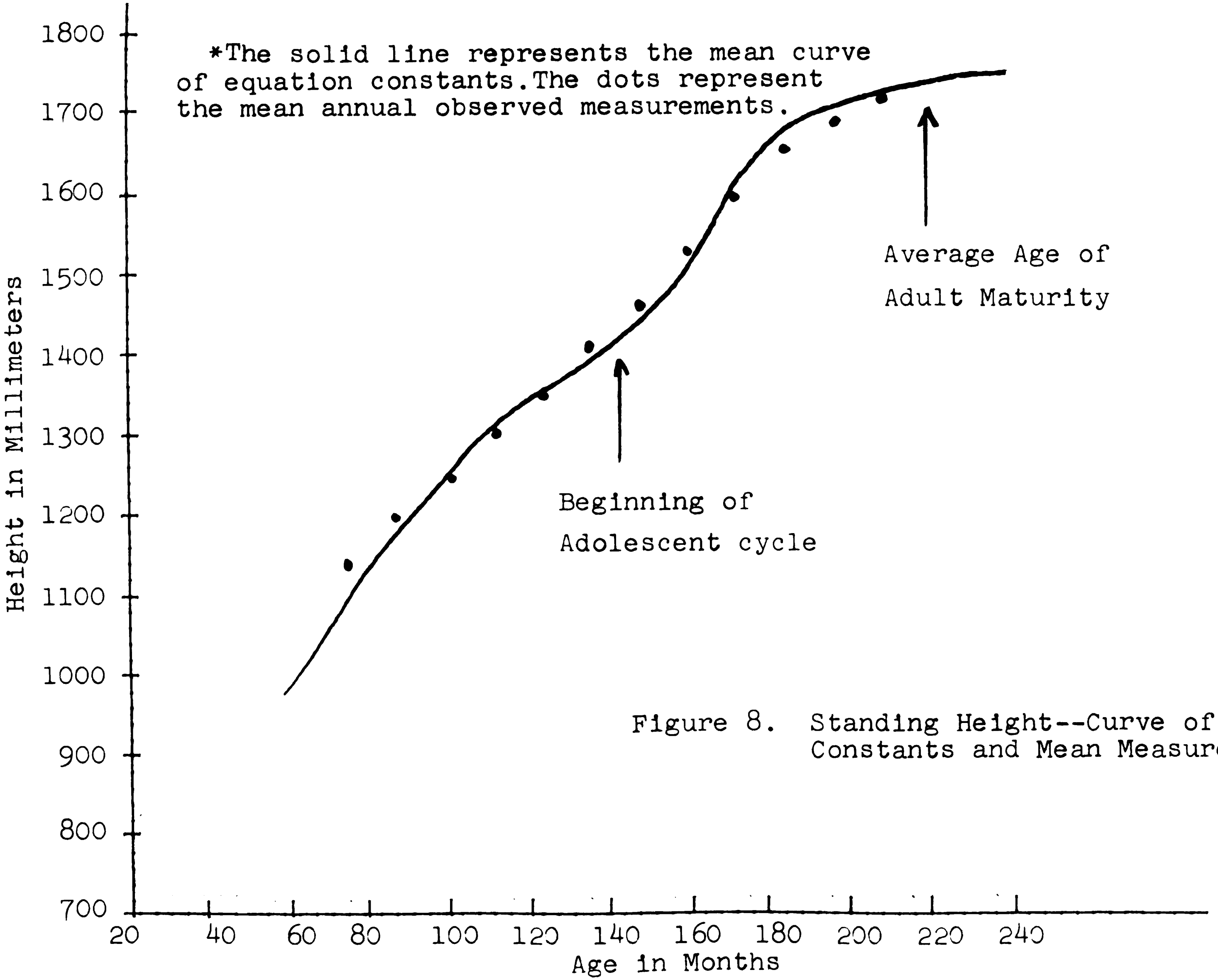

Figure 8. Standing Height--Curve of Equation Constants and Mean Measurements*

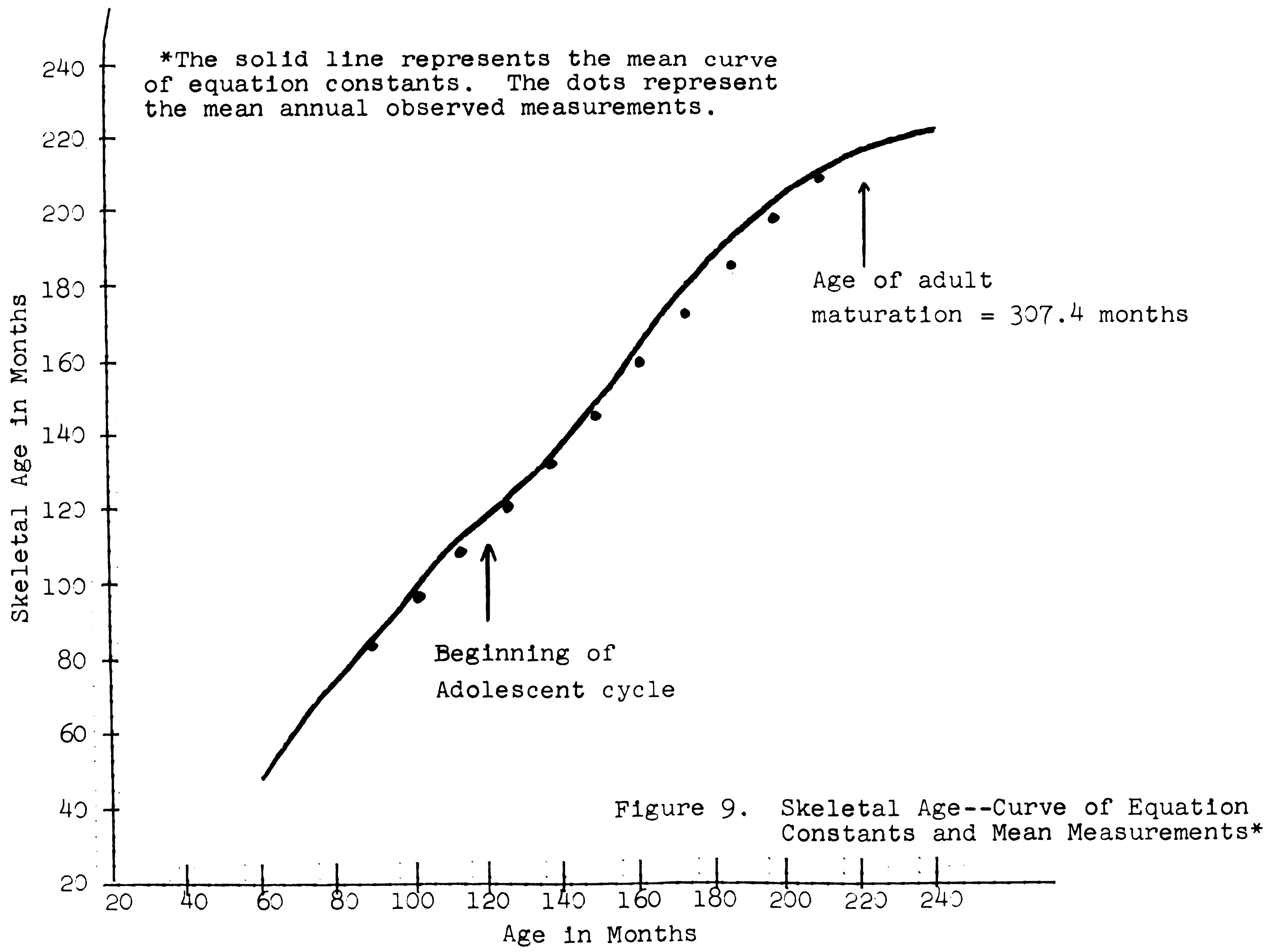

Figure 9. Skeletal Age--Curve of Equation Constants and Mean Measurements*

*The solid line represents the mean curve of equation constants. The dots represent the mean annual observed measurements.

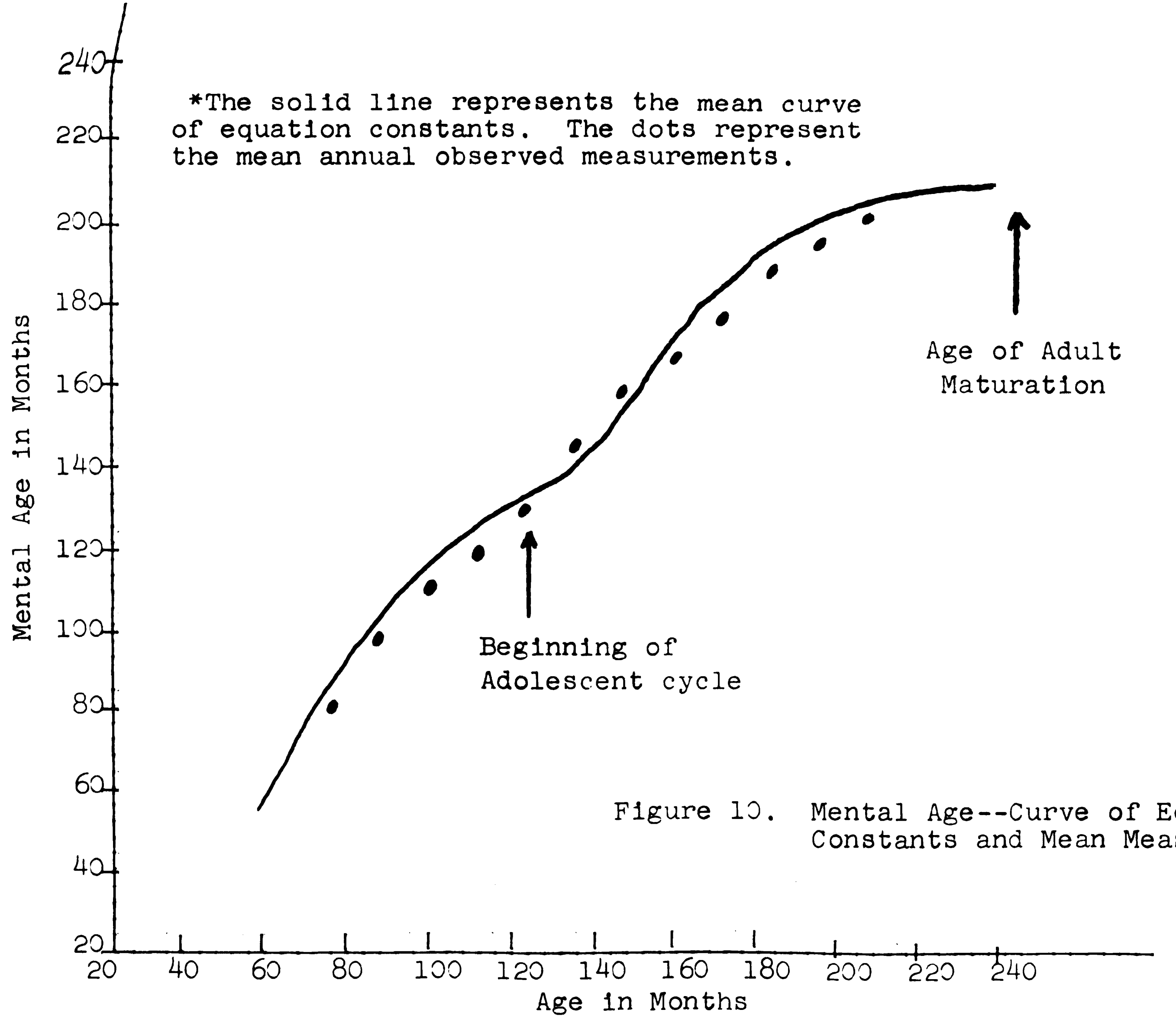

Figure 10. Mental Age--Curve of Equation Constants and Mean Measurements*

*The solid line represents the mean curve of equation constants. The dots represent the mean annual observed measurements.

The distribution of individual equation errors is presented in Tables XV, XVI, and XVII. From these data it can be noted that 78.9 per cent of the cases fell within or below the range which included the mean average error for standing height. Sixty-five per cent of the cases fell within or below the range which included the mean average error for the skeletal age estimates, and fifty-nine per cent of the cases were included in this range in the case of the mental age estimate errors. Equation constants for each of the sixty-six cases in standing height, skeletal age, and mental age are recorded in Appendix B of this thesis.

TABLE XV

DISTRIBUTION OF ERRORS OF EQUATION ESTIMATES FOR SIXTY-SIX BOYS IN STANDING HEIGHT GROWTH

Percentile	Range of Deviations in Millimeters	Number of Cases	Per Cent of Cases	Cumulative Per Cent of Cases
0- 10	4.11-- 5.55	12	18.2	18.2
10- 20	5.56-- 6.99	17	25.8	44.0
20- 30	7.00-- 8.43	9	13.7	57.7
30- 40	8.44-- 9.87	14	21.2	78.9
40- 50	9.88--11.30	6	9.1	88.0
50- 60	11.31--12.74	3	4.5	92.5
60- 70	12.75--14.18	2	3.0	95.5
70- 80	14.19--15.61	1	1.5	97.0
80- 90	15.62--17.05	1	1.5	98.5
90-100	17.06--18.48	1	1.5	100.0

TABLE XVI

DISTRIBUTION OF ERRORS OF EQUATION ESTIMATES
FOR SIXTY-SIX BOYS IN SKELETAL AGE GROWTH

Percentile	Range of Deviations in Months	Number of Cases	Per Cent of Cases	Cumulative Per Cent of Cases
0- 10	.83--1.35	10	15.2	15.2
10- 20	1.36--1.87	24	36.1	51.3
20- 30	1.88--2.39	9	13.7	65.0
30- 40	2.40--2.92	8	12.2	77.2
40- 50	2.93--3.45	10	15.2	92.4
50- 60	3.46--3.97	0	0.0	92.4
60- 70	3.98--4.50	1	1.5	93.9
70- 80	4.51--5.02	1	1.5	95.4
80- 90	5.03--5.54	2	3.0	98.4
90-100	5.55--6.07	1	1.5	100.0

TABLE XVII

DISTRIBUTION OF ERRORS OF EQUATION ESTIMATES
FOR SIXTY-SIX BOYS IN MENTAL AGE GROWTH

Percentile	Range of Deviations in Months	Number of Cases	Per Cent of Cases	Cumulative Per Cent of Cases
0- 10	2.40-- 3.54	4	6.0	6.0
10- 20	3.55-- 4.68	9	13.7	19.7
20- 30	4.69-- 5.82	15	22.7	42.4
30- 40	5.83-- 6.96	11	16.6	59.0
40- 50	6.97-- 8.10	12	18.2	77.2
50- 60	8.11-- 9.24	1	1.5	78.7
60- 70	9.25--10.38	9	13.7	92.4
70- 80	10.39--11.52	3	4.6	97.0
80- 90	11.53--12.66	0	0.0	97.0
90-100	12.67--13.80	2	3.0	100.0

Tables XVIII to XXII indicate the mean, standard deviation and range for the various phenomena of cyclic growth of the sixty-six boys in standing height, skeletal age, and mental age. From these data, it was possible to observe individual variability in growth aspects in terms of the range represented within the various growth constants. Examination of Table XVIII reveals, for instance, that the range in rate of growth in isochrons during the childhood cycle of development was from .1209 to .2280 isochrons in standing height, with a standard deviation of .0265 isochrons.

During the adolescent cycle of development, individual variability in rate of growth appeared to be even more disperse than in the childhood cycle as is revealed by comparison of the standard deviations and ranges of isochronic values in Table XVIII.

With respect to computed maximum development in each cycle of growth for the three developmental aspects, the variability of growth can again be noted. Inasmuch as second cycle maxima represent a residual value of childhood cycle maxima, it was not possible to determine the nature of the difference of variability in second cycle maxima from that of the childhood cycle. In Table XIX standing height maxima values are given in millimeters, while skeletal age and mental age are given in growth age equivalents in months.

TABLE XVIII

MEANS, STANDARD DEVIATIONS, AND RANGES OF RATES OF DEVELOPMENT IN ISOCHRONS FOR CHILDHOOD CYCLE AND ADOLESCENT CYCLE OF GROWTH FOR SIXTY-SIX BOYS IN STANDING HEIGHT, SKELETAL AGE, AND MENTAL AGE

	Rates -- Childhood Cycle			Rates -- Adolescent Cycle		
Measurement	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range
Standing Height	.1778	.0265	.1209--.2687	.8719	.2411	.3796--1.450
Skeletal Age	.2365	.0556	.1319--.4152	.3433	.0794	.2132--.6041
Mental Age	.3163	.0965	.1768--.7723	.5476	.1592	.2440--.9925

TABLE XIX

MEANS, STANDARD DEVIATIONS, AND RANGES OF MAXIMUM DEVELOPMENT OF CHILDHOOD CYCLE AND ADOLESCENT CYCLE OF GROWTH IN STANDING HEIGHT, SKELETAL AGE, AND MENTAL AGE FOR SIXTY-SIX BOYS

Measurement	Maxima--Childhood Cycle			Maxima--Adolescent Cycle		
	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range
Standing Height	1576.45	75.26	1388--1729	196.91	31.76	109--261
Skeletal Age	158.35	18.75	111--210	71.32	19.62	31--108
Mental Age	148.45	26.02	101--210	60.00	18.75	16--112

Examination of the data in Table XX for the incipiency of each cycle led to similar conclusions about individual growth variability as were reached in the case of rates of growth. Here again individual variability seemed to be more disperse in the second cycle than in the first, although the wide differences in individuals was immediately clear upon examination of the ranges of the isochronic values in the first cycle of growth.

Table XXI shows the average computed times of one per cent of development of the adolescent cycle of growth, as well as the computed time of ninety-nine per cent of adult maturity. Again the wider variability of the ranges and standard deviations can be noted at the termination of the adolescent cycle. From these data, the conclusion was drawn that there is wide individual variance in growth in standing height, skeletal age, and mental age. That is to say, it may be concluded that each individual case revealed a unique pattern of growth with respect to growth constants which were represented by rate, incipiency, maximum, and times of maturing. In the case of rate, incipiency, and time, there appeared to be greater variance in growth of the sixty-six boys during the adolescent cycle than during the childhood cycle. It was not possible to make such a conclusion with respect to maxima, because of the nature of the data.

TABLE XX

MEANS, STANDARD DEVIATIONS, AND RANGES OF INCIPIENCY IN ISOCHRONS OF CHILDHOOD CYCLE AND ADOLESCENT CYCLE OF GROWTH IN STANDING HEIGHT, SKELETAL AGE, AND MENTAL AGE FOR SIXTY-SIX BOYS

Measurement	Incipiency--Childhood Cycle			Incipiency--Adolescent Cycle		
	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range
Standing Height	26.69	2.54	19.21--31.92	$\bar{1}10.72$	35.14	$\bar{1}96.12$--$\bar{3}5.48$
Skeletal Age	14.05	3.57	4.34--20.76	$\bar{2}6.85$	12.19	$\bar{6}6.62$-- $\bar{6}.27$
Mental Age	11.62	8.39	$\bar{3}0.36$--26.76	55.82	26.82	$\bar{1}33.65$--$\bar{1}1.01$

TABLE XXI

MEANS, STANDARD DEVIATIONS, AND RANGES OF TIMES OF CYCLE BREAK AND ADULT MATURITY IN MONTHS OF SIXTY-SIX BOYS IN STANDING HEIGHT, SKELETAL AGE, AND MENTAL AGE

Measurement	Time at Which Cycle Break Occurred			Age of Adult Maturity		
	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range
Standing Height	144.07	9.70	118.16--162.19	220.16	13.93	183.10--293.60
Skeletal Age	119.90	12.00	91.67--150.91	307.41	35.51	228.19--386.51
Mental Age	125.88	15.36	92.92--162.58	245.68	27.05	195.80--351.63

Table XXII indicates the average per cents of childhood development and of computed total development which the sixty-six boys had reached in each developmental aspect at the mean time of occurrence of cycle break. In standing height, for instance, the boys had attained a mean of 89.77 per cent of childhood cycle maximum at a mean age of 144.07 months. The range was from 85.7 per cent to 96.3 per cent. At the same time (144.07 months), they had reached a mean of 80.01 per cent of their computed adult height maturity, with a range from 74.11 to 88.49 per cent. The individual variability of growth can be further noted by examination of the data in Table XXII for skeletal age and mental age per cents of development.

The major problem of this study was that of determining the degree of relationship which existed among the timing aspects of growth for sixty-six boys in standing height, skeletal age, and mental age. After it had been determined that the growth constants inherent in the equation could be assumed to be efficient at the ninety-five per cent level of confidence for describing growth of the boys, it was then possible to compute partial and multiple correlation coefficients in timing aspects among the three growth variables as well as other correlations which will be reported in the discussion which follows.

Table XXIII reveals the computed partial correlations between the various growth constants. Examination of the

TABLE XXII

PER CENTS OF DEVELOPMENT OF CHILDHOOD CYCLE MAXIMA AND ADULT MAXIMA OF ACHIEVED GROWTH AT THE TIME OF CYCLE BREAK

	Per Cent of Childhood Cycle Maximum			Per Cent of Adult Maximum		
Measurement	Mean	Standard Deviation	Range	Mean	Standard Deviation	Range
Standing Height	89.77	1.89	85.7--96.3	80.01	2.54	74.11--88.49
Skeletal Age	73.50	8.79	40.2--93.3	50.57	6.11	30.92--61.20
Mental Age	85.60	9.70	53.2--99.8	60.87	8.14	36.23--86.17

TABLE XXIII

CORRELATION COEFFICIENTS BETWEEN GROWTH CONSTANTS OF EQUATIONS FOR STANDING HEIGHT, SKELETAL AGE, AND MENTAL AGE OF SIXTY-SIX BOYS

	r* Height and Skeletal Age	r* Height and Mental Age	r* Skeletal Age and Mental Age
Childhood Cycle Rate	-.100	.132	.018
Childhood Cycle Incipiency	.044	.148	.066
Childhood Cycle Maximum	.135	-.142	-.163
Adolescent Cycle Rate	-.006	-.086	-.025
Adolescent Cycle Incipiency	-.072	-.006	.035
Adolescent Cycle Maximum	.185	.015	.136
Adult Maximum	.000	.008	.000
Time of Cycle Break	.153	.236	.357
Age of Adult Maturity	.187	-.089	-.091
Per Cent of Childhood Maximum	.153	.160	-.009
Per Cent of Adult Maximum	.219	.126	.285

$$* \; r = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{[N\sum X^2 - (\sum X)^2]\,[N\sum Y^2 - (\sum Y)^2]}}$$

table readily reveals that no correlation among the constants can be assumed except in the case of time at which cycle breaks occurred, and per cents of total development at that time. The correlations at the time of cycle break are positive but low. For N=66, the rejection region at the ninety-five per cent level is $r \leq .204$, if $\rho = 0$, and hence the correlation between times of cycle break of height and mental maturity where $r = .236$ may be assumed to have a positive relationship. This was also true between skeletal age and mental age times of cycle break where $r = .357$. However, these values are so near the rejection region that it would be difficult to state the degree of relationship without some doubt as to its true efficiency. The same is true in the case of the per cents of total development at the time of occurrence of cycle breaks, where the three correlation coefficients were:

$$r_{\text{Height, Skeletal}} = .219$$

$$r_{\text{Height, Mental}} = .126$$

$$r_{\text{Skeletal, Mental}} = .286$$

The multiple correlation coefficient among the three times of occurrence of cycle breaks was $R_{M \cdot HS} = .302$. For per cents of total development at the time of cycle breaks, the multiple correlation coefficient was $R_{M \cdot HS} = .138$. An F test, stating the hypothesis that $R_{M \cdot HS} = 0$, was accepted at the ninety-five per cent level. Table XXIV gives the multiple correlation coefficients, the computed F values, and critical values for $F_{.95}$, when $n_1 = 3$ and $n_2 = 62$. It was concluded that the hypothesis of no multiple relationships among the three variables must be assumed at the ninety-five per cent level of confidence.

TABLE XXIV

MULTIPLE CORRELATION COEFFICIENTS, COMPUTED F VALUES AND CRITICAL $F_{.99}$ VALUES FOR TIMES OF CYCLE BREAK AND PER CENTS OF ADULT MATURITY AT TIME OF CYCLE BREAK

	$R_{M \cdot HS}$	Computed F Value	Critical $F_{.95(3,62)}$
Time of Cycle Break	.302	2.07	2.75
Per Cent of Adult Maturity at Time of Cycle Break	.138	.40	2.75

From the correlation coefficients obtained by comparison of the various constants inherent in the growth equations, it seems that no relationships existed among the various growths for the sixty-six boys. The next step was then to compare the mean annual increments at yearly intervals from age seven to seventeen as computed from the composite growth equations for standing height, skeletal age, and mental age, which were reported in Table IV. Rank-Difference correlation coefficients and Pearson r

zero-order correlation coefficients between the mean annual increments appear in Table XXV.[1]

Nor N=8, the critical rank-difference $R_{.95} = .74$.[2] In this case, N=10, and therefore it may be assumed that values of .867, .843, and .946 are positively significant values, and that they are significantly different from zero.

TABLE XXV

RANK-DIFFERENCE CORRELATION COEFFICIENTS AND PEARSON r CORRELATION COEFFICIENTS FOR MEAN ANNUAL INCREMENTS IN STANDING HEIGHT, SKELETAL AGE, AND MENTAL AGE OF SIXTY-SIX BOYS

	r_s*	r
Height-Skeletal	.867	.884
Height-Mental	.843	.862
Skeletal-Mental	.946	.972

$$* \; r_s = \frac{1 - 6\Sigma d^2}{N\,(N^2 - 1)}$$

In the case of the correlations obtained by the formula:

$$r_{xy} = \frac{N\Sigma XY - (\Sigma X)\;(\Sigma Y)}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2]\;[N\Sigma Y^2 - (\Sigma Y)^2]}}$$

[1]By this method it is possible to compute a single correlation between two series of means.

[2]Helen M. Walker and Joseph Lev, Statistical Inference (New York: Henry Holt and Company, 1953), p. 478.

critical $r_{.95}$ = .550 for N-2 degrees of freedom = 8. Hence, the correlations of .884, .862, and .972 may be assumed to be highly significant correlations.

The null hypothesis that $\rho = 0$ was rejected, and the hypothesis that $\rho \neq 0$ was assumed to be true on the basis of the F test which was applied to the multiple correlation of annual increments in growth as reported in Table XXVI.

TABLE XXVI

MULTIPLE CORRELATION, OBSERVED F VALUES AND CRITICAL $F_{.95(3,6)}$ VALUES FOR ANNUAL GROWTH INCREMENTS IN STANDING HEIGHT, SKELETAL AGE, AND MENTAL AGE OF SIXTY-SIX BOYS

$R_{M \cdot HS}$	Observed F Value	Critical $F_{.95(3,6)}$
.862	5.78	4.76

The general conclusion, then, from these findings indicates that even though significant positive correlations exist among the growth aspects of standing height, skeletal age, and mental age when mean annual increments are compared, such relationships are not revealed by comparison of individual growth constants of rate, incipiency, maximum, timing aspects, or per cents of development. It was only when all constants were integrated as a composite whole that true growth relationships were revealed. That is to say, the low correlation coefficients which were obtained for each of the various equation constants were affected by the fact that all other equation constants were in effect immobilized. The multiple correlation of these constants was revealed only when the weighting of all constants, that is their contribution to the whole, was included in the computation of the multiple correlations. Statistically speaking, the notion may be applied that the computed coefficient of correlation between two variables is misleading because there is little or no relation between them beyond what is induced by their common dependence on a third or upon several other variables. In this case, rate, incipiency, and maximum are dependent on each other, and the wide individual variation between or among any of the three constants which contribute to the equation as a whole may be so disperse as to obscure true relationships.

The next question which was raised as a result of the findings when annual increments from the composite growth equations were computed, was that of the relationships which may be revealed by simply averaging observed measurements for each of the sixty-six cases at annual intervals. This was done, and the findings are reported in Table XXVII.

Examination of the individual observed scores revealed that many of the mental age scores showed a decline from one testing period to the next as is shown by examination of the data in Appendix A. Sixty-two of the sixty-six

cases showed a decline in mental age score from at least one annual measurement to the next. The distribution of declining scores at annual intervals appears in Table XXVIII.

TABLE XXVII

CORRELATION COEFFICIENTS OF MEAN ANNUAL OBSERVED INCREMENTS IN STANDING HEIGHT, SKELETAL AGE, AND MENTAL AGE OF SIXTY-SIX BOYS

r_{HS}	r_{RM}	r_{SM}
.568	.308	.080

TABLE XXVIII

DISTRIBUTION OF DECLINING MENTAL AGE SCORES AT ANNUAL INTERVALS*

Yearly Age Interval	Frequency of Declining Scores
7 -- 8	11
8 -- 9	16
9 --10	14
10 --11	6
11 --12	5
12 --13	16
13 --14	10
14 --15	15
15 --16	20
16 --17	10

*The mental age scores represented here are Stanford-Binet percentile equivalents of average mental age scores taken from two mental age tests administered at a given annual interval. It would be of future interest to determine which tests were contributing to the declining mental age equivalents. See Walter F. Dearborn and J. W. Rothney, Predicting the Child's Development (Cambridge, Mass.: Sci-Art Publishers, 1941), pp. 136-139 for table of equivalent mental test percentiles.

From the table, it may be observed that the declining scores were evident at all age intervals. This fact rules out the hypothesis of faulty test scores at any one testing time. The greatest number of declining scores occurred at age fifteen to sixteen. Since the Stanford-Binet equivalents assess adult mental maturity at sixteen years, it is possible that this may have accounted in part for the larger frequency of declining scores at that point.

These observations lend further support to former evidence that a multiplicity of factors influence mental age scores. Further, inasmuch as mental age scores are dependent on chronological age, the average curve of growth tends to be directed toward a straight line, and fails to distinguish periods of rapid and slow development. Obviously, it would be expected that some growth in mental age would occur from one annual measurement to the next, and the declines in mental age measurements among the boys would need to be explained by exterior factors such as health conditions, rapport between the examiner and the subject, and variation in the tests used.

The norms which were used in the Harvard Study to assess skeletal age scores suffered from the same defect as the mental age scores. That is, inasmuch as skeletal age scores are dependent on chronological age, the growth curve was directed toward a straight line and hence the cyclic nature of individual growth was obscured.

The computation of a growth equation by use of the Courtis method served the purpose of smoothing the growth curves. It produced a curvilinear line of best fit for the data and described the data with better than 97.5 per cent efficiency. Therefore, the correlation coefficients obtained from the comparison of mean annual increments from equation computations represent the relationships of the developmental aspects of standing height, skeletal age, and mental age after the growth curves have been smoothed and testing discrepancies have been reduced.

It is possible that a higher degree of correlation among timing aspects may be found if integrated and non-integrated growers are selected out of the total group for analysis. That is, some children have what may be termed a high integration index in terms of time when cycle break occurs, while others show wide divergence in timing aspects from one growth variable to another. While it was not the purpose of this study to select out such individuals, but rather to study the group of sixty-six boys as a whole, it is recommended that such selection be made in future studies of this nature.

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

The purpose of this investigation was to analyze longitudinal data for sixty-six boys in standing height, skeletal age, and mental age for the purpose of determining growth relationships between and among the physical and mental growth aspects. The sixty-six cases were selected from the Third Harvard Growth Study which was inaugurated in 1922 in the Psycho-Educational Clinic of the Harvard Graduate School of Education.

A Chi-Square test of "goodness of fit" was applied to the distribution of scores in standing height, skeletal age, and mental age. From this test, it was assumed that the distribution of scores in all cases were representative of those of a random sampling drawn from a normal distribution.

The Courtis technique which utilizes the Gompertz equation was employed to analyze the data, and was found to describe growth patterns with better than ninety-five per cent efficiency for all three developmental aspects.

Correlation coefficients were computed among the growth constants of maxima, rates, and incipiencies as well as time of occurrence of cycle break, time of ninety-nine per cent of achieved adult maturity, and per cents of development of first cycle maxima and adult maxima at the time of cycle break. Mean annual increments were also compared to determine the degree of relationships in patterns of growth in physical and mental aspects of development among the sixty-six boys.

Conclusions

The major conclusions which were drawn relative to growth relationships among developmental aspects of standing height, skeletal age, and mental age of the sixty-six boys were as follows:

The pattern of growth for each of the boys was that of a two cycle curve in standing height, skeletal age, and mental age, with the cycle breaks occuring between mean ages of ten and twelve years.

Correlations between equation constants were not statistically significant.

Correlation coefficients between times at which cycle breaks occurred in standing height, skeletal age, and mental age were positive but too low to be stated as significant with any degree of assurance.

Growth is so variable from one individual to the next, and from one cycle to another, that a comparison of equation constants, because they are dependent on each other, does not provide a sufficient basis on which to compare growth relationships.

The significant relationships between physical and mental aspects of growth were revealed when all equation constants were analyzed as a composite whole. The correlation between all aspects of growth was positively significant when mean annual increments obtained from equation constants were compared.

The use of a multi-cyclic regression equation for describing human growth in standing height, skeletal age, and mental age predicts growth with good efficiency, provides a means for smoothing the growth curves, and tends to reduce testing errors.

The degree to which ethnic and cultural influences affected the growth patterns of the sixty-six boys was not known. However, for these children who lived in the area of Boston, patterns of growth in standing height, skeletal age, and mental age were significantly related.

Correlation coefficients between and among the mean annual increments of the sixty-six boys were much higher than those which have been obtained in previous studies where growth aspects were analyzed on a cross-sectional basis.

Implications

Several important implications for educators, psychologists, pediatricians, social workers, and others who deal with children emerged as a result of the major conclusions of this study.

The evidence to the effect that growth in physical and mental aspects of development is multi-cyclic in nature emphasizes the need for recognition that children grow at different rates at various stages of development.

Growth is variable from individual to individual, and hence no two individuals may be fitted into the same pattern of educational treatment in terms of stresses for learning at various ages. The wide divergence in times at which cycle breaks occur provides evidence to support this recommendation.

Total patterns of growth in terms of annual increment are significantly related, as was revealed by the correlation coefficients obtained for the standing height, skeletal age, and mental age annual composite equation increments of the sixty-six boys. From this finding, it is recommended that educators recognize that from a normative point of view, small incremental gains in physical growth are generally accompanied by small incremental gains in mental growth; and that conversely greater increments in physical development are accompanied by increments of greater magnitude in mental development.

On the basis of this study, total magnitude of mental ability bears no relationship to total magnitude of physical stature, as was revealed by the near zero or negative correlations between physical and mental maxima. Therefore, any preconceived notions that tall people are dull and short people are smart or vice versa must be abandoned.

Inadequacies of mental test scores and mental testing situations shown in the study necessitate the analysis of growth on an individual longitudinal basis by the utilization of a suitable statistical technique which describes growth efficiently, and will tend to reduce errors in testing.

More adequate scales for the assessment of skeletal age scores need to be employed which will more adequately describe periods of slow and rapid development, rather than direct the growth curve toward a straight line. More adequate scales than those used in the Third Harvard Growth Study, and which have been utilized since 1950, were cited in this study.

It is recommended that future studies in the area of growth relationships attempt to delineate integrated and non-integrated growers in terms of timing aspects, in order to analyze more fully the unique patterns of growth within individuals.

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APPENDIX A

Key to Ethnic Origin and Socio-Economic Status

ETHNIC ORIGIN

J	--	Jewish
NE	--	North European
M	--	Mixed Stock
It.	--	Italian
N	--	Negro
U	--	Unknown

SOCIO-ECONOMIC STATUS

I	--	Professional
II	--	Semi-professional, large business, important managerial
III	--	Skilled labor, small business, small managerial
IV	--	Semi-skilled labor
V	--	Unskilled labor
O	--	Unknown

CASE 4M. Ethnic Origin--J; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.23	74.76	1119	67.6	84.48	44.93	77	36.2
7.19	86.28	1172	70.8	114.75	61.05	85	39.9
8.19	98.28	1229	74.2	122.85	65.37	96	45.1
9.19	110.28	1277	77.1	112.69	59.85	108	50.7
10.21	122.52	1322	80.0	139.67	74.33	120	56.3
11.20	134.40	1369	82.7	160.61	85.46	131	61.5
12.19	146.28	1396	84.3	174.80	93.01	144	67.6
13.18	158.16	1433	86.5	166.07	88.36	157	73.7
14.18	170.16	1524	92.0	167.61	89.18	170	79.8
15.18	182.16	1605	96.9	184.89	98.38	183	85.9
16.22	194.64	1637	98.9	187.83	99.94	199	93.4
17.21	206.52	1656	100.0	187.93	100.00	213	100.0

CASE 15M. Ethnic Origin--NE; Socio-Economic Status IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.88	82.56	1242	70.4	71.82	37.37	84	37.0
7.66	91.92	1282	72.7	91.00	47.35	96	42.3
8.73	104.76	1335	75.7	100.56	52.33	108	47.6
9.69	116.28	--	--	119.76	62.32	119	52.4
10.72	128.64	--	--	132.49	68.95	135	59.5
11.72	140.65	1500	85.1	132.20	69.16	150	66.1
12.69	152.28	1591	90.2	149.23	77.66	167	73.6
13.69	164.28	1685	95.6	172.49	89.76	185	81.5
14.66	175.92	1733	98.3	168.88	87.88	197	86.8
15.69	188.28	1749	99.2	180.74	94.06	208	91.6
16.68	200.16	1759	99.8	192.15	100.00	227	100.0
17.67	212.04	1763	100.0	186.56	97.09	227	100.0

CASE 37M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.59	79.08	1238	68.2	120.20	50.91	84	40.0
7.63	91.56	1303	71.8	128.18	54.29	96	45.7
8.58	120.96	1365	75.2	152.38	64.55	108	51.4
9.61	115.32	1426	78.5	161.44	68.38	119	56.7
10.58	126.96	1468	80.8	158.70	67.22	132	62.9
11.59	139.08	1533	84.4	190.53	80.71	144	68.6
12.59	151.08	1578	86.9	216.04	91.51	150	71.4
13.56	162.72	1641	90.4	231.06	97.88	161	76.7
14.59	175.08	1728	95.2	236.35	100.00	174	82.9
15.57	186.84	1791	98.6	227.94	96.56	190	90.5
16.57	198.84	1816	100.0	228.66	96.86	210	100.0

CASE 56M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
8.30	99.60	--	--	121.51	60.24	89	39.2
9.32	111.84	1263	74.4	117.43	58.22	101	44.5
10.36	124.32	1322	77.9	121.83	60.40	114	50.2
11.32	135.84	1372	80.8	123.61	61.28	125	55.1
12.34	148.08	1428	84.1	155.48	77.08	143	62.99
13.31	159.72	1506	88.7	175.69	87.10	157	69.16
14.32	171.84	1611	94.9	178.71	88.60	180	79.3
15.28	183.36	1668	98.2	201.69	100.00	192	84.6
16.33	195.96	1693	99.7	194.00	96.18	212	93.4
17.35	208.20	1698	100.0	197.79	98.06	227	100.0

CASE 60M. Ethnic Origin--NE; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.16	85.92	1135	67.23	105.68	59.68	68	32.4
7.96	95.52	1174	69.54	99.34	56.10	80	38.1
9.02	108.24	1223	72.45	100.66	56.84	92	43.8
9.97	119.64	1277	75.65	106.47	60.13	105	50.0
11.00	132.00	1321	78.25	117.48	66.35	--	--
11.95	143.40	1361	80.62	139.09	78.55	130	61.9
12.95	155.40	1413	83.70	139.86	78.99	144	68.6
13.98	167.76	1457	86.31	132.53	74.85	156	74.3
14.94	179.28	1502	88.98	159.55	90.11	166	79.0
15.97	191.64	1566	92.77	164.81	93.08	174	82.9
16.96	203.52	1659	98.28	177.06	100.00	187	89.0
17.95	215.40	1688	100.00	174.47	98.53	210	100.0

CASE 68M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.81	81.72	1103	65.53	--	--	78	36.3
7.77	93.24	1150	68.33	97.90	45.35	89	41.4
8.68	105.36	1201	71.36	128.53	59.54	102	47.4
9.78	117.36	1241	73.73	143.17	66.32	115	53.5
10.79	129.48	1284	76.29	155.37	71.97	126	58.6
11.78	141.36	1335	79.32	163.97	75.95	135	62.8
12.77	153.24	1388	82.47	174.69	80.92	144	66.97
13.77	165.24	1440	85.56	188.37	87.26	157	73.0
14.78	177.36	1528	90.79	202.19	93.66	172	80.0
15.78	189.36	1624	96.49	215.87	100.00	185	86.0
16.77	201.24	1646	97.80	211.30	97.88	198	92.1
17.79	213.48	1683	100.00	194.26	89.06	215	100.0

CASE 69M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.51	90.12	1172	67.24	77.50	43.61	87	39.9
8.41	100.92	1230	70.56	86.79	48.84	97	45.4
9.42	113.04	1293	74.18	97.21	54.71	111	50.9
10.46	125.52	1346	77.22	110.45	62.16	122	55.9
11.43	137.16	1388	79.63	133.04	74.87	134	61.5
12.42	149.04	1441	82.67	141.58	79.68	147	67.4
13.43	161.16	1497	85.88	146.65	82.53	154	70.6
14.39	172.68	1578	90.53	145.05	81.63	--	--
15.42	185.04	1671	95.86	153.58	86.43	181	83.0
16.44	197.28	1709	98.04	165.71	93.26	192	88.1
17.42	209.04	1731	99.31	177.68	100.00	213	97.7
18.48	221.76	1743	100.00	176.83	99.52	218	100.0

CASE 81M. Ethnic Origin--M; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.09	85.08	--	--	129.32	53.66	95	49.5
8.08	96.96	1197	72.98	122.17	50.69	107	55.7
9.12	109.44	1257	76.64	145.56	60.40	119	61.9
10.10	121.20	1296	79.02	156.35	64.88	130	67.7
11.09	133.08	1338	81.58	168.35	69.86	140	72.9
12.08	144.96	1377	83.96	179.75	74.59	148	77.1
13.07	156.84	1421	86.64	194.48	80.70	156	81.3
14.10	169.20	1466	89.39	208.96	86.71	162	84.4
15.09	181.08	1541	93.96	220.01	91.30	172	89.6
16.13	193.56	1613	98.35	230.34	95.58	182	94.8
17.09	205.08	1640	100.00	240.97	100.00	192	100.0

CASE 82M. Ethnic Origin--It.; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.77	81.24	1143	66.49	87.74	48.43	82	38.14
7.73	92.76	1183	68.81	102.04	56.32	94	43.72
8.75	105.00	1252	72.83	108.68	59.99	107	49.76
9.74	116.88	1298	75.50	107.53	59.35	120	55.81
10.76	129.12	1343	78.12	106.52	58.80	132	61.39
11.74	140.88	1382	80.39	133.13	73.49	143	66.51
12.73	152.76	1431	83.24	147.41	81.37	156	72.55
13.74	164.88	1498	87.14	145.09	80.09	166	77.21
14.73	176.76	1591	92.55	159.08	87.81	179	83.25
15.73	188.76	1662	96.68	168.00	92.74	191	88.83
16.74	200.88	1696	98.66	165.72	91.48	204	94.88
17.76	213.12	1719	100.00	181.15	100.00	215	100.00

CASE 83M. Ethnic Origin--It.; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.14	73.68	1126	67.3	73.68	49.34	--	--
8.06	96.72	1223	73.1	108.68	72.68	91	45.04
9.06	108.72	1272	76.0	86.43	57.80	105	51.98
10.07	120.84	1325	79.2	100.30	67.07	116	57.42
11.05	132.60	1365	81.5	98.79	66.06	127	62.87
12.04	144.48	1413	84.4	114.86	76.81	139	68.81
13.04	156.48	1452	86.7	106.41	71.16	153	75.74
14.05	168.60	1527	91.2	114.65	76.67	166	82.17
15.05	180.60	1609	96.1	129.13	86.35	179	88.61
16.06	192.72	1650	98.6	146.47	97.95	191	94.55
17.07	204.84	1674	100.0	149.53	100.00	202	100.00

CASE 94M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.78	93.36	1164	70.84	85.89	48.38	77	43.50
8.58	102.96	1208	73.52	119.43	67.28	88	49.71
9.59	115.08	1261	76.74	111.63	62.88	101	57.06
10.62	127.44	1300	79.12	102.59	57.79	113	63.84
11.59	139.08	1331	81.01	114.74	64.63	124	70.05
12.63	151.56	1375	83.68	136.40	76.84	135	76.27
13.61	163.32	1417	86.24	139.64	78.66	148	83.61
14.58	174.96	1450	88.25	150.47	84.76	152	85.87
15.62	187.44	1499	91.23	159.32	89.75	159	89.83
16.60	199.20	1571	95.61	173.30	97.62	168	94.91
17.61	211.32	1643	100.00	177.51	100.00	177	100.00

CASE 108M. Ethnic Origin--NE; Socio-Economic Status--O

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
10.28	123.36	1305	76.79	92.52	45.61	--	--
11.10	133.20	1387	78.89	139.86	68.96	137	60.35
12.18	146.16	1442	82.02	125.70	61.97	149	65.63
13.15	157.80	1480	84.18	127.03	62.63	161	70.92
14.12	169.44	1525	86.74	147.41	72.68	173	76.21
15.14	181.68	1576	89.64	169.87	83.75	179	78.85
16.12	193.44	1662	94.53	176.03	86.79	185	81.49
17.09	205.08	1722	97.95	178.42	87.97	192	84.58
18.12	217.44	1742	99.08	173.95	85.76	212	93.39
19.12	229.44	1752	99.65	182.50	89.98	226	99.55
20.12	241.44	1758	100.00	202.81	100.00	227	100.00

CASE 119M. Ethnic Origin--NE; Socio-Economic Status--I.

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.06	84.72	1157	66.30	81.33	37.04	77	38.11
8.03	96.36	1219	69.85	--	--	90	44.55
9.01	108.12	1274	73.00	132.45	60.32	101	50.00
10.01	120.12	1314	75.30	134.53	61.26	113	55.94
11.01	132.12	1374	78.73	160.53	73.11	124	61.38
11.98	143.76	1423	81.54	171.79	78.23	136	67.32
13.00	156.00	1480	84.81	175.50	79.92	150	74.25
13.99	167.88	1550	88.82	177.95	81.04	161	79.70
15.00	180.00	1650	94.55	207.90	94.68	--	--
15.98	191.76	1714	98.22	219.57	100.00	188	93.06
16.99	203.88	1745	100.00	203.88	92.85	202	100.00

CASE 123M. Ethnic Origin--NE; Socio-Economic Status--O

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.28	87.36	1178	68.64	78.62	42.64	91	40.01
8.07	96.84	1229	71.62	93.93	50.94	106	46.69
9.13	109.56	1304	75.99	107.36	58.23	119	52.42
10.08	120.96	1356	79.02	130.64	70.86	126	55.50
11.11	133.32	1406	81.92	130.65	70.86	--	--
12.08	144.96	1452	84.61	144.96	78.62	147	64.75
13.09	157.08	1511	88.05	157.08	85.20	156	68.72
14.09	169.08	1587	92.48	165.70	89.87	164	72.24
15.06	180.72	1660	96.73	178.91	97.04	177	77.97
16.09	193.08	1691	98.54	173.77	94.25	195	85.90
17.07	204.84	1707	99.47	184.36	100.00	216	95.15
18.07	216.84	1716	100.00	182.15	98.80	227	100.00

CASE 150M. Ethnic Origin--It.; Socio-Economic Status--O

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
5.42	65.04	1025	62.12	59.83	28.26	58	25.55
6.38	76.56	1095	66.36	73.49	34.71	--	--
7.40	88.80	1160	70.30	84.80	40.06	77	33.92
8.40	100.80	1218	73.81	101.30	47.85	90	39.65
9.41	112.92	1270	76.96	130.42	61.61	107	47.13
10.40	124.80	1342	81.33	144.14	68.09	124	54.62
11.39	136.68	1435	86.96	155.13	73.28	144	63.43
12.39	148.68	1527	92.54	179.15	84.63	166	73.12
13.40	160.80	1598	96.84	190.54	90.01	180	79.29
14.38	172.56	1627	98.60	199.30	94.15	202	88.98
15.39	184.68	1637	99.21	197.60	93.34	216	95.15
16.41	196.92	1650	100.00	211.68	100.00	226	99.55
17.48	209.76	1644	99.13	--	--	227	100.00

CASE 162M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.33	87.96	1146	70.09	106.43	47.36	77	34.84
8.37	100.44	1202	73.51	120.53	53.63	89	40.27
9.38	112.56	1243	76.02	122.12	54.34	101	45.70
10.35	124.20	1283	78.47	137.86	61.34	113	51.13
11.39	136.68	1330	81.34	162.64	72.37	125	56.56
12.36	148.32	1380	84.40	171.30	76.27	138	62.44
13.31	159.72	1452	88.80	184.47	82.08	156	70.58
14.34	172.08	1549	94.74	197.03	87.67	174	78.73
15.36	184.32	1603	98.04	210.12	93.50	190	85.97
16.34	196.08	1625	99.38	215.68	95.97	208	94.11
17.34	208.08	1635	100.00	224.72	100.00	221	100.00

CASE 166M. Ethnic Origin--NE; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.59	79.08	1140	65.55	--	--	58	29.29
7.55	90.60	1199	68.94	101.47	45.87	72	36.36
8.56	102.72	1255	72.16	102.20	46.20	84	42.42
9.56	114.72	1300	74.75	103.82	46.93	--	--
10.59	127.08	1350	77.63	128.98	58.31	107	54.04
11.58	138.96	1398	80.39	129.92	58.73	118	59.59
12.56	150.72	1446	83.15	143.93	65.07	129	65.15
13.56	162.72	1489	85.62	170.85	77.24	142	71.71
14.56	174.72	1537	88.38	179.08	80.96	155	78.28
15.57	186.84	1614	92.81	183.10	82.78	169	85.35
16.57	198.84	1697	97.58	201.11	90.92	182	91.91
17.59	211.08	1739	100.00	221.18	100.00	198	100.00

CASE 203M. Ethnic Origin--It.; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.96	83.52	1137	68.41	81.85	37.99	92	40.52
7.92	95.04	1183	71.17	110.25	51.18	104	45.81
8.94	107.28	1252	75.33	119.08	55.28	118	51.98
9.94	119.28	1294	77.85	114.51	53.16	126	55.50
10.95	131.40	1342	80.74	137.97	64.05	134	59.03
11.94	143.28	1396	83.99	160.47	74.49	144	63.43
12.93	155.16	1446	87.00	172.23	79.95	161	70.92
13.93	167.16	1539	92.59	168.83	78.37	172	75.77
14.93	179.16	1613	97.05	209.62	97.31	186	81.93
15.94	191.28	1641	98.73	202.76	94.13	202	88.98
16.94	203.28	1657	96.69	197.19	91.54	219	96.47
17.95	215.40	1662	100.00	215.40	100.00	227	100.00

CASE 227M. Ethnic Origin--NE; Socio- Economic Status--II

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.08	72.96	1122	63.21	88.28	33.03	76	35.64
6.87	82.44	1180	66.47	103.87	38.87	88	41.31
7.94	95.28	1240	69.85	131.49	49.20	102	47.88
8.85	106.20	1292	72.78	124.25	46.49	114	53.52
9.91	118.92	1356	76.39	147.46	55.18	124	58.21
10.88	130.56	1411	79.49	147.53	55.20	134	62.91
11.89	142.68	1472	82.92	169.79	63.53	148	69.48
12.89	154.68	1526	85.97	193.35	72.35	160	75.11
13.86	166.32	1607	90.53	207.90	77.80	170	79.81
14.89	178.68	1698	95.65	237.64	88.93	182	85.44
15.87	190.44	1750	98.59	257.09	96.20	196	92.01
16.87	202.44	1775	100.00	267.22	100.00	213	100.00

CASE 232M. Ethnic Origin--NE; Socio-Economic Status--III

Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
5.93	71.16	--	--	163.18	59.21	85	41.66
7.00	84.00	1302	72.98	152.04	55.17	97	47.54
8.01	96.12	1361	76.28	150.91	54.76	111	54.41
9.05	108.60	1418	79.48	177.02	64.24	121	59.31
10.02	120.24	1462	81.95	167.13	60.65	132	64.70
11.01	132.12	1507	84.47	183.65	66.64	144	70.58
12.02	144.24	1566	87.78	219.24	79.56	152	74.50
12.98	155.76	1610	90.24	195.32	70.88	160	78.43
14.01	168.12	1710	95.85	221.92	80.53	175	85.78
15.03	180.36	1755	98.37	248.90	90.32	187	91.66
16.01	192.12	1776	99.55	226.70	82.27	204	100.00
17.01	204.12	1784	100.00	275.56	100.00	--	--

CASE 250M. Ethnic Origin--NE; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
5.97	71.64	1103	65.92	64.47	32.51	80	42.78
6.88	82.56	1160	69.33	99.07	49.95	90	48.12
7.89	94.68	1212	72.44	88.05	44.40	102	54.54
8.93	107.16	1260	75.31	122.16	61.60	114	60.96
9.90	118.80	1306	78.06	134.24	67.69	122	65.24
10.89	130.68	1354	80.93	143.74	72.48	132	70.58
11.90	142.92	1406	84.04	165.64	83.53	141	75.40
12.86	154.32	1440	86.07	175.92	88.71	152	81.28
13.89	166.68	1505	89.95	190.01	95.81	164	87.70
14.91	178.92	1599	95.57	186.07	93.83	174	93.04
15.89	190.68	1673	100.00	198.30	100.00	187	100.00

CASE 255M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.01	84.12	--	--	80.75	37.76	72	31.71
8.08	96.96	1305	74.82	95.02	44.43	88	38.76
9.17	110.04	1368	78.44	--	--	103	45.37
10.13	121.56	1427	81.82	122.77	57.41	125	55.06
11.10	133.20	1494	85.66	135.86	63.53	144	63.43
12.09	145.08	1592	91.28	163.94	76.67	161	70.92
13.10	157.20	1697	97.30	183.13	85.64	185	81.49
14.06	168.72	1716	98.39	192.34	89.95	198	87.22
15.09	181.08	1738	99.65	178.16	83.32	216	95.15
16.11	193.32	1739	99.71	191.38	89.50	222	97.79
17.10	205.20	1740	99.77	207.25	96.92	227	100.00
18.09	217.08	1744	100.00	213.82	100.00	227	100.00

CASE 269M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
8.16	97.92	1143	68.07	--	--	--	--
9.07	108.84	1230	73.25	96.86	53.09	103	47.68
10.11	121.32	1288	76.71	106.76	58.51	115	53.24
11.12	133.44	1340	79.80	125.43	68.75	126	58.33
12.09	145.08	1383	82.37	139.27	76.33	139	64.35
13.09	157.08	1424	84.81	150.79	82.65	150	69.44
14.10	169.20	1505	89.63	172.58	94.59	162	75.00
15.10	181.20	1596	95.05	148.58	81.44	179	82.87
16.10	193.20	1652	98.39	156.49	85.77	192	88.89
17.12	205.44	1670	99.46	164.35	90.08	204	94.44
18.10	217.20	1679	100.00	182.44	100.00	216	100.00

CASE 280M. Ethnic Origin--N; Socio-Economic Status--V

Age Year	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.38	76.56	1201	67.35	68.13	41.80	90	39.64
7.19	86.28	1246	69.88	92.31	56.64	102	44.93
8.25	90.00	1306	73.24	101.97	62.57	--	--
9.20	110.40	1367	76.66	101.56	62.32	125	55.06
10.21	122.52	1427	80.03	99.24	60.89	135	59.47
11.18	134.16	1475	82.72	118.06	72.44	147	64.75
12.19	146.28	1543	86.53	131.65	80.78	157	69.16
13.19	158.28	1637	91.81	126.62	77.70	168	74.00
14.16	169.92	1702	95.45	127.44	78.20	179	78.85
15.18	182.16	1752	98.26	134.79	82.71	192	84.58
16.23	194.76	1776	99.60	142.17	87.24	216	95.15
17.19	206.28	1783	100.00	162.96	100.00	227	100.00

CASE 288M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.94	83.28	1163	65.89	100.76	39.70	89	41.58
7.75	93.00	1211	68.61	140.43	55.34	102	47.66
8.79	105.48	1277	72.33	140.28	55.28	113	52.80
9.75	117.00	1335	75.63	120.51	47.49	125	58.41
10.78	129.36	1385	78.47	153.93	60.66	136	63.55
11.74	140.88	1444	81.81	167.64	66.06	146	68.22
12.75	153.00	1491	84.47	177.48	69.94	156	72.89
13.75	165.00	1543	87.42	207.90	81.93	162	75.70
14.75	177.00	1623	91.95	235.41	92.77	173	80.84
15.78	189.36	1709	96.82	253.74	100.00	185	86.44
16.75	201.00	1754	99.37	239.19	94.26	196	91.58
17.75	213.00	1765	100.00	253.34	99.84	214	100.00

CASE 319M. Ethnic Origin--NE; Socio-Economic Status--I

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.10	85.20	--	--	97.98	41.53	89	42.58
8.12	97.44	1332	72.66	147.13	62.37	103	49.27
9.16	109.92	1396	76.15	167.07	70.83	118	56.45
10.11	121.32	1450	79.10	172.27	73.03	130	62.19
11.14	133.68	1507	82.21	204.53	86.71	143	68.41
12.11	145.32	1583	86.36	193.27	81.93	156	74.63
13.13	157.56	1722	93.94	206.40	87.50	169	80.85
14.12	169.44	1791	97.70	210.10	89.07	183	87.55
15.12	181.44	1821	99.34	235.87	100.00	198	94.72
16.14	193.68	1833	100.00	220.79	93.60	209	100.00

CASE 343M. Ethnic Origin--NE; Socio-Economic Status--I

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.11	85.32	1160	68.96	81.90	36.25	78	34.36
8.07	96.84	1207	71.75	117.17	51.87	90	39.64
9.09	109.08	1273	75.68	121.14	53.63	102	44.93
10.08	120.96	1317	78.29	119.14	52.74	113	49.77
11.10	133.20	1363	81.03	146.52	64.86	126	55.50
12.08	144.96	1403	83.41	160.18	70.91	140	61.67
13.08	156.96	1441	85.67	160.80	71.18	151	66.51
14.08	168.96	1491	88.64	174.02	77.04	167	73.56
15.07	180.84	1571	93.40	184.45	81.65	178	78.41
16.09	193.08	1641	97.56	207.56	91.88	198	87.22
17.09	205.08	1664	98.92	213.28	94.42	214	94.27
18.10	217.20	1682	100.00	225.88	100.00	227	100.00

CASE 350M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.91	94.92	--	--	116.75	49.75	92	40.53
8.92	107.04	1281	73.87	142.36	60.66	104.	45.81
9.92	119.04	1344	77.50	136.89	58.33	119	52.42
10.93	131.16	1390	80.16	136.40	58.12	131	57.70
11.94	143.28	1446	83.39	156.17	66.55	144	63.43
12.97	155.64	1533	88.40	174.43	74.33	160	70.48
13.96	167.52	1627	93.82	185.94	79.23	172	75.77
14.91	178.92	1680	96.88	191.44	81.58	186	81.93
15.96	191.52	1711	98.67	197.26	84.06	198	87.22
16.94	203.28	1722	99.30	213.44	90.95	212	93.39
17.94	215.28	1734	100.00	208.82	88.98	217	95.59
18.94	227.28	1731	99.82	234.66	100.00	227	100.00

CASE 368M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.64	79.68	1142	69.54	71.71	43.64	70	40.46
7.65	91.80	1198	72.95	88.12	53.63	--	--
8.62	103.44	1264	76.97	96.19	58.54	90	52.02
9.61	115.32	1325	80.69	--	--	112	64.73
10.61	127.32	1380	84.04	106.94	65.08	126	72.83
11.56	138.72	1426	86.84	135.94	82.73	132	76.30
12.56	150.72	1479	90.07	149.21	90.81	138	79.76
13.59	163.08	1515	92.26	146.77	89.32	149	86.12
14.59	175.08	1546	94.15	155.82	94.83	160	92.48
15.56	186.72	1583	96.40	164.31	100.00	167	96.53
16.56	198.72	1642	100.00	160.96	97.96	173	100.00

CASE 371M. Ethnic Origin--It.; Socio-Economic Status--V

7.14	85.68	1080	67.62	83.12	46.19	74	32.59
8.05	96.60	1128	70.63	95.63	53.14	84	37.00
9.14	109.68	1187	74.32	107.50	59.74	101	44.49
10.10	121.20	1232	77.14	106.65	59.26	113	49.77
11.07	132.84	1280	80.15	112.88	62.73	127	55.94
12.06	144.72	1333	83.46	115.76	64.33	144	63.43
13.07	156.84	1444	90.41	--	--	161	70.92
14.03	168.36	1526	95.55	134.72	74.86	178	78.41
15.06	180.72	1572	98.43	160.82	89.37	196	76.34
16.08	192.96	1573	98.49	167.91	93.31	209	92.07
17.08	204.96	1586	99.31	170.15	94.55	221	97.35
18.07	216.84	1597	100.00	179.94	100.00	227	100.00

CASE 372M. Ethnic Origin--It.; Socio-Economic Status--0

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
8.54	102.5	1275	75.17	76.87	47.53	103	48.13
9.45	113.4	1320	77.83	137.21	84.84	118	55.14
10.54	126.5	1368	80.66	122.70	75.87	129	60.28
11.50	138.0	1409	83.07	138.00	85.33	142	66.35
12.47	149.6	1455	85.79	139.12	86.02	153	71.49
13.50	162.0	1497	88.26	150.66	93.16	164	76.63
14.49	137.9	1594	93.98	161.72	100.00	178	83.17
15.44	185.3	1655	97.58	155.65	96.24	190	88.78
16.49	197.9	1684	99.29	154.36	95.44	203	94.85
17.51	210.1	1696	100.00	157.57	97.43	214	100.00

CASE 373M. Ethnic Origin--It.; Socio-Economic Status--0

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
9.06	108.7	1134	73.54	92.39	52.62	88	38.76
9.97	119.6	1170	75.87	117.20	66.75	101	44.49
11.06	132.7	1217	78.92	116.77	66.51	114	50.22
12.02	144.2	1274	82.61	106.70	60.77	132	58.14
12.99	155.9	1341	86.96	120.04	68.37	148	65.19
14.02	168.2	1439	93.32	--	--	162	71.36
15.00	180.0	1510	97.92	142.20	80.99	197	86.78
15.96	191.5	1517	98.37	143.62	81.80	210	92.78
17.01	204.1	1537	99.67	155.11	88.35	221	92.51
18.02	216.2	1540	99.87	170.79	97.28	227	97.35
19.00	228.2	1542	100.00	175.56	100.00	227	100.00

CASE 380M. Ethnic Origin--It.; Socio-Economic Status--IV

Age Years	Age Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.17	74.0	1107	66.01	85.84	43.02	60	26.54
7.13	85.6	--	--	94.16	47.19	71	31.41
8.15	97.8	1232	73.46	117.36	58.82	82	36.28
9.15	109.8	1282	76.44	122.97	61.63	93	41.15
10.16	121.9	1336	79.66	125.55	62.92	108	47.78
11.15	133.8	1396	83.24	137.81	69.07	136	60.17
12.14	145.7	1491	88.90	163.18	81.79	154	68.14
13.14	157.7	1580	94.21	171.89	86.15	167	73.89
14.15	169.9	1631	97.25	176.69	88.56	180	79.64
15.13	181.6	1657	98.80	188.86	94.66	200	88.49
16.14	193.7	1665	99.28	199.51	100.00	216	95.57
17.17	206.0	1672	99.70	197.76	99.12	218	96.46
18.23	218.8	1677	100.00	--	--	226	100.00

CASE 402M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Age Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.30	87.6	--	--	77.96	43.14	90	39.64
8.32	99.8	1237	72.63	105.78	58.54	104	45.81
9.36	112.3	1326	77.86	99.94	55.31	114	50.22
10.31	123.7	1373	80.62	110.09	60.92	125	55.06
11.34	136.1	1418	83.26	121.12	67.03	139	61.23
12.31	147.7	1465	86.02	134.40	74.38	154	67.84
13.33	160.0	1573	92.36	168.00	92.97	168	74.00
14.32	171.8	1641	96.35	163.21	90.32	179	78.85
15.29	183.5	1672	98.17	159.64	88.35	200	88.10
16.32	195.8	1678	98.53	156.64	86.68	211	92.95
17.31	207.7	1689	99.17	180.69	100.00	227	100.00
18.30	219.6	1703	100.00	175.68	97.22	227	100.00

CASE 407M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.92	83.2	1281	71.12	86.52	38.75	94	41.40
7.72	92.6	1329	73.79	96.30	43.13	107	47.13
8.78	105.4	1403	77.90	109.61	49.10	120	52.86
9.73	116.8	1456	80.84	131.98	59.12	131	57.70
10.76	129.1	1513	84.00	142.01	63.61	144	63.43
11.73	140.8	1556	86.39	143.61	64.33	155	68.27
12.74	152.3	1620	89.95	166.00	74.36	166	73.12
13.74	164.9	1692	93.94	187.98	84.20	178	78.41
14.71	176.5	1758	97.61	197.68	88.55	191	84.13
15.74	188.9	1783	99.00	198.34	88.85	202	88.98
16.72	200.6	1790	99.38	210.63	94.35	215	94.70
17.72	212.6	1801	100.00	223.23	100.00	227	100.00

CASE 412M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.73	92.8	1308	71.67	72.38	44.26	74	32.59
8.53	102.4	1346	73.75	69.63	42.57	87	38.32
9.60	115.2	1405	76.98	78.34	47.90	99	43.61
10.56	126.7	1454	79.67	90.59	55.39	114	50.22
11.59	139.1	1507	82.57	102.93	62.94	129	56.82
12.59	151.1	1562	85.58	102.75	62.83	147	64.75
13.54	162.5	1614	88.43	122.69	75.02	160	70.48
14.52	174.2	1695	92.87	130.65	79.89	173	76.20
15.53	186.4	1772	97.09	135.14	82.63	192	84.57
16.54	198.5	1806	98.95	136.97	83.75	205	90.30
17.58	211.0	1817	99.56	163.53	100.00	219	96.47
18.55	222.6	1825	100.00	153.59	93.92	227	100.00

CASE 417M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.20	86.5	--	--	102.94	53.57	80	44.20
8.22	98.6	1261	74.13	103.53	53.88	90	49.72
9.26	111.1	1311	77.07	120.44	63.68	101	55.80
10.22	122.6	1353	79.54	124.44	64.76	112	61.88
11.25	135.0	1398	82.18	145.80	75.88	125	69.06
12.21	146.5	1429	84.00	154.56	80.44	134	74.03
13.22	158.6	1472	86.53	166.53	86.67	145	80.11
14.22	170.6	1498	88.06	179.98	93.67	156	86.19
15.22	182.6	1546	90.88	174.38	90.75	162	89.50
16.24	194.9	1619	95.17	179.31	93.32	172	95.03
17.22	206.6	1701	100.00	192.14	100.00	181	100.00

CASE 442M. Ethnic Origin--It.; Socio-Economic Status--0

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.90	82.8	1215	67.91	79.49	46.02	84	43.97
7.87	94.4	1275	71.26	80.24	46.45	96	50.25
8.88	106.6	1337	74.73	86.35	49.99	109	57.06
9.88	118.6	1394	77.92	84.80	49.09	121	63.34
10.89	130.7	1444	80.71	111.75	64.70	132	69.10
11.88	142.6	1502	83.95	121.92	70.58	143	74.86
12.87	154.4	1564	87.42	128.15	74.19	156	81.66
13.87	166.4	1647	92.06	122.30	70.80	168	87.95
14.88	178.6	1729	96.64	169.67	98.23	--	--
15.86	190.3	1789	100.00	158.90	91.99	191	100.00
16.93	203.2	--	--	172.72	100.00	--	--

CASE 444M. Ethnic Origin--It.; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.17	74.0	1180	66.36	59.20	28.81	77	35.81
7.00	84.0	1232	69.29	94.92	46.20	90	41.86
8.01	96.1	1300	73.11	87.93	42.80	102	47.44
9.04	108.5	1356	76.26	104.16	50.70	114	53.02
10.01	120.1	1402	78.85	109.89	53.49	126	58.60
11.05	132.6	1463	82.28	116.69	56.80	137	63.72
12.02	144.2	1519	85.43	--	--	152	70.59
12.98	155.8	1581	88.92	142.50	69.36	164	76.27
14.00	168.0	1680	94.48	159.60	77.69	178	82.78
15.02	180.2	1743	98.03	205.43	100.00	192	89.29
16.01	192.1	1764	99.21	197.86	96.31	203	94.41
17.01	204.1	1778	100.00	189.81	92.39	215	100.00

CASE 456M. Ethnic Origin--It.; Socio-Economic Status--II

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.31	87.7	1217	70.30	85.06	52.01	89	46.84
8.11	97.3	1258	72.67	88.54	54.14	101	53.15
9.12	109.4	1320	76.25	110.49	67.56	113	59.47
10.15	121.8	1379	79.66	110.83	67.77	125	65.78
11.13	133.6	1429	82.55	134.93	82.51	137	72.10
12.16	145.9	1472	85.03	140.06	85.64	150	78.94
13.14	157.7	1548	89.42	154.54	94.50	162	85.26
14.11	169.3	1657	95.72	154.06	94.20	175	92.10
15.14	181.7	1731	100.00	163.53	100.00	190	100.00

CASE 460M. Ethnic Origin--It.; Socio-Economic Status--V

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.09	85.1	1036	68.65	--	--	66	31.57
8.05	96.6	1077	71.37	--	--	79	37.79
9.06	108.7	1118	74.08	84.78	59.16	90	43.05
10.06	120.7	1157	76.67	80.86	56.43	104	49.75
11.08	133.0	1198	79.39	105.07	73.32	118	56.45
12.05	144.6	1239	82.10	92.54	64.58	131	63.67
13.05	156.6	1300	86.14	103.35	72.12	144	68.89
14.06	168.7	1393	92.31	102.90	71.81	168	80.37
15.06	180.7	1463	96.95	128.29	89.53	--	--
16.06	192.7	1493	98.93	142.59	99.51	192	91.85
17.06	204.7	1509	100.00	143.29	100.00	209	100.00

CASE 474M. Ethnic Origin--It.; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.81	81.7	1069	65.22	87.41	44.97	77	36.66
7.77	93.2	1109	67.66	108.11	55.62	89	42.38
8.78	105.4	1156	70.53	110.67	56.93	102	48.57
9.78	117.4	1215	74.13	122.09	62.81	115	54.76
10.80	129.6	1265	77.18	129.60	66.67	126	60.00
11.77	141.2	1315	80.23	145.43	74.82	138	65.71
12.77	153.2	1372	83.70	163.92	84.33	149	70.95
13.79	165.5	1436	87.61	162.19	83.44	161	76.67
14.77	177.2	1532	93.47	177.20	91.16	172	81.90
15.78	189.4	1603	97.80	183.71	94.51	184	87.62
16.78	201.4	1622	99.63	191.33	98.43	198	94.28
17.80	213.6	1639	100.00	194.37	100.00	210	100.00

CASE 478M. Ethnic Origin--NE; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.35	88.2	--	--	127.00	55.99	89	39.20
8.37	100.4	1351	75.94	123.49	54.44	102	44.93
9.41	112.9	1397	78.52	111.77	49.27	114	50.21
10.37	124.4	1451	81.56	128.13	56.49	127	55.94
11.40	136.8	1494	83.97	151.84	66.94	142	62.55
12.36	148.3	1543	86.73	169.06	74.53	154	67.84
13.39	160.7	1653	92.91	194.44	85.72	166	73.12
14.38	172.6	1730	97.24	219.20	96.64	179	78.85
15.37	184.4	1763	99.10	226.81	100.00	195	85.89
16.40	196.8	1778	99.94	222.38	98.04	215	94.70
17.37	208.4	1779	100.00	210.48	92.80	227	100.00

CASE 479M. Ethnic Origin--NE; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.42	77.0	1108	67.85	72.38	52.15	66	36.26
7.23	86.8	1161	71.09	77.25	55.66	78	42.85
8.29	99.5	1215	74.40	81.59	58.79	90	49.44
9.24	110.9	1264	77.40	100.91	72.71	103	56.59
10.25	123.0	1317	80.64	--	--	115	63.18
11.22	134.6	1352	82.79	99.60	71.77	127	69.77
12.23	146.8	1391	85.18	110.10	79.33	139	76.36
13.23	158.8	1428	87.44	117.51	84.67	150	82.41
14.20	170.4	1476	90.38	121.80	92.09	--	--
15.22	182.6	1543	94.48	138.77	100.00	--	--
16.25	195.0	1633	100.00	138.45	99.76	182	100.00

CASE 483M. Ethnic Origin--NE; Socio-Economic Status--II

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.33	76.0	--	--	72.20	32.91	75	39.26
7.40	88.8	1230	68.14	89.68	42.83	85	44.49
8.41	100.9	1291	71.52	108.97	49.68	97	50.78
9.45	113.4	1345	74.51	105.46	48.08	107	56.01
10.41	124.9	1399	77.50	138.63	63.20	120	62.82
11.41	136.9	1445	80.05	179.33	81.75	130	68.05
12.42	149.0	1502	83.21	169.86	77.44	143	74.86
13.39	160.7	1550	85.87	165.52	75.46	155	81.14
14.41	172.9	1606	88.97	186.73	85.13	159	83.23
15.42	185.0	1682	93.18	214.60	97.83	172	90.04
16.41	196.9	1755	97.22	218.55	99.63	180	94.23
17.41	208.9	1805	100.00	219.34	100.00	191	100.00

CASE 488M. Ethnic Origin--NE; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.13	73.6	1085	69.37	74.33	35.30	67	38.28
6.94	83.3	1133	72.44	166.62	79.13	78	44.57
7.99	95.9	1189	76.02	117.95	56.01	89	50.85
8.93	107.2	1232	78.77	108.62	51.58	98	56.00
9.96	119.5	1279	81.77	129.06	61.29	104	59.42
10.97	131.6	1317	84.20	147.39	69.99	108	61.71
11.92	143.0	1356	86.70	165.16	78.43	116	66.28
12.95	155.4	1398	89.38	170.16	80.81	125	71.42
13.91	166.9	1424	91.04	176.07	83.61	135	77.14
14.93	179.2	1461	93.41	210.56	100.00	148	84.57
15.92	191.0	1499	95.84	209.14	99.32	161	92.00
16.92	203.0	1564	100.00	204.01	96.88	175	100.00

CASE 526M. Ethnic Origin--It.; Socio-Economic Status--V

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.15	73.8	1078	65.73	77.49	41.09	69	35.02
7.11	85.3	1133	69.08	85.30	45.23	80	40.60
8.11	97.3	1186	72.31	103.13	54.69	93	47.20
9.11	109.3	1246	75.97	99.46	52.74	106	53.80
10.13	121.6	1299	79.20	106.40	56.43	119	60.40
11.10	133.2	1352	82.43	123.87	65.69	130	65.98
12.10	145.2	1402	85.48	134.31	71.23	143	72.58
13.09	157.1	1481	90.30	153.17	81.23	160	81.21
14.10	169.2	1575	96.03	164.97	87.49	175	88.83
15.11	181.3	1619	98.71	188.55	100.00	186	94.41
16.11	193.3	1640	100.00	188.46	99.95	197	100.00

CASE 530M. Ethnic Origin--It.; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.83	82.0	1131	68.05	85.28	52.34	71	31.27
7.62	91.4	1175	70.69	97.37	59.76	--	--
8.70	104.4	1231	74.06	--	--	100	44.05
9.64	115.7	1269	76.35	111.07	68.17	112	49.33
10.67	128.0	1321	79.48	120.32	73.84	123	54.18
11.62	139.4	1370	82.43	125.46	77.00	--	--
12.62	151.4	1423	85.61	125.66	77.12	--	--
13.63	163.6	1488	89.53	140.69	86.34	156	68.72
14.61	175.3	1543	92.83	133.22	81.76	167	73.56
15.62	187.4	1604	96.51	157.41	96.61	180	79.29
16.64	199.7	1637	98.49	153.76	94.37	194	85.46
17.63	211.6	1662	100.00	162.93	100.00	209	92.07
18.87	226.4	1661	99.93	160.74	98.65	227	100.00

CASE 534M. Ethnic Origin--M; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.50	78.0	1129	66.96	75.66	34.70	76	34.08
7.30	87.6	1175	69.69	92.85	42.59	88	39.46
8.35	100.2	1234	73.19	107.21	49.18	104	46.63
9.33	112.0	1283	76.09	118.72	54.46	116	52.01
10.31	123.7	1328	78.76	129.88	59.58	130	58.29
11.34	136.1	1379	81.79	149.71	68.68	141	63.22
12.30	147.6	1449	85.94	172.69	79.22	156	69.95
13.33	160.0	1581	93.77	169.60	77.80	170	76.23
14.29	171.5	1649	97.80	188.65	86.54	182	81.61
15.31	183.7	1667	98.87	198.39	91.01	198	88.78
16.30	195.6	1682	99.76	191.68	87.93	206	92.37
17.30	207.6	1686	100.00	217.98	100.00	223	100.00

CASE 542M. Ethnic Origin--NE; Socio-Economic Status--II

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.21	86.5	1123	66.60	94.28	41.61	71	31.27
8.02	96.2	1165	69.09	86.58	38.21	77	33.92
9.09	109.1	1217	72.18	118.91	52.48	89	39.20
10.04	120.5	1262	74.85	126.52	55.84	104	45.81
11.07	132.8	1315	77.99	134.12	59.19	120	52.86
12.06	144.7	1365	80.96	144.70	63.86	134	59.03
13.02	156.2	1465	86.89	149.95	66.18	153	67.40
14.05	168.6	1553	92.11	187.14	82.59	168	74.00
15.01	180.1	1618	95.96	187.30	82.66	180	79.29
16.03	192.4	1651	97.92	198.17	87.46	196	86.34
17.02	204.2	1669	98.99	191.94	84.71	208	91.62
18.08	217.0	1682	99.76	206.24	91.02	219	96.47
19.27	213.2	1686	100.00	226.57	100.00	227	100.00

CASE 574M. Ethnic Origin--It.; Socio-Economic Status--O

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.41	76.92	--	--	110.76	44.64	90	44.11
7.39	88.68	1338	74.04	144.54	58.25	101	49.50
8.45	101.40	1395	77.19	135.87	54.76	113	55.39
9.41	112.92	1446	80.02	156.95	63.25	125	61.27
10.44	125.28	1504	83.23	184.16	74.22	136	66.66
11.40	136.80	1541	85.27	206.56	83.25	144	70.58
12.39	148.68	1587	87.82	221.53	89.28	152	74.50
14.41	172.92	1670	92.41	240.35	96.87	169	82.84
15.44	185.28	1709	94.57	231.60	93.34	179	87.74
16.41	196.92	1772	98.06	248.11	100.00	190	93.13
17.55	210.60	1807	100.00	231.66	93.36	204	100.00

CASE 585M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.64	91.68	1237	70.16	134.76	56.65	78	40.62
8.46	101.52	1278	72.49	165.47	69.56	90	46.50
9.52	114.24	1342	76.12	143.94	60.50	102	53.12
10.51	126.12	1386	78.61	156.38	65.73	113	58.85
11.48	137.76	1436	81.45	184.59	77.59	125	65.10
12.51	150.12	1481	84.00	210.16	88.34	138	71.87
13.50	162.00	1529	86.72	205.74	86.48	149	77.50
14.45	173.40	1575	89.33	195.94	82.37	161	83.80
15.50	186.00	1656	93.93	232.50	97.73	184	95.83
16.52	198.24	1724	97.78	237.88	100.00	--	--
17.49	209.88	1763	100.00	222.47	93.52	192	100.00

CASE 599M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.24	86.88	1129	77.70	86.88	48.63	77	45.02
8.14	97.68	1171	80.59	97.68	54.68	89	52.04
9.15	109.80	1210	83.27	107.60	60.23	101	59.06
10.21	122.52	1248	85.89	107.82	60.35	112	65.49
11.16	133.92	1275	87.74	124.55	69.72	124	72.51
12.20	146.40	1318	90.70	140.54	78.67	135	78.94
13.17	158.04	1360	93.59	143.82	80.51	149	87.13
14.19	170.28	1397	96.14	154.95	86.74	--	--
15.19	182.28	1453	100.00	178.63	100.00	171	100.00

CASE 620M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.11	85.32	--	--	100.68	38.24	72	36.36
8.12	97.44	1245	73.36	112.06	42.56	84	42.42
9.12	109.44	1304	76.84	146.65	55.70	95	47.97
10.14	121.68	1349	79.49	161.83	61.46	108	54.54
11.13	133.56	1386	81.67	157.60	59.86	120	60.60
12.17	146.04	1429	84.20	229.28	87.08	132	66.66
13.15	157.80	1474	86.85	219.34	83.31	144	72.72
14.11	169.32	1514	89.21	225.20	85.53	155	78.28
15.15	181.80	1600	94.28	239.98	91.15	166	83.83
16.17	194.04	1660	97.81	260.01	98.76	180	90.90
17.14	205.68	1697	100.00	263.27	100.00	198	100.00

CASE 623M. Ethnic Origin--NE; Socio-Economic Status--0

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.19	86.28	1212	68.24	--	--	66	29.07
7.98	95.76	1267	71.34	88.09	44.90	79	34.80
9.05	108.60	1325	74.60	122.72	62.56	93	40.96
10.00	120.00	1388	78.15	117.60	59.95	106	46.69
11.03	132.36	1435	80.79	131.04	66.98	119	52.42
11.98	143.76	1495	84.17	142.32	72.56	133	58.59
12.98	155.76	1602	90.20	160.43	81.78	157	69.16
14.01	168.12	1703	95.88	154.67	78.85	176	77.53
14.97	179.64	1741	98.02	163.47	83.33	191	84.14
15.99	191.88	1755	98.81	168.85	86.08	207	91.18
17.99	215.88	1776	100.00	181.34	92.44	227	100.00
19.23	230.76	1768	99.54	196.15	100.00	227	100.00

CASE 626M. Ethnic Origin--NE; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.24	86.88	1129	67.76	--	--	--	--
8.05	96.60	1171	70.28	97.57	43.71	88	40.74
9.09	109.08	1236	74.18	136.35	61.08	101	46.75
10.07	120.84	1280	76.83	116.01	51.97	113	52.31
11.07	132.84	1334	80.07	164.72	73.79	126	58.33
12.06	144.72	1376	82.59	164.98	73.90	139	64.35
13.08	156.96	1432	85.95	167.95	75.23	152	70.37
14.03	168.36	1513	90.81	178.46	79.94	166	76.85
15.06	180.72	1592	95.55	177.11	79.34	179	82.87
16.08	192.96	1638	98.31	189.10	84.71	191	88.42
17.07	208.84	1657	99.45	210.93	94.49	204	94.44
18.06	216.72	1666	100.00	223.22	100.00	216	100.00

CASE 630M. Ethnic Origin--NE; Socio-Economic Status--I

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.20	74.40	--	--	77.37	30.35	71	33.80
7.01	84.12	1214	68.85	96.73	37.95	86	40.95
8.06	96.72	1285	72.88	136.85	53.69	96	45.71
9.00	108.00	1334	75.66	148.50	58.26	108	51.42
10.30	120.36	1391	78.89	186.55	73.19	119	56.66
11.04	132.48	1443	81.84	192.09	75.37	132	62.85
12.01	144.12	1504	85.30	210.41	82.56	146	69.52
13.01	156.12	1582	89.73	226.37	88.82	161	76.66
13.98	167.76	1688	95.74	248.28	97.42	175	83.33
15.00	180.00	1735	98.41	232.20	91.11	190	90.47
15.99	191.88	1759	99.77	254.24	99.76	199	94.76
16.99	203.88	1763	100.00	254.85	100.00	210	100.00

CASE 645M. Ethnic Origin--J; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.40	76.80	1118	65.95	95.23	39.02	77	60.62
7.36	88.32	1183	69.79	106.86	43.79	89	70.07
8.38	100.56	1239	73.09	128.71	52.74	102	80.31
9.38	112.56	1289	76.04	152.51	62.50	114	89.76
10.39	124.68	1339	78.99	174.55	71.53	127	100.00
11.38	136.56	1390	82.00	189.81	77.78	--	--
12.39	148.68	1454	85.78	205.17	84.08	--	--
13.36	160.32	1553	91.62	232.46	95.26	--	--
14.37	172.44	1636	96.51	229.34	93.98	--	--
15.35	184.20	1687	99.52	225.82	92.54	--	--
16.37	196.44	1691	99.76	238.67	97.81	--	--
17.38	208.56	1695	100.00	244.01	100.00	--	--

CASE 648M. Ethnic Origin--NE; Socio-Economic Status--II

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.95	83.40	1168	69.19	100.91	42.29	77	41.17
7.76	93.12	1216	72.03	125.71	52.69	87	46.52
8.80	105.60	1275	75.53	140.44	58.86	101	54.01
9.75	117.00	1322	78.31	133.96	56.15	113	60.42
10.78	129.36	1371	81.22	178.51	74.82	125	66.84
11.75	141.00	1412	83.64	176.95	74.17	131	70.05
12.76	153.12	1457	86.31	195.99	82.15	139	74.33
13.76	165.12	1482	87.79	196.49	82.36	150	80.21
14.76	177.12	1526	90.40	218.74	91.69	156	83.42
15.78	189.36	1572	93.12	213.01	89.28	166	88.77
16.75	201.00	1630	96.56	234.16	98.15	179	95.72
17.75	213.00	1688	100.00	238.56	100.00	187	100.00

CASE 661M. Ethnic Origin--NE; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.45	77.40	1166	66.21	58.82	26.10	78	37.68
7.26	87.12	1216	69.05	87.12	38.66	89	42.99
8.31	99.72	1273	72.28	105.70	46.90	102	49.27
9.28	111.36	1321	75.01	124.16	55.10	114	55.07
10.31	123.72	1372	77.91	124.95	55.45	125	60.38
11.26	135.12	1416	80.40	135.12	59.96	132	63.76
12.25	147.00	1466	83.24	159.49	70.78	145	70.04
13.27	159.24	1514	85.97	157.64	69.95	156	75.36
14.24	170.88	1550	88.01	153.79	68.25	161	77.77
15.26	183.12	1591	90.34	174.87	77.60	168	81.15
16.26	195.12	1654	93.92	188.29	83.56	174	84.05
17.26	207.12	1732	98.35	202.97	90.07	180	86.95
18.50	222.00	1761	100.00	225.33	100.00	207	100.00

CASE 669M. Ethnic Origin--NE; Socio-Economic Status--II

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.06	72.73	1201	67.39	58.90	29.19	77	33.92
6.85	82.20	1240	69.58	101.10	50.11	89	39.20
7.91	94.92	1299	72.89	105.36	52.22	101	44.49
8.87	106.44	1364	76.54	92.07	45.64	114	50.22
9.90	118.80	1420	79.68	114.04	56.53	125	55.06
10.90	130.80	1475	82.77	116.41	57.70	137	60.35
11.89	142.68	1543	86.58	133.40	66.12	151	66.51
12.87	154.44	1616	90.68	146.71	72.72	162	71.36
13.85	166.20	1710	95.95	156.22	77.44	180	79.29
14.87	178.44	1755	98.48	178.44	88.45	203	89.42
15.86	190.32	1755	98.48	201.73	100.00	215	94.71
16.86	202.32	1782	100.00	188.15	93.26	227	100.00

CASE 685M. Ethnic Origin--It.; Socio-Economic Status--III

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.39	76.68	1114	66.94	66.71	34.65	71	31.27
7.20	86.40	1171	70.37	82.08	42.63	83	36.56
8.25	99.00	1232	74.03	83.16	43.19	93	40.96
9.22	110.64	1276	76.68	98.46	51.14	111	48.89
10.25	123.00	1321	79.38	111.93	58.14	124	54.62
11.20	134.40	1363	81.91	112.89	58.64	135	59.47
12.19	146.28	1420	85.33	122.87	63.82	--	--
13.21	158.52	1475	88.64	144.25	74.93	159	70.04
14.18	170.16	1559	93.68	151.44	78.66	168	74.00
15.20	182.40	1619	97.29	147.74	76.74	180	79.29
16.21	194.40	1650	99.15	159.40	82.80	199	87.66
17.21	206.52	1652	99.27	175.54	91.18	221	97.35
18.44	221.28	1664	100.00	192.51	100.00	227	100.00

CASE 699M. Ethnic Origin--NE; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.77	93.24	1285	71.38	93.24	48.68	89	39.20
8.76	105.12	1336	74.22	103.01	53.78	102	44.93
9.75	117.00	1393	77.38	122.85	64.14	113	49.77
10.74	128.88	1438	79.88	121.14	63.25	123	54.18
11.71	140.52	1491	82.83	115.22	60.16	132	58.14
12.10	152.40	1542	85.66	134.11	70.02	145	63.87
13.71	164.52	1618	89.88	138.19	72.15	156	68.72
14.67	176.04	1722	95.66	153.15	79.96	176	77.53
15.70	188.40	1763	97.94	165.79	86.56	192	84.58
16.70	200.40	1779	98.83	172.34	89.98	216	95.15
17.70	212.40	1794	99.66	176.29	92.04	227	100.00
18.71	224.52	1800	100.00	170.63	89.09	227	100.00
19.95	239.40	1800	100.00	191.52	100.00	227	100.00

CASE 721M. Ethnic Origin--NE; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.78	93.36	1259	70.13	109.23	56.64	77	38.88
8.75	105.00	1302	72.53	126.00	65.33	90	45.45
9.74	116.88	1360	75.76	118.36	61.37	101	51.01
10.73	128.76	1414	78.77	135.20	70.10	114	57.57
11.70	140.40	1450	80.77	143.91	74.62	126	63.63
12.73	152.76	1490	83.00	169.56	87.92	139	70.20
13.71	164.52	1554	86.57	161.23	83.60	151	76.26
14.67	176.04	1637	91.19	161.96	83.98	162	81.81
15.72	188.64	1724	96.04	166.00	86.08	173	87.37
16.74	200.88	1769	98.55	192.84	100.00	185	93.43
17.75	213.00	1795	100.00	191.70	99.40	198	100.00

CASE 1801M. Ethnic Origin--NE; Socio-Economic Status--IV

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
7.49	89.88	--	--	94.37	50.25	--	--
8.50	102.00	1228	71.93	--	--	90	40.54
9.51	114.12	1273	74.57	118.68	63.19	103	46.39
10.52	126.24	1315	77.03	122.45	65.20	117	52.70
11.51	138.12	1367	80.08	146.40	77.95	129	58.10
12.55	150.60	1407	82.42	161.14	85.80	139	62.61
13.52	162.21	1472	86.23	147.63	78.61	150	67.56
14.49	173.88	1565	91.68	158.23	84.25	163	73.42
15.53	186.36	1652	96.77	169.58	90.30	180	81.08
16.56	198.72	1689	98.94	172.88	92.06	192	86.48
17.53	210.36	1707	100.00	185.11	98.57	211	95.04
18.63	223.56	1699	99.53	187.79	100.00	222	100.00

CASE 2848M. Ethnic Origin--NE; Socio-Economic Status--II

Age Years	Mos.	Height in mm.	% of Dev.	M.A.	% of Dev.	S.A.	% of Dev.
6.05	72.60	1106	62.73	87.84	40.22	62	31.95
6.83	81.96	1160	65.79	105.72	48.41	71	36.59
7.90	94.80	1225	69.48	127.03	58.17	83	42.78
8.86	106.32	1289	73.11	114.82	52.58	94	48.45
9.89	118.68	1339	75.95	145.97	66.84	106	54.63
10.98	131.76	1390	78.84	152.84	69.99	118	60.82
11.86	142.32	1433	81.28	162.24	74.29	130	67.01
12.86	154.32	1482	84.06	168.20	77.02	145	74.74
13.83	165.96	1545	87.63	187.53	85.87	156	80.41
14.86	178.32	1634	92.68	196.15	89.82	168	86.59
15.85	190.20	1716	97.33	214.92	98.42	181	93.29
16.85	202.20	1763	100.00	218.37	100.00	194	100.00

APPENDIX B

CASE 4M

	Height	Skeletal Age	Mental Age
K_1	1410	156	174
r_1	.2687	.1713	.3654
i_1	24.23	20.76	6.19
K_2	261	88	16
r_2	.813	.2770	.7907
i_2	-102.29	-15.91	-97.36
t_2	143.93	110.61	141.76
K_3	1671	224	190
t_3	18.3	27.65	18.27
Average error of equation	9.85	1.807	7.25

CASE 15M

	Height	Skeletal Age	Mental Age
K_1	1574	128	140
r_1	.1530	.4152	.4211
i_1	31.92	4.34	-0.80
K_2	253	102	49
r_2	.8536	.3418	.4000
i_2	-92.86	-20.39	-29.93
t_2	126.04	102.75	111.65
K_3	1827	230	189
t_3	16.48	23.50	22.07
Average error of equation	8.72	2.59	4.40

CASE 37M

	Height	Skeletal Age	Mental Age
K_1	1610	156	166
r_1	.2211	.2300	.4077
i_1	25.66	16.29	9.15
K_2	243.6	96	77
r_2	.945	.3370	.6873
i_2	-123.61	-30.33	-64.90
t_2	146.3	133.70	115.85
K_3	1853.6	252	243
t_3	17.60	26.29	17.08
Average error of equation	11.01	2.85	5.49

CASE 56M

	Height	Skeletal Age	Mental Age
K_1	1514	144	127
r_1	.2487	.2623	.4255
i_1	19.21	11.02	8.03
K_2	230.0	102	78
r_2	.7693	.3650	.4358
i_2	-92.62	-30.08	-33.44
t_2	139.54	122.76	110.53
K_3	1744	246	205
t_3	18.26	24.22	20.93
Average error of equation	6.44	1.759	5.878

CASE 60M

	Height	Skeletal Age	Mental Age
K_1	1566	117	111
r_1	.1457	.3423	.3450
i_1	28.77	7.00	18.00
K_2	200	108	69
r_2	.826	.2317	.3738
i_2	-111.62	-8.27	-25.71
t_2	153.0	99.27	108.13
K_3	1766	225	180
t_3	18.93	30.31	22.67
Average error of equation	16.26	2.51	4.80

CASE 68M

	Height	Skeletal Age	Mental Age
K_1	1523	143	170
r_1	.1306	.2387	.4320
i_1	30.64	15.45	-3.67
K_2	247.0	95	56
r_2	.7036	.2848	.4437
i_2	-85.56	-19.70	-41.69
t_2	146.91	120.89	127.16
K_3	1770.0	238	226
t_3	19.13	28.00	22.10
Average error of equation	10.24	6.07	4.76

CASE 69M

	Height	Skeletal Age	Mental Age
K_1	1612	159	150
r_1	.1759	.2310	.2279
i_1	25.47	14.05	12.97
K_2	188.3	72	35
r_2	.8850	.2827	.8335
i_2	-119.07	-19.93	-103.13
t_2	151.18	122.60	141.40
K_3	1800.3	231	185
t_3	18.37	28.27	18.45
Average error of equation	6.35	2.748	7.16

CASE 81M

	Height	Skeletal Age	Mental Age
K_1	1525	154	180
r_1	.1792	.2570	.3208
i_1	26.73	15.27	10.80
K_2	175.3	53	66
r_2	.8958	.2132	.4233
i_2	-125.20	-6.27	-37.12
t_2	156.20	98.50	122.48
K_3	1700.3	207	246
t_3	18.71	32.15	22.27
Average error of equation	5.24	2.18	3.203

CASE 82M

	Height	Skeletal Age	Mental Age
K_1	1547	166	116
r_1	.1665	.1911	.2750
i_1	28.19	17.82	23.07
K_2	237.8	73	61
r_2	.6053	.2972	.6900
i_2	-70.88	-20.69	-79.20
t_2	141.43	119.18	136.13
K_3	1784.8	239	177
t_3	20.22	27.11	18.74
Average error of equation	6.21	2.25	6.230

CASE 83M

	Height	Skeletal Age	Mental Age
K_1	1519	157	116
r_1	.1722	.2382	.2344
i_1	29.15	12.82	19.22
K_2	212.5	68	36
r_2	.7426	.3097	.5980
i_2	-90.67	-22.15	-58.44
t_2	141.93	119.08	122.35
K_3	1731.5	225	152
t_3	18.70	26.41	18.73
Average error of equation	7.77	.83	7.590

CASE 94M

	Height	Skeletal Age	Mental Age
K_1	1528	157	135
r_1	.1600	.2117	.2294
i_1	27.88	13.86	16.35
K_2	208.2	31	52
r_2	.6839	.3684	.5045
i_2	-95.78	-31.86	-54.43
t_2	161.5	126.46	137.08
K_3	1736.2	188	187
t_3	20.92	26.66	21.54
Average error of equation	9.39	1.68	6.200

CASE 108M

	Height	Skeletal Age	Mental Age
K_1	1653	184	127
r_1	.1768	.1728	.3491
i_1	24.05	19.49	20.10
K_2	155.0	54	57
r_2	.5488	.3775	.4770
i_2	-71.62	-35.76	-43.41
t_2	157.34	133.75	139.53
K_3	1808.0	238	184
t_3	22.41	24.67	20.86
Average error of equation	9.80	5.31	9.010

CASE 119M

	Height	Skeletal Age	Mental Age
K_1	1605	157	182
r_1	.1716	.1953	.3600
i_1	26.42	17.27	2.33
K_2	221.9	70	50
r_2	.8659	.2971	.4495
i_2	-117.08	-19.80	-42.13
t_2	152.22	116.22	126.49
K_3	1826.9	227	232
t_3	18.58	26.87	21.9
Average error of equation	6.67	1.49	7.06

CASE 123M

	Height	Skeletal Age	Mental Age
K_1	1596	160	140
r_1	.1877	.2423	.3207
i_1	25.65	15.30	8.24
K_2	163	84	49
r_2	1.063	.2616	.7041
i_2	-140.79	-18.29	-75.28
t_2	146.30	126.22	127.83
K_3	1759	244	189
t_3	16.99	30.03	17.90
Average error of equation	5.16	5.18	4.06

CASE 150M

	Height	Skeletal Age	Mental Age
K_1	1492	200	168
r_1	.1740	.1716	.1768
i_1	28.48	14.41	18.39
K_2	226	60	60
r_2	.9583	.3353	.7225
i_2	-98.51	-17.57	-66.90
t_2	118.16	96.33	112.98
K_3	1718	260	228
t_3	15.17	23.55	16.48
Average error of equation	7.72	4.03	5.06

CASE 162M

	Height	Skeletal Age	Mental Age
K_1	1488	140	143
r_1	.1566	.2362	.3505
i_1	29.58	14.52	10.98
K_2	230.7	108	85
r_2	.7164	.2863	.3875
i_2	-82.65	-17.98	-26.37
t_2	135.92	114.25	106.06
K_3	1718.7	248	228
t_3	19.12	27.35	22.02
Average error of equation	6.06	1.69	3.20

CASE 166M

	Height	Skeletal Age	Mental Age
K_1	1596	138	135
r_1	.1585	.2338	.2646
i_1	28.20	12.88	15.72
K_2	219	93	75
r_2	.9025	.2346	.4240
i_2	-131.14	-12.24	-36.01
t_2	161.62	114.96	119.66
K_3	1804	231	210
t_3	20.03	31.34	22.01
Average error of equation	8.78	1.53	7.71

CASE 203M

	Height	Skeletal Age	Mental Age
K_1	1531	154	153
r_1	.1666	.2546	.2708
i_1	28.25	15.09	15.32
K_2	189	90	67
r_2	.7854	.3554	.5345
i_2	-91.42	-30.02	-53.15
t_2	135.15	125.91	126.99
K_3	1720	244	220
t_3	17.76	24.86	20.13
Average error of equation	7.57	2.69	7.75

CASE 227M

	Height	Skeletal Age	Mental Age
K_1	1635	144	170
r_1	.1608	.2700	.2650
i_1	27.84	14.69	14.93
K_2	216.8	107	112
r_2	1.010	.2246	.5045
i_2	-132.32	-8.20	-50.05
t_2	145.5	102.09	128.40
K_3	1851.8	251	282
t_3	17.18	31.24	20.82
Average error of equation	10.37	1.71	4.21

CASE 232M

	Height	Skeletal Age	Mental Age
K_1	1678	159	182
r_1	.1804	.2235	.2961
i_1	28.33	18.67	21.74
K_2	161.1	70	97
r_2	1.395	.2512	.4178
i_2	-191.23	-11.12	-35.14
t_2	147.64	102.91	119.36
K_3	1839.1	229	279
t_3	15.96	28.90	22.17
Average error of equation	6.15	2.09	10.05

CASE 250M

	Height	Skeletal Age	Mental Age
K_1	1544	142	148
r_1	.1579	.2141	.2687
i_1	29.39	20.37	13.62
K_2	240.6	64	57
r_2	.6857	.2606	.6171
i_2	-82.89	-9.16	-53.03
t_2	142.36	91.67	109.80
K_3	1784.6	186	205
t_3	19.30	27.23	17.42
Average error of equation	10.14	1.46	5.80

CASE 255M

	Height	Skeletal Age	Mental Age
K_1	1627	182	149
r_1	.2015	.1952	.2761
i_1	25.61	14.15	11.73
K_2	177.6	62	72
r_2	.8208	.5619	.4020
i_2	-84.04	-52.22	-31.23
t_2	120.33	119.14	114.32
K_3	1804.6	244	221
t_3	16.24	19.01	22.23
Average error of equation	9.50	3.18	7.23

CASE 269M

	Height	Skeletal Age	Mental Age
K_1	1546	172	155
r_1	.2281	.2070	.2121
i_1	19.25	13.95	15.88
K_2	178.0	62	43
r_2	.8592	.3631	.4380
i_2	-116.21	-34.31	-36.68
t_2	152.39	135.05	117.37
K_3	1724.0	234	198
t_3	18.64	25.32	21.44
Average error of equation	6.99	1.15	9.99

CASE 280M

	Height	Skeletal Age	Mental Age
K_1	1658	170	118
r_1	.1823	.2237	.2100
i_1	26.98	17.50	22.68
K_2	183.8	74	58
r_2	.7854	.2658	.4683
i_2	-89.85	-16.57	-45.94
t_2	133.0	117.75	129.55
K_3	1841.8	244	176
t_3	17.59	29.02	21.69
Average error of equation	7.98	3.29	9.79

CASE 288M

	Height	Skeletal Age	Mental Age
K_1	1629	168	170
r_1	.1570	.2180	.2515
i_1	27.96	16.46	19.01
K_2	224.3	54	100
r_2	.8046	.3560	.7254
i_2	-106.05	-30.40	-87.02
t_2	150.1	126.76	140.26
K_3	1853.3	222	270
t_3	18.85	24.90	18.73
Average error of equation	10.9	3.005	9.63

CASE 319M

	Height	Skeletal Age	Mental Age
K_1	1686	160	183
r_1	.2095	.2761	.7723
i_1	24.01	11.73	-30.36
K_2	207.6	72	67
r_2	1.251	.3450	.2440
i_2	-157.34	-25.41	-9.80
t_2	137.54	116.34	100.53
K_3	1893.6	232	250
t_3	15.54	24.49	29.30
Average error of equation	5.21	1.039	6.00

CASE 343M

	Height	Skeletal Age	Mental Age
K_1	1568	210	164
r_1	.1701	.1319	.2565
i_1	27.31	18.78	14.15
K_2	166	60	73
r_2	.9299	.4002	.4335
i_2	-131.66	-39.04	-45.85
t_2	157.42	134.35	139.74
K_3	1734	270	237
t_3	18.60	23.95	23.42
Average error of equation	5.09	2.76	5.87

CASE 350M

	Height	Skeletal Age	Mental Age
K_1	1604	188	158
r_1	.2106	.1837	.3230
i_1	22.41	15.78	11.24
K_2	169.6	57	55
r_2	1.115	.3860	.5018
i_2	-145.86	-36.83	-49.59
t_2	144.02	133.57	128.17
K_3	1773.6	245	213
t_3	16.58	24.36	20.85
Average error of equation	4.11	1.52	6.03

CASE 368M

	Height	Skeletal Age	Mental Age
K_1	1552	142	106
r_1	.2128	.1795	.5994
i_1	24.46	19.13	-8.17
K_2	158.3	44	64
r_2	.4811	.5028	.5725
i_2	-50.91	-42.59	-55.35
t_2	136.43	114.00	122.41
K_3	1710.3	186	170
t_3	21.98	19.65	19.12
Average error of equation	12.19	4.519	4.93

CASE 371M

	Height	Skeletal Age	Mental Age
K_1	1464	182	117
r_1	.1804	.2000	.4215
i_1	26.34	13.52	5.15
K_2	194.6	61	65
r_2	1.162	.4621	.5885
i_2	-148.14	-44.69	-68.14
t_2	140.10	128.58	140.81
K_3	1658.6	243	182
t_3	16.06	21.76	20.41
Average error of equation	9.57	1.46	2.40

CASE 372M

	Height	Skeletal Age	Mental Age
K_1	1557	165	145
r_1	.2280	.2620	.2690
i_1	22.78	11.49	20.98
K_2	168.5	67	25
r_2	1.198	.4350	.9055
i_2	-168.90	-44.94	-132.49
t_2	155.8	137.17	162.58
K_3	1725.5	232	170
t_3	17.31	23.17	19.18
Average error of equation	4.57	2.37	11.315

CASE 373M

	Height	Skeletal Age	Mental Age
K_1	1391	184	123
r_1	.2167	.1837	.2520
i_1	21.47	12.48	16.80
K_2	191.7	64	60
r_2	.8331	.6041	.4588
i_2	-101.78	-66.62	-51.53
t_2	139.85	134.66	144.42
K_3	1582.7	248	183
t_3	17.78	19.67	23.16
Average error of equation	8.71	3.46	4.76

CASE 380M

	Height	Skeletal Age	Mental Age
K_1	1534	192	139
r_1	.1794	.1539	.3284
i_1	27.78	16.72	12.89
K_2	202.3	59	64
r_2	.8531	.3630	.5838
i_2	-91.89	-20.58	-63.04
t_2	124.97	97.27	133.21
K_3	1736.3	251	203
t_3	16.39	22.17	19.84
Average error of equation	6.30	3.47	6.28

CASE 402M

	Height	Skeletal Age	Mental Age
K_1	1597	150	130
r_1	.2223	.2883	.3287
i_1	21.50	11.45	7.44
K_2	139.7	83	61
r_2	1.450	.4020	.4469
i_2	-196.12	-35.05	-40.23
t_2	145.41	123.83	122.98
K_3	1736.7	233	191
t_3	15.64	23.02	21.67
Average error of equation	4.61	2.25	7.43

CASE 407M

	Height	Skeletal Age	Mental Age
K_1	1691	150	150
r_1	.2121	.3721	.2602
i_1	24.84	6.47	14.03
K_2	143	98	80
r_2	.9178	.2879	.5062
i_2	-114.68	-17.42	-46.99
t_2	141.00	121.04	121.92
K_3	1834	248	230
t_3	17.31	27.04	20.25
Average error of equation	6.88	2.29	5.18

CASE 412M

	Height	Skeletal Age	Mental Age
K_1	1701	192	113
r_1	.1684	.1775	.2764
i_1	27.26	14.15	10.98
K_2	183	57	45
r_2	.754	.4280	.4421
i_2	-90.56	-42.60	-42.85
t_2	139.64	133.94	130.24
K_3	1884	249	158
t_3	18.40	23.09	23.40
Average error of equation	8.62	2.04	5.03

CASE 417M

	Height	Skeletal Age	Mental Age
K_1	1585	168	160
r_1	.1612	.1908	.3108
i_1	28.83	16.27	11.10
K_2	205.6	35	36
r_2	.5887	.3657	.5796
i_2	-72.74	-34.03	-61.15
t_2	148.58	133.33	130.91
K_3	1790.6	203	196
t_3	21.05	25.07	19.72
Average error of equation	15.59	1.48	5.64

CASE 442M

	Height	Skeletal Age	Mental Age
K_1	1646	159	130
r_1	.1785	.2350	.3393
i_1	26.79	15.40	4.92
K_2	231.7	53	46
r_2	.5890	.4030	.5014
i_2	-62.27	-35.03	-47.78
t_2	130.7	123.47	124.67
K_3	1877.7	212	176
t_3	19.55	22.96	20.57
Average error of equation	7.59	1.27	9.802

CASE 444M

	Height	Skeletal Age	Mental Age
K_1	1636	136	121
r_1	.1608	.2895	.3092
i_1	29.45	14.97	15.16
K_2	206.3	96	96
r_2	1.445	.2910	.4981
i_2	-195.22	-15.35	-50.45
t_2	145.20	103.36	130.85
K_3	1842.3	232	217
t_3	15.63	26.16	21.15
Average error of equation	9.04	1.61	7.39

CASE 456M

	Height	Skeletal Age	Mental Age
K_1	1591	155	148
r_1	.1957	.2722	.2463
i_1	25.82	11.90	13.66
K_2	232.4	60	27
r_2	1.038	.3665	.5213
i_2	-137.14	-27.56	-44.21
t_2	146.31	115.38	113.06
K_3	1823.4	215	175
t_3	17.11	23.54	19.21
Average error of equation	5.62	1.317	3.80

CASE 460M

	Height	Skeletal Age	Mental Age
K_1	1388	136	108
r_1	.1570	.2883	.2735
i_1	28.36	8.56	11.92
K_2	184.7	96	47
r_2	1.004	.3345	.6439
i_2	-129.22	-26.78	-81.32
t_2	143.37	124.09	149.16
K_3	1572.7	232	155
t_3	17.03	25.61	20.36
Average error of equation	6.33	3.119	5.23

CASE 474M

	Height	Skeletal Age	Mental Age
K_1	1508	154	130
r_1	.1209	.2310	.5875
i_1	30.84	14.97	11.95
K_2	235.8	84	65
r_2	.9755	.2479	.6993
i_2	-129.11	-14.42	-81.36
t_2	147.45	117.58	137.40
K_3	1743.8	238	195
t_3	17.52	30.39	18.75
Average error of equation	1361	1.66	6.77

CASE 478M

	Height	Skeletal Age	Mental Age
K_1	1637	518	131
r_1	.1939	.2371	.4350
i_1	26.92	14.40	14.46
K_2	191	96	98
r_2	1.265	.3304	.9454
i_2	-164.48	-26.27	-109.11
t_2	141.66	124.09	130.99
K_3	1828	254	229
t_3	15.84	25.79	16.32
Average error of equation	5.33	2.57	9.49

CASE 479M

	Height	Skeletal Age	Mental Age
K_1	1572	148	101
r_1	.1500	.2371	.1934
i_1	29.25	13.76	25.81
K_2	165.5	56	42
r_2	.6423	.3300	.4833
i_2	-84.74	-22.68	-38.82
t_2	154.86	113.36	110.80
K_3	1737.5	204	143
t_3	20.85	24.91	19.79
Average error of equation	12.17	0.83	3.13

CASE 483M

	Height	Skeletal Age	Mental Age
K_1	1679	148	155
r_1	.1562	.1940	.3445
i_1	27.82	18.88	5.77
K_2	214.6	60	68
r_2	.5792	.2619	.7572
i_2	-70.51	-11.50	-86.31
t_2	147.16	100.15	133.43
K_3	1893.6	208	223
t_3	21.07	27.84	17.86
Average error of equation	9.12	1.49	9.73

CASE 488M

	Height	Skeletal Age	Mental Age
K_1	1512	111	174
r_1	.1562	.4146	.2345
i_1	29.38	6.35	13.93
K_2	120.6	88	51
r_2	.3796	.2988	.4134
i_2	-35.48	-21.58	-29.42
t_2	132.30	121.51	106.79
K_3	1632.6	199	225
t_3	24.46	27.21	21.25
Average error of equation	7.27	1.20	13.007

CASE 526M

	Height	Skeletal Age	Mental Age
K_1	1506	158	116
r_1	.1571	.2205	.2622
i_1	29.52	15.58	19.63
K_2	208.9	56	84
r_2	1.043	.3966	.3512
i_2	-125.75	-31.37	-21.73
t_2	134.68	116.23	103.81
K_3	1714.9	214	200
t_3	16.11	22.56	23.19
Average error of equation	10.5	1.97	4.58

CASE 530M

	Height	Skeletal Age	Mental Age
K_1	1551	137	127
r_1	.1676	..3357	.3088
i_1	27.36	6.74	14.83
K_2	178.0	94	37
r_2	.570	.2682	.7214
i_2	-63.43	-16.49	-85.12
t_2	137.1	116.40	138.41
K_3	1729	231	164
t_3	20.38	28.74	18.61
Average error of equation	7.08	3.31	3.69

CASE 534M

	Height	Skeletal Age	Mental Age
K_1	1554	155	162
r_1	.1730	.2553	.3323
i_1	27.66	13.49	1.65
K_2	192.7	87	65
r_2	1.436	.2940	.5300
i_2	-187.29	-18.25	-56.77
t_2	140.68	112.17	134.90
K_3	1746.7	242	225
t_3	15.27	26.71	20.87
Average error of equation	6.08	1.41	13.80

CASE 542M

	Height	Skeletal Age	Mental Age
K_1	1501	195	152
r_1	.1781	.1747	.2769
i_1	26.50	13.88	13.47
K_2	232.2	48	66
r_2	.7853	.4912	.3710
i_2	-93.71	-51.60	-32.20
t_2	138.08	135.03	126.49
K_3	1733.2	243	218
t_3	18.00	21.65	24.30
Average error of equation	6.11	3.35	6.17

CASE 574M

	Height	Skeletal Age	Mental Age
K_1	1729	164	190
r_1	.1608	.2227	.2678
i_1	29.49	17.85	15.62
K_2	144.9	68	63
r_2	.6819	.2262	.5314
i_2	-87.49	-11.43	-37.33
t_2	149.90	115.64	97.96
K_3	1873.9	232	253
t_3	19.98	32.21	17.76
Average error of equation	14.07	1.63	4.85

CASE 585M

	Height	Skeletal Age	Mental Age
K_1	1645	168	187
r_1	.1785	.1805	.3790
i_1	25.72	16.22	7.02
K_2	193.6	47	53
r_2	.7725	.3262	.5088
i_2	-108.18	-23.93	-41.37
t_2	159.1	118.51	110.25
K_3	1838.6	315	240
t_3	19.86	25.53	19.21
Average error of equation	6.69	0.83	10.37

CASE 599M

	Height	Skeletal Age	Mental Age
K_1	1388	150	129
r_1	.1831	.2264	.3310
i_1	29.86	14.12	10.48
K_2	109	41	54
r_2	.666	.5050	.5945
i_2	-72.09	-47.78	-89.52
t_2	130.36	123.78	125.58
K_3	1497	191	183
t_3	18.52	20.42	19.05
Average error of equation	5.01	1.54	4.43

CASE 620M

	Height	Skeletal Age	Mental Age
K_1	1590	160	178
r_1	.1667	.1905	.3842
i_1	28.17	16.04	1.89
K_2	191.2	53	86
r_2	.704	.3287	.7890
i_2	-94.23	-25.10	-11.01
t_2	154.70	121.17	132.12
K_3	1781.2	213	264
t_3	20.15	25.63	17.48
Average error of equation	5.54	1.83	10.96

CASE 623M

	Height	Skeletal Age	Mental Age
K_1	1629	132	157
r_1	.2015	.3323	.2880
i_1	24.16	4.97	7.85
K_2	190	102	41
r_2	1.095	.4042	.2770
i_2	-134.89	-34.46	-51.84
t_2	136.63	121.69	92.92
K_3	1819	234	198
t_3	16.04	22.77	17.4
Average error of equation	8.13	1.14	7.77

CASE 626M

	Height	Skeletal Age	Mental Age
K_1	1538	160	178
r_1	.1732	.2441	.3110
i_1	26.52	11.51	5.20
K_2	186.1	75	55
r_2	.9385	.2955	.4662
i_2	-123.47	-22.09	-30.35
t_2	147.25	124.60	142.79
K_3	1724.1	235	233
t_3	17.71	27.66	22.85
Average error of equation	5.31	1.44	10.69

CASE 630M

	Height	Skeletal Age	Mental Age
K_1	1618	154	207
r_1	.1847	.2309	.3200
i_1	26.93	15.69	6.57
K_2	206	73	54
r_2	1.105	.3547	.4331
i_2	-141.35	-26.59	-23.21
t_2	141.2	116.49	104.08
K_3	1824	227	261
t_3	16.38	24.10	20.46
Average error of equation	9.96	1.70	5.17

CASE 645M

	Height	Skeletal Age	Mental Age
K_1	1542	143	210
r_1	.1781	.2726	.2496
i_1	27.21	13.83	12.85
K_2	225	61	41
r_2	.8203	.3647	.3935
i_2	-95.15	-24.37	-106.24
t_2	133.90	107.21	96.41
K_3	1767	204	251
t_3	17.38	22.93	21.01
Average error of equation	8.82	0.93	3.82

CASE 648M

	Height	Skeletal Age	Mental Age
K_1	1607	147	195
r_1	.1650	.2540	.3119
i_1	27.09	13.00	9.44
K_2	167.7	53	47
r_2	.620	.3395	.8017
i_2	-85.83	-28.83	-65.83
t_2	162.19	128.30	150.89
K_3	1774.7	200	242
t_3	21.75	25.73	18.94
Average error of equation	9.47	2.07	5.39

CASE 661M

	Height	Skeletal Age	Mental Age
K_1	1638	151	159
r_1	.1469	.2761	.2688
i_1	29.27	12.28	11.82
K_2	190.6	36	85
r_2	.4844	.3270	.5004
i_2	-61.70	-21.48	-39.35
t_2	157.78	110.73	160.99
K_3	1828.6	187	244
t_3	23.68	24.84	23.62
Average error of equation	18.48	3.302	5.61

CASE 669M

	Height	Skeletal Age	Mental Age
K_1	1661	166	126
r_1	.1638	.2173	.2145
i_1	28.95	16.62	26.76
K_2	194.7	79	58
r_2	1.283	.3914	.4675
i_2	-164.12	-32.21	-25.46
t_2	139.39	119.92	115.67
K_3	1855.7	245	184
t_3	15.59	23.04	20.5
Average error of equation	11.45	1.84	9.88

CASE 685M

	Height	Skeletal Age	Mental Age
K_1	1553	176	117
r_1	.1665	.2050	.2870
i_1	28.19	15.22	14.48
K_2	175.3	68	65
r_2	.9608	.2996	.3350
i_2	-124.77	-25.53	-80.31
t_2	145.10	134.37	119.97
K_3	1728.3	244	182
t_3	17.40	27.68	25.24
Average error of equation	6.56	3.16	7.32

CASE 699M

	Height	Skeletal Age	Mental Age
K_1	1661	158	129
r_1	.1771	.2400	.3183
i_1	27.04	13.13	10.47
K_2	191.3	83	51
r_2	.7125	.4208	.6575
i_2	-85.30	-43.88	-54.16
t_2	140.39	139.28	144.54
K_3	1852.3	241	180
t_3	18.84	23.74	19.81
Average error of equation	9.16	2.43	4.77

CASE 721M

	Height	Skeletal Age	Mental Age
K_1	1655	172	148
r_1	.1608	.2077	.3150
i_1	27.89	12.61	12.81
K_2	213.2	46	50
r_2	.7802	.3370	.5362
i_2	-104.62	-31.21	-64.56
t_2	152.9	136.32	133.51
K_3	1868.2	218	198
t_3	19.29	26.51	20.23
Average error of equation	4.70	1.3999	7.53

CASE 1801M

	Height	Skeletal Age	Mental Age
K_1	1553	167	150
r_1	.1754	.2541	.2273
i_1	26.43	8.53	18.17
K_2	217.3	76	42
r_2	.8746	.3993	.7065
i_2	-116.93	-45.53	-90.64
t_2	150.53	150.91	149.16
K_3	1770.3	243	192
t_3	18.38	25.36	19.65
Average error of equation	5.89	1.375	5.93

CASE 2848M

	Height	Skeletal Age	Mental Age
K_1	1622	143	170
r_1	.1583	.2235	.3060
i_1	28.09	15.54	12.33
K_2	232.7	75	51
r_2	.8421	.3034	.9925
i_2	-112.77	-20.15	-133.65
t_2	151.40	114.96	149.50
K_3	1854.7	218	221
t_3	18.76	26.41	17.60
Average error of equation	7.28	1.236	3.94