THE CYCLIC PATTERN OF HEIGHT GROWTH FROM BIRTH TO MATURITY

By

Reuben Robert Rusch

AN ABSTRACT

Submitted to the School for Advanced Graduate Studies of
Michigan State University of Agriculture and Applied
Science in partial fulfillment of the requirements
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ABSTRACT

The purpose of this study was to determine the individual cyclic pattern of height growth from birth to maturity. Although much research has been done with cross-sectional height data, there is relatively little evidence showing the individual pattern of height growth over even short periods of the growth process, and even less evidence to show the individual pattern from birth to maturity.

Fels Research Institute, Yellow Springs, Ohio, provided the longitudinal height measures which were used. Of the cases they had available the serial measurements of 46 girls and 31 boys met the criteria of completeness chosen for this study.

The straight line that best fitted the data was individually determined from the serial height measures taken at six month intervals. The measured heights were then compared to this straight line. The individual data and its straight line of best fit were plotted on separate graphs. To determine the cyclic pattern objectively and mathematically, the equations of the straight line were solved for each time that height was actually measured. The difference between the measured heights and the result of solving the straight line equations was termed a deviation. If the recorded measure was above the straight line, that is greater than the magnitude represented by the straight line, the deviation was considered positive, if it was below the straight line, it was considered negative.

The deviations were then analyzed to determine the number of cycles of height growth, according to three criteria for determining cycles. In general, a cycle was considered to be characterized by increasing upward movement followed by decreasing upward movement.

A definite cyclic pattern of height growth from birth to maturity was found in all cases.

There were differences in the patterns of height growth of boys and girls although the patterns of most boys as well as girls showed either three or four cycles.

In all cases the cycle occurring immediately after birth was the most pronounced. The rate of growth was most rapid after birth and gradually decreased for the next two or three years.

Almost all cases exhibited a distinguishable curve or cycle at what might be considered the time of adolescence. This pattern was, however, less obviously curvilinear in some cases.

The individuality of the cyclic patterns of height growth was shown especially during the period between the beginning cycle and the adolescent cycle. During this period of the growth process the rate changed more frequently in some cases than it did in others resulting in a greater number of cycles.

It was concluded that the general cyclic pattern of height growth for the various individuals showed many similarities, although unique characteristics were found, especially between infancy and adolescence.

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CHAPTER I

INTRODUCTION

The approach to precision of measurement, description, and analysis of data in the exact sciences such as physics and chemistry has been followed at a later date by similar advances in the social sciences.

The analytical balance, microscope, and electron microscope are examples of the improvement of instruments for measurement in the exact sciences. Likewise the sliding calipers calibrated in millimeters, the Baldwin square, and x-ray apparatus are examples of almost equally precise measuring instruments used in human growth and development research, a field considered as belonging to the social sciences.

Mathematical equations have been devised that describe the results of repeated experiments in the exact sciences. Similarly in the social sciences mathematical equations have been used to describe the growth of individuals and of groups.[1]

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[1] Nathan Shock, "Growth Curves," Handbook of Experimental Psychology, ed. by S. S. Stevens (New York: Wiley, 1951), pp. 330-346.

Even the important change from metaphysical alchemy to chemistry and the numerous implications that this change has brought about has a parallel in importance in the social sciences. This equally important change, occuring years later, is the change from the cross-sectional to the longitudinal approach in the collection, analysis, and interpretation of data. Nowhere in the area of the social sciences has this change in approach been better demonstrated than in the comparitively recent research literature concerned with human growth and development.

In describing observation of phenomena, objectivity and the law of the single variable have been of utmost importance among the exact scientists for some time. Many authors among the social scientists have shown their awareness of the necessity of objectivity in experimentation and the reporting of these results. However, the law of the single variable seems foreign to most of the writers who have conducted cross-sectional studies in the social sciences. Courtis[2] is one of the few who has shown his awareness of the law of the single variable or as he puts it "the court of last resort in science." He has conducted some important individual longitudinal research on school children which was governed by this law.

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[2] S. A. Courtis, Towards A Science of Education (Ann Arbor: Edwards Browthers, 1951), p. 5.

In the area now designated as child growth and development, Stewart[3] is frequently given credit as one of the first to realize some of the advantages of the longitudinal approach. He was one of the first to conclude that the pattern shown by averaging the growth of a group of children had little relationship to the pattern of individual growth.[4]

Hence, since these conclusions of Stewart there has been a shifting of emphasis in the research relating to child growth and development. Former studies which sought to ascertain the relation between two variables measured in a large group of children at a given time are being replaced by studies of the growth process made by many cumulative observations of the same child or children.

The shifting of emphasis in the collection of data is slowly being realized. Social scientists are now collecting objective longitudinal measurements on individuals over a period of time. They are constantly striving to devise experiments in which the law of the single variable is operating.

In the analysis of the data, this change or shifting of emphasis is even more gradual. For purpose of analysis these

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[3] S. F. Stewart, "Physical Growth and School Standing of Boys," Journal of Educational Psychology, 7:414-426, 1916.

[4] Ibid., p. 426.

scientists have grouped the data according to sexes and some other phenomena such as the menarche and then proceeded to analyze the group pattern with regard to the population mean or some other similar average.

Thus since social scientists have followed the letter of the law in the collection of information, but not the spirit of the law in the analysis of this information, comparatively little has been discovered about individual longitudinal growth.

One of the schools of thought which has made this transition in point-of-view as well as in the statement of the general principle is the organismic school. This theory for explaining growth of the whole individual, is based on the most recent individual longitudinal research. Supported by Courtis[5], Millard[6], Olson[7], and others[8,9], the organismic

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[5] S. A. Courtis, "Growth and Development in Children," Advances in Health Education, Proceedings of Seventh Health Conference, Ann Arbor, Michigan, 1933 (New York: American Child Health Association, 1934).

[6] Cecil V. Millard, Child Growth and Development (Boston: D. C. Heath and Co., 1951).

[7] Willard C. Olson, Child Development (Boston: D. C. Heath and Co., 1949).

[8] Arthur R. DeLong, "Longitudinal Study of Individual Children," Michigan Education Association Journal, November, 1951, p. 115.

[9] Thomas P. F. Nally and A. R. DeLong, "An Appraisal of a Method of Predicting Growth," Child Development Lab. Publication, Series II, No. 1, (East Lansing, Michigan, 1952).

concept interprets all aspects of development in respect to a life pattern.[10] Thus the part that time plays in the development of the individual is recognized.

The majority of the modern writers in the child development area seem to feel that most growth is cyclic in nature.[11, 12, 13, 14,15] One of the most convincing reports

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[10] Cecil V. Millard, Child Growth and Development, op. cit., p. 4.

[11] Raymond N. Hatch, Guidance Services In The Elementary School (Dubuque, Iowa: Wm. C. Brown, 1951), p. 10.

[12] S. A. Courtis, "What is a Growth Cycle?", Growth, 1: 7-13, 1937.

[13] C. V. Millard, "The Nature and Character of Preadolescent Growth in Reading Achievement," Child Development, Vol. 11, No. 2, 1940.

[14] H. P. Stoltz and L. M. Stoltz, The Somatic Development of Adolescent Boys (New York: MacMillan, 1951), pp. 112-113.

[15] S. A. Courtis, Maturation Units and How to Use Them (Ann Arbor: Edward Brothers, 1950), pp. 179-180.

of cyclic growth of the human body is the statement of Shuttleworth:

> . . . . First, all twenty-two dimensions exhibit two major growth cycles consisting of accelerating and decelerating phases. Second, the growth phases of the first cycle are initiated at different ages and are of different durations such that the growth trends of the twenty-two dimensions are not synchronized. Third, the growth phases of the second cycle, in respect to a given menarcheal or M G - age group, are initiated at approximately the same ages and are of similar durations such that the growth trends of the twenty-two dimensions are synchronized.[16]

In spite of the accumulation of data to support the ideas of cyclic growth and in spite of the use of the term by many writers, there has been relatively little attempt made to explain the specific constitution of a growth cycle. Courtis,[17,18] one of the proponents of the organismic concept whose studies have most rigorously followed the law of the single variable, has not only defined empirically the term cycle, but has devised a mathematical method for describing growth within a cycle. This mathematical description of growth is built on the Gompertz discovery[19] and assumes a law of growth.[20]

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[16]Frank K. Shuttleworth, "The Physical and Mental Growth of Girls and Boys Age 6 to 19 in Relation to Age at Maximum Growth," <u>Monographs of the Society for Research in Child Development</u>, Vol. XIV, No.2, Serial No. 50, 1939, p. 221.

[17]S. A. Courtis, "What is a Growth Cycle?", <u>op. cit</u>.

[18]S. A. Courtis, <u>Maturation Units and How to Use Them</u>, <u>op. cit</u>., p. 179-180.

[19]Benjamin Gompertz, <u>Philosophical Transactions of the Royal Society of London for the Year MDCCCXXV,Part I</u>. Printed by W. Nicol, St. James, Pall Mall, Printers to the Royal Society, MDCCCXV

[20]S. A. Courtis, <u>Maturation Units and How to Use Them</u>, <u>op. cit</u>., p. 2.

Millard[21], DeLong[22], Nally[23], Kowitz[24], Rusch[25,26], Greenshields[27], and others[28] have demonstrated that the Courtis[29] technique adequately describes individual longitudinal growth. Although this description of growth is reasonably accurate and mathematical, certain procedures for determining the exact equation require the judgment of the writer of the equation.

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[21] C. V. Millard, "The Nature and Character of Preadolescent Growth in Reading Achievement," Child Development, op. cit.

[22] Thomas P. F. Nally and A. R. DeLong, "An Appraisal of a Method of Predicting Growth," Child Development Laboratory Publication, op. cit.

[23] 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, 1953.

[24] 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, 1954.

[25] Reuben R. Rusch, "The Relationship Between Growth in Height and Growth in Weight." Unpublished Master's thesis, Michigan State College, 1954.

[26] Reuben R. Rusch, "Center of Gravity and the Law of Growth." Unpublished paper as part of requirement for Education 524.

[27] C. M. Greenshields, "The Relationship Between Consistent IQ Scores, Decreasing IQ Scores and Reading Scores Compared on Two Developmental Bases," Unpublished Master's thesis, Michigan State University, 1955.

[28] Lillian Larner, "A Comparison of Growth in Height with Growth in Achievement." Unpublished paper in partial fulfillment of the requirements for the course Education 524, April 12, 1955.

[29] S. A. Courtis, Maturation Units and How to Use Them, op. cit., passim.

One of these judgments is the determination of just where the individual cycles of growth occur.*

Statement of the Problem

Many of the implications and advantages of the longitudinal approach are in the process of being realized. Some of the first authors collected longitudinal data on the growth of children and treated the data according to the then standard cross-sectional methods. Thus even using longitudinal measurements, because of the treatment of the measurements, facts about the growth of individuals were hidden and much still remains to be discovered -- discovered only when longitudinal data are treated in an individual longitudinal manner.

Mathematical equations have been used advantageously to describe individual growth within a cycle.[30,31,32,33,34]

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[30] C. V. Millard, "The Nature and Character of Preadolescent Growth in Reading Achievement," <u>Child Development, op. cit</u>.

[31] Thomas P. F. Nally and A. R. DeLong, "An Appraisal of a Method of Predicting Growth," <u>Child Development Laboratory Publication</u>, <u>op. cit</u>.

[32] Thomas P. F. Nally, "The Relationship Between Achieved Growth in Height and the Beginning of Growth in Reading," <u>op. cit</u>.

[33] Reuben R. Rusch, "Center of Gravity and the Law of Growth," <u>op. cit</u>.

[34] C. M. Greenshields, "The Relationship Between Consistent IQ Scores, Decreasing IQ Scores and Reading Scores Compared on Two Developmental Bases," <u>op. cit</u>.

*G. Holmgren, R. Rusch, and L. Barron have worked out a mathematical method for determining the maximum of each individual cycle. Using this method all equation writers are able to write identical equations.

In this method we have seen demonstrated a technique for analyzing individual longitudinal data in terms of the individuals continuous growth pattern.

It is the purpose of this study to determine the individual pattern of height growth from birth to maturity and in so doing to give indication as to where cycles of height growth occur.

Importance of the Study

A great variety of material supposedly dealing with the growth and development of children has been accumulated and numerous concepts and theories have been postulated in an attempt to analyze and explain the data and hence, growth. Until the past 30 years, most of the measurements collected and analyzed were of the cross-sectional variety.

Stewart[35] was the first to provide evidence that showed that cross-sectional studies do not yield the same results as longitudinal studies.

DeLong[36] in using the Holt Data to compare the longitudinal and cross-sectional method of analysis showed that there was a significant difference in the results of a cross-sectional and longitudinal study of similar children. He

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[35] S. F. Stewart, "Physical Growth and School Standing of Boys," Journal of Educational Psychology, op. cit.

[36] 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, p.9.

points out that the two basic assumptions of the cross-sectional approach are:

> . . . . when group scores are used individual differences average out, therefore the measure of central tendency is representative of the group. . . . . When a statistical interpretation is made cross-sectionally about how growth occurs, the assumption is made that individuals hold their positions in their group.[37]

DeLong's study proceeds to show that the individual does not hold his position in the group and that the measures of central tendency describe only a very small portion of the group and for only a very short period of time.[38] Thus we see rational and conclusive evidence to illustrate that [1] cross-sectional and longitudinal studies do not yield the same results, and [2] that the basic assumptions made when interpreting cross-sectional data to show growth are in error.

Since the individual does not hold his position in the group and since the measure of central tendency does not describe the growth of any individual for any period of time, norms based on grouped data do not represent any individual's growth pattern. For example, since according to Olson[39] the average height for a group of six year old boys is 52.9 inches and for a group of

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[37] *Ibid.*, p. 5, 7.

[38] *Ibid.*, p. 9

[39] Willard C. Olson and Byron O. Hughes, "Manual for the Description of Growth in Age Units," University of Michigan, Elementary School, Ann Arbor, Michigan, 1950.

seven year old boys it is 54.7 inches we have no bases for concluding that any six year old boy in that group is exactly 52.9 inches or any 7 year old boy in that group is exactly 54.7 inches. And we have even less reason to believe that any six year old will grow exactly 1.8 inches or the difference between 54.7 and 52.9 inches in the next year. Therefore the rates as represented by the norm have no relationship [as far as showing growth is concerned] to individual growth rates. Stoddard[40] reports the same conclusion when speaking of mental growth. "No generalized growth curve can describe the pattern for a single individual."

The growth equations that are written using the Courtis Technique[41] assume a law of growth but use the longitudinal measurements available on a single individual to provide the bases for the equation, and hence for the individual growth curve. This Technique[42] also assumes, on the basis of much evidence, that growth is cyclic and hence the equations are written for each individual in terms of his cyclic pattern of growth.

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[40] George D. Stoddard, The Meaning of Intelligence (New York: The MacMillan Co., 1943), p. 179.

[41] S. A. Courtis, Maturation Units and How to Use Them, op. cit., p. 104.

[42] Ibid.

Cross-sectional studies revealed nothing about individual growth.[43,44] Most longitudinal studies reported grouped longitudinal data and were carried on over a limited period of time. To date there has been no true longitudinal study of the height growth of boys and girls from birth to maturity reported in the literature. No author has attempted to accumulate a sampling of cases of boys and girls with measures from birth to maturity, and to analyze the data on an individual cyclic bases. Thus there is a limited amount of evidence from which to conclude about the number and magnitude of individual growth cycles over the entire growth period.

Even among the proponents of the organismic school of growth there is not complete agreement as to exactly where growth cycles occur and the writers of the equations have set up different criteria for writing the equations that describe the growth process.[45,46] Thus it seems reasonable to assume, that since most equation writers compared some aspect of growth to height growth, it would be advantageous to them, as well as to others who use other methods to describe and compare serial

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[43] Arthur R. DeLong, "The Relative Usefulness of Longitudinal and Cross-Sectional Data." op. cit.

[44] S. F. Stewart, "Physical Growth and School Standing of Boys," Journal of Educational Psychology, op. cit.

[45] Cecil V. Millard, Child Growth and Development, op. cit., p. 65.

[46] S. A. Courtis, Maturation Units and How to Use Them, op. cit., pp. 140-141.

growth of the individual, to have added information about the cyclic pattern of height growth from birth to maturity.

Definition of Terms

$y = mx + b$:	"The graph of this rational and integral equation of the first degree having two variables is always a straight line."[47]
m:	The slope of the line.[48]
b:	The intercept on the y axis.[49]
x and y:	The independent and dependent variables.[50]
rate:	Increase per unit of time.
cycle:	Increasing upward movement followed by decreasing upward movement.*
Trauma:	An experience of such magnitude that it might possibly affect the pattern of growth.

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[47] W. Wells and W. W. Hart, Progressive Second Algebra (Boston: D. C. Heath and Co., 1934), p. 31.

[48] Raymond W. Brink, A First Year of College Mathematics (New York: D. Appleton - Century Company, Inc.), 1937.

[49] Ibid., p. 26.

[50] Ibid., p. 27

* This definition is to be held tenatively until such a time when an empirical definition can be derived from the data.

CHAPTER II

REVIEW OF THE LITERATURE

An abundance of information has been accumulated on the growth of height, and several authors at different times historically have accomplished exhaustive reviews of the literature.[51,52,53] Therefore, only a sampling of the studies need to be reported in this review in an attempt to give an overview of the literature dealing with height.

Almost all of the earlier anthropometric research was of a cross-sectional variety and told us little about the

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[51] 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, Vol.1, No. 2, 1936.

[52] 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, Vol. XIII, No. 3.

[53] Review of Educational Research, Vol. III (April, 1933); Vol. VI (Feb., 1936); Vol. IX (Feb.,1939); Vol. XI (Dec., 1941); Vol. XIV (Dec. 1944); Vol. XX (Dec.,1950), and Vol. XII (Dec., 1952).

individual growth of children. Dickson published some of the first of the cross-sectional material on height in this country.[54]

> My next table is a very interesting one, giving the measurements, weight, etc., of the young gentlemen of the Virginia Military Institute at Lexington; for which, I am indebted to one of their body, Mr. Hart, to whom I thus make my acknowledgements.
>
> One hundred and fifty names are set down -150. Of these the average height is . . . 5 ft. 09 in. . . . .
>
> It is presumed that they are all Virginians. The tallest is 6 feet, 04 inches; age, 21; of Irish and Scotch descent. The shortest is 5 feet, 03 inches; age, 15; of Scotch and French descent. . . .
>
> Under the Rev. Dr. Buist's care, in Laurens, (South Carolina) there are 83 young girls between the ages of 5 and 18 - one young lady is set down at 21.
>
> From 12 to 21 years of age there are 52, whose average age is 14 years and 1 month. Of these, the average height is . . . . 5 feet, the average weight is . . . . 100 1/5 lbs.
>
> Under 12 years - some mere children - there are 31 young girls. Of these,
> the average age is about . . . . 9 years
> the average height is . . . . .4 ft., .01 1/16 in.
> the average weight is . . . . .57 11/12 lbs.
> Three of them were born in Texas, one in Alabama, one in Georgia, the rest are South Carolinians.

In this study of Dickson's the information was grouped according to sexes, and mention was made of the ethnic and environmental backgrounds of the people involved, thus a beginning was made in understanding some of the variables operating in research.

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[54] Samuel Henry Dickson, "Some Additional Statistics of Height and Weight," Charleston Medical Journal and Review, 1858, 13, No.4, p. 500.

This publication demonstrates in a historic manner the progress that has been made since that time. Even to a person who, today, is still somewhat cross-sectionally oriented, the errors and improvements needed in a study of this type must be obvious.

In terms of a cross-sectional frame of reference the children were not grouped according to age level. We have no evidence to indicate the amount of clothing, shoes, etc. that was worn when the measures were taken. No recognition was given to the known fact that children grow heavier and taller as they get older cronologically or with the passing of time. The children were, however, dealt with more adequately than if all had been lumped into a single group.

Bowditch,[55,56] in the 1870's and 80's collected cross-sectional data on several thousand school children (boys and girls) over a period of time. From these measurements he made conclusions as to the relationship of weight and height and by averaging the heights of groups of boys and girls he drew average growth curves. Since he recorded measurements over a period of time, Bowditch can be identified as one of the first

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[55] H. P. Bowditch, "Comparative Rate of Growth in the Two Sexes," Boston Medical and Surgical Journal, 1872, 10, 434-435.

[56] H. P. Bowditch, "The Growth of Children," Eighth Annual Report of Massachusetts State Board of Health, 1877. Pp. xxv, 498, pp. 273-324.

to accumulate short term longitudinal data on groups. Further, he should be given credit for realizing that group growth is not straight line but curvilinear or even cyclic. Since he drew average growth curves on the accumulated short term longitudinal measures, he did not get an adequate picture of individual growth differences.

Another of Bowditch's conclusions was the important contribution, which he supported by evidence, that growth is most rapid during the earliest years of life. From this statement it seems logical to conclude that he also realized that the growth rate is not constant.

In 1881 Peckham[57] reported an investigation in the public schools of Milwaukee on 5,107 boys and 5,130 girls ranging in age from four to 19 years. Colored children and those physically deformed were not included. Peckham's exclusion of racial groups and those not classified as normal was a good beginning in the realization that a reduction in variables leads to more useful results. These findings he then compared with the corresponding values for Boston children as reported by Bowditch[58, 59] and concluded that Milwaukee

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[57] Geo. W. Peckham, "The Growth of Children," Sixth Annual Report of the State Board of Health of Wisconsin, 1881. Pp. lxxxiv, 146, p. 28-73.

[58] H. P. Bowditch, "Comparative Rate of Growth in the Two Sexes," Boston Medical and Surgical Journal, op. cit.

[59] H. P. Bowditch, "The Growth of Children," Eighth Annual Report of Massachusetts State Board of Health, 1877, op. cit.

children were taller than Boston children because the population of Milwaukee was less dense than that of Boston.[60] His conclusion thus implies that environment affects physical growth.

Apparently there was some realization of the wholeness of growth - the idea that one aspect of growth affects another - on the part of Tarbell,[61] since in 1881 he reported a growth study of the stature and body weight of idiotic and feeble minded children. From this study he concluded:

> 1. Idiotic and feeble-minded children are shorter and lighter than public school children throughout the age period from six to nineteen years. Beyond sixteen years the inferiority of the feebleminded children is well marked.
>
> 2. 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 years. Thus, on the average, feeble-minded girls appear to exceed feeble-minded boys in stature and body weight during the age interval from about fourteen to seventeen years.[62]

Tarbell thus presented some of the first evidence to show that there is some relationship between mental and physical growth -- between height and weight, and intelligence.

The first published height norms in the United States of England seem to be those presented in 1887 at the International

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[60]Geo. W. Peckham, "Various Observations on Growth," Seventh Annual Report of the State Board of Health of Wisconsin, 1882. Public Document No. 14, p. 61.

[61]G. G. Tarbell, "On the Height, Weight, and Relative Rate of Growth of Normal and Feeble-minded Children," Proc. Assoc. Med. Officers, American Institutions for Idiotic and Feeble-minded Persons. (Philadelphia, Pa.: Lippincott, 1883), pp. 188-189.

[62]Ibid., p. 188.

Medical Congress held in Washington. Stephenson,[63] presented tables giving averages for stature, annual absolute increases in stature, average for body weight, and annual absolute increases in body weight, all at yearly intervals. Stephenson's norms provided a partial picture of how the average of a group of children grew and not a representation of the pattern of growth of any one child.

In 1891, Greenwood,[64] analyzing some height and weight data collected in the public schools of Kansas City, organized the material into what later became common groupsings: [1] race, and [2] date of collected information. He found that for all groups studied, girls exceeded boys in both stature and weight at 13 and 14 years. Hence, evidence was established for what has been interpreted by some as the adolescent spurt.

Further evidence of the difference in rate of growth among boys and girls at adolescence and of the nature of this

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[63]Wm. Stephenson, "On the Rate of Growth in Children," Trans. International Meeical Congress, Ninth Session, Washington, 1887, 3, 446-452.

[64]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), pp. 192.

growth was contributed by Bowditch.[65] In 1891, he presented a further analysis of the data collected in Boston. He applied Galton's method of percentile grades to the Boston data and drew curves of the measurements of a given sex. These curves showed marked differences between the sexes during the adolescent period.

Stewart,[66] in a study showing the relationship of school standing and the physical growth of boys was one of the first in the area of human growth and development to demonstrate that he was consciously aware of the idea that individual growth might be different from group growth. This idea is shown in the organization of his study.

> The first part of the study deals with average heights and average weights of groups of boys of different school grades. The second part is a study of the individual records of twenty-nine boys whose physical measurements are complete for four or more successive years. The third part is a summary of the points suggested.[67]

And it is in the following questionable conclusions of Stewart that we find some of the first empirical evidence to show that cross-sectional and longitudinal analysis do not

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[65] H. P. Bowditch, "The Growth of Children, Studied by Galton's Method of Percentile Grades," Twenty-Second Annual Report of the State Board of Health of Massachusetts, Public Document No. 34, 1891, pp. 479-522.

[66] S. F. Stewart, "Physical Growth and School Standing of Boys," Journal of Educational Psychology, op. cit.

[67] Ibid., p. 414.

yield the same results. It is here that we see that cross-sectional data may yield confusing and contradictory evidence about individual growth and hence from the conclusions of cross-sectional studies we gain no information about how individuals grow.

> 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 averages 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:
>
> a. Heavy or tall boys of early development rank better than light boys of early or medium development.
>
> 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.[68]

Since Stewart's study, DeLong[69] showed that there was a significant difference in the results of a cross-sectional

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[68] *Ibid.*, p. 426.

[69] Arthur R. DeLong, "The Relative Usefulness of Longitudinal and Cross-Sectional Data," *op. cit.*

and a longitudinal study of similar children. He then explained that the two basic assumptions made when using cross-sectional data to show growth are incorrect. These two incorrect assumptions are:

> . . . when group scores are used individual differences average out, therefore the measure of central tendency is representative of the group. . . . When a statistical interpretation is made cross-sectionally about how growth occurs, the assumption is made that individuals hold their positions in their group.[70]

Figure 1 has been designed to show that analyses of cross-sectional studies do not illustrate the true pattern of individual growth. Line A represents the height growth pattern of one six year old boy and line B the height growth pattern of another six year old boy. The broken line represents the average of the measurements of the two boys at all times.

According to Figure 1 the average height of the group of boys at two years is 33.8 inches and at three years it is 36.9 inches. The average rate of growth between two and three years is 3.1 inches. It is obvious from the individual patterns that the averages do not describe the growth pattern of either individual, since neither boy A nor B is 33.8 inches at two years or 36.9 inches at three years and certainly neither of the boys grew 3.1 inches between the ages of two and three. Since DeLong[71] found that this was also true when large numbers

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[70]Ibid., p. 7.

[71]Ibid.,

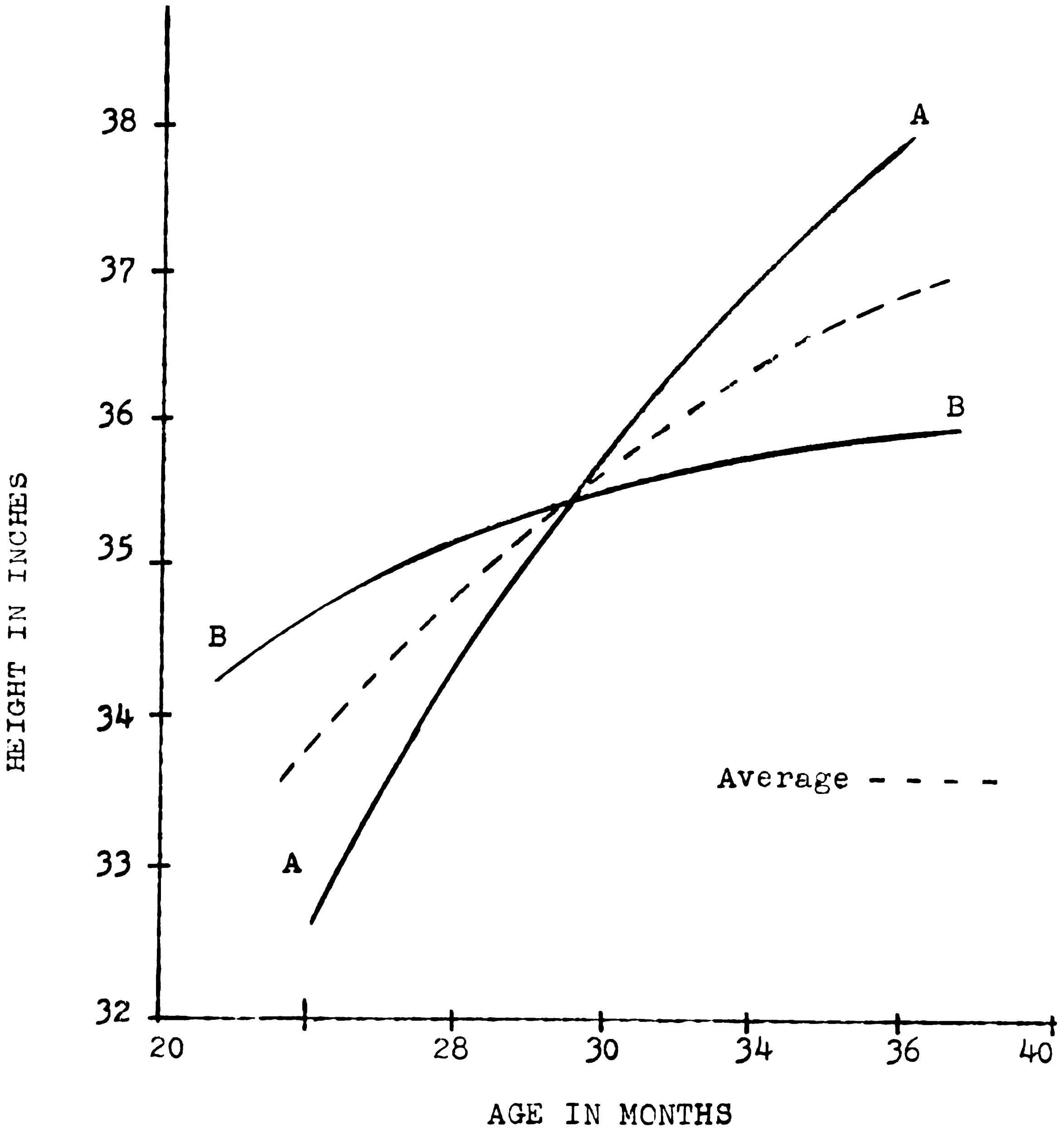

Fig. 1. Variation in Rate of Individual Height Growth[72]

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[72]Willard C. Olson and Byron O. Hughes, "Manual for the Description of Growth in Age Units," op. cit., p. 22.

of children were involved, it seems quite rational to conclude that cross-sectional studies reveal little about individual growth.

Many studies somewhat following the basic pattern used by Stewart followed in the literature.[73,74,75] Most of the authors made some improvement in objectivity, design, or technique of analysis.

Bayer and Gray[76] devised a method of graphically plotting growth of children from one to 19 years. The chart showed the relation of the individual to the average of a group. Burgess[77] presented a similar chart using percentile curves.

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[73]Ethel Abernethy, "Relationship Between Mental and Physical Growth," Monographs for Society of Research in Child Development, Vol. 1, 1929.

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

[75]H. Gray and A. M. Walker, "Length and Weight," American Journal of Physical Anthropology, 1921, 4, 231-8.

[76]L. M. Bayer and H. Gray, "Plotting of a Graphic Record of Growth for Children Aged One to 19 Years," American Journal of Diseases of Children, 1935, 50, 1408-17.

[77]M. A. Burgess, "The Construction of Two Height Charts," Journal of American Statistical Association, 1937, 32, 290-310.

Wetzel[78,79] devised a method of plotting the relationship of height to weight in such a manner that normal growth was straight line. This method has since been discredited.[80] More recently Sontag and Reynolds[81] have used the standard deviation to develop what they call a standard score. On the composit sheet many aspects of growth can be compared to one another and to the average and the distribution of a group. Olson and Hughes[82] have developed growth ages in months for physical growth (dental, carpal, height, weight, grip etc.) similar to the growth ages that some authors have gotten on mental tests. According to this technique the individuals

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[78] Norman C. Wetzel, The Treatment of Growth Failure in Children (Cleveland: N.E.A. Service, Inc., 1948).

[79] Norman C. Wetzel, "The Motion of Growth --Theoretical Foundations," Growth I, April, 1937.

[80] Stanley Marion Garn, "Individual and Group Deviations from 'Channelwise' Grid Progression in Girls," Child Development, Vol. 23, No. 3, September, 1952.

[81] L.W. Sontag and E. L. Reynolds, "The Fels Composite Sheet: A Practical Method for Analyzing Growth Progress," Journal of Pediatrics, 1945, 26, 327-35.

[82] Willard C. Olson and Byron O. Hughes, "Growth of the Child as a Whole," Child Behavior and Development, ed. by Barker, Kovin, and Wright (New York: McGraw-Hill Book Co, 1943).

specific growth age is dependent upon the age of the average of a group of children who measure approximately the same, but differ widely in cronological age.

In spite of these studies, little individual longitudinal data on the entire growth period was collected. In 1932 when analyzing the growth curves of six adolescents Boaz concluded:

> 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 an adequate insight into the phenomena.[83]

The same dilemma was again presented in 1951 by Shock when discussing individual growth curves, ". . . measurements of individual over the entire growth period are extremely rare."[84] It might be added that individual longitudinal analyses of the measurements are even more rare.

Scammon[85] give Gueneau de Montbeillard credit for being the pioneer investigator in the individual method, for accumulating individual measurements from birth to maturity. Montbeillard measured the growth in height of his son from

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[83] Frank Boaz, "Studies in Growth," A Journal of Human Biology, 1932, 4, p. 307.

[84] Nathan Shock, "Growth Curves," Handbook of Experimental Psychology, ed. by S. S. Stevens (New York: Wiley, 1951), p. 336.

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

birth until he was nearly eighteen years. These measurements were taken semi-annually or more frequently, and are reported and analyzed in an individual manner by Buffon in "Histoire Naturelle." According to Scammon, Buffon noted two important findings regarding growth.

> Of these the first is the observation that stature tends to decrease during the day and with prolonged exertion, and that this loss is regained with rest. The second is the recognition of a seasonal difference in growth.[86]

Figure 2 shows the data of Gueneau de Montbeillard presented in a manner similar to that of Scammon.[87] From this graphic presentation Scammon says:

> It will be noted that the curve shows the typical four phases which most modern students have observed in the postnatal growth in stature of man, and which are characteristic of the growth of so many parts of the body. There is a period of rapid growth during infancy and early childhood; a middle period, extending from three to nearly thirteen years, in which growth is slow but constant; a marked period of prepuberal acceleration, from about thirteen and one-half to fifteen years, and a period of slow terminal increment thereafter.[88]

The straight line in Figure 2 extending from the measurement at three years to the measurement near 13 years

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[86] *Ibid.*, p. 333.

[87] *Ibid.*, p. 333.

[88] *Ibid.*, p. 331.

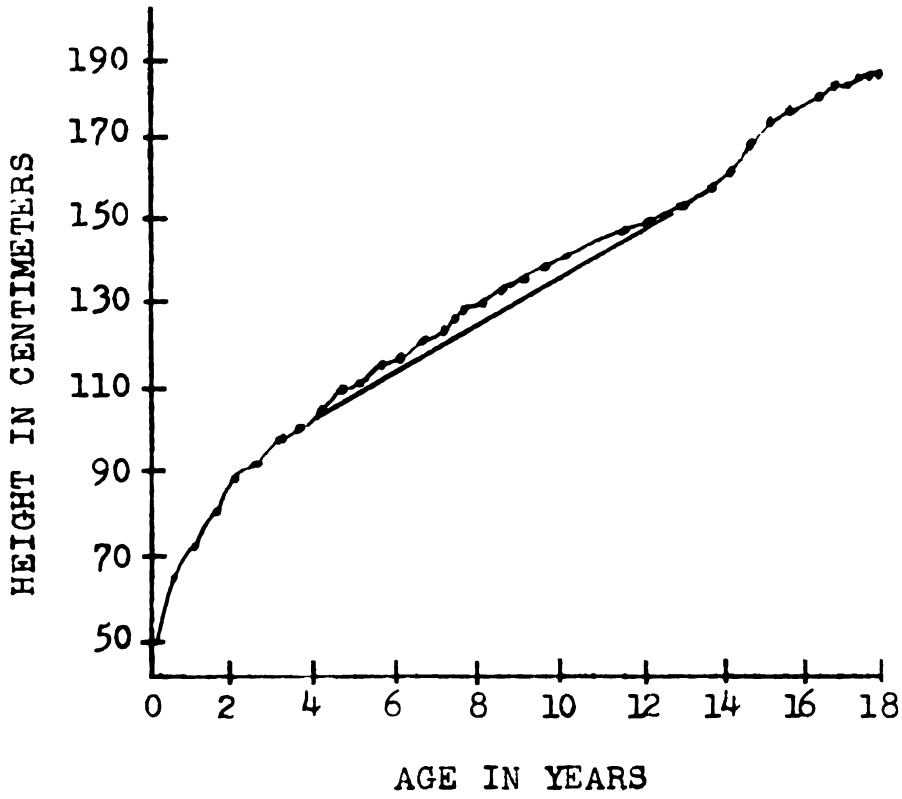

Fig. 2. Height Growth of a Single Individual Using the Data of Montbeillard Similar to the Figure Presented by Scammon.[89]

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89 <u>Ibid</u>., p. 333.

has been added by the author to show the error in Scammons analysis. If the rate from three to nearly thirteen were constant in terms of increase in inches per unit time the growth pattern from three to thirteen would be a straight line. Since the growth pattern based on semi-annual measurements is obviously not straight, the rate, in terms of the definition given must be changing.

Hence the idea that height growth is in four phases or two cycles as suggested by Scammon[90] and supported by Shuttleworth[91] and others needs further analyzing on an individual longitudinal bases using frequent measurements on the same individuals from birth to maturity.

The cyclic nature of growth among plants and animals has been known for some time, but it is only comparatively recently that the cyclic growth of man has been recognized. The idea that cyclic growth can be described by a mathematical formula is a concept that has received sporadic attention for the past century, Verhulst,[92] Mitscherlich,[93] Robertson,[94]

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[90] Ibid., p. 331.

[91] Frank K. Shuttleworth, "The Physical and Mental Growth of Girls and Boys Age 6 to 19 in Relation to Age at Maximum Growth," Monographs of Society for Research of Child Development, op. cit.

[92] S. A. Courtis, Maturation Units and How to Use Them, op. cit., pp. 179-180.

[93] Ibid., pp. 179-180.

[94] Ibid., pp. 179-180.

Thurstone,[95] Pearl,[96] Reed,[97] Brody,[98,99] Spellman,[100] and and more recently Courtis[101] and Bayley[102] are some of the persons who have published formula on growth curves. Each of the writers has a different formula, assumes that there are a different number of cycles in the growth process, and believes these cycles occur at somewhat different times.

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[95] *Ibid.*, p. 179-180.

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

[97] *Ibid.*

[98] S. Brody, *Growth and Development, III Growth Rates* Research Bulletin,(University of Missouri, College of Agriculture: Agriculture Experimental Station, Bulletin 97), January, 1927.

[99] S. A. Courtis, *Maturation Units and How to Use Them*, *op. cit.*, pp. 179-180.

[100] *Ibid.*

[101] *Ibid.*

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

The most popular individual growth curve now being used to describe the growth of human beings is the S. A. Courtis adaptation of the Gompertz function.[103] The Gompertz discovery, according to Courtis, describes the law of growth and has wide application in the social and biological sciences.

Windsor compared mathematically the popular logistic curve and the Gompertz curve and concluded:

> The Gompertz curve and the logistic possess similar properties 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." In each curve, the degree of skewness, as measured by the relation of the ordinate at the point of inflection to the distance between the asymptote, is fixed. It has been found in practice that the logistic gives good fits on material showing an inflection about 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 37 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 difference in the additional freedom provided.[104]

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[103] S. A. Courtis, Maturation Units and How to Use Them, op. cit.

[104] C. P. Winson, "The Gompertz Curve as a Growth Curve," Proceedings of the National Academy of Science, 18: p. 7, 1932.

Since this comparison was made, however, Millard,[105] DeLong,[106] Nally,[107] Kowitz,[108] Rusch,[109-110] and Greenshields[111] have shown the extent to which the Gompertz curve adequately describes growth. All of these writers have compared some aspect of growth to growth in height. They have followed a plan outlined by Courtis in writing the equations and in

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[105] C. V. Millard, "The Nature and Character of Pre-adolescent Growth in Reading Achievement," Child Development, op. cit.

[106] Thomas P. F. Nally and A. R. DeLong, "An Apprasial of a Method of Predicting Growth," Child Development Laboratory Publication, op. cit.

[107] 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, 1953.

[108] 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, 1954.

[109] Reuben R. Rusch, "The Relationship Between Growth in Height and Growth in Weight." Unpublished Master's thesis, Michigan State College, 1954.

[110] Reuben R. Rusch, "Center of Gravity and the Law of Growth." Unpublished paper as part of requirement for Education 524.

[111] C. M. Greenshields, "The Relationship Between Consistent IQ Scores, Decreasing IQ Scores, and Reading Scores Compared on Two Developmental Bases." Unpublished Master's thesis, Michigan State University, 1955.

determining the number of cycles.[112] However, over the latter procedure there seems to be considerable conflict.[113,114] Equation writers have expressed their concern as to just where cycles occur.

Since individual longitudinal height data from birth to maturity has not been analyzed in an individual longitudinal way, and since the occurrence of individual cycles of height growth has caused some conflict among modern researchers, the related problem, the individual cyclic pattern of height growth was chosen for this study.

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[112] S. A. Courtis, Maturation Units and How to Use Them, op. cit.

[113] Ibid., pp. 140-141.

[114] Cecil V. Millard, Child Growth and Development (Boston: D. C. Heath and Co., 1951), p. 65.

CHAPTER III

LONGITUDINAL ANALYSES FROM BIRTH TO MATURITY

In order to show the individual longitudinal pattern of height growth from birth to maturity, it was necessary to have height measures that covered this period of growth. One of the largest collections of data available in the world is at Michigan State University. However, none of their material covers the complete period from birth to maturity. Letters were sent to several of the leading Child Development Laboratories in the United States, asking whether they had this type of information and whether it was available for this longitudinal analysis. One hundred per cent response was received to the letters, but few places reported having any available data that was this complete. Fels Research Institute, however, replied that they had this information on approximately 300 children and that the information would be made available for analysis.

The Fels program from which the data for this study was obtained was begun in 1929. Families from which these children come, live locally or in nearby towns and communities. They enroll the child early in the pregnancy of the mother and all mothers are voluntary participants. About a dozen new families are admitted to the study annually to replace the children who drop out when they reach physical maturity or for some other reason such as the family moving out of that region. The main factor in the selection of the families is the probability of long residence in this area.

According to Reynolds:

> The group as a whole is a fair cross-section of the white population of Southwest Ohio and the children belong to that large and almost undefinable class known as "normal" children.[115]

The Fels program is a long term, integrative multidisciplinary study of growth and development of these children, from fetal life through maturity. Thus the skills and contributions of such disciplines as anatomy, anthropology, biochemistry, genetics, pediatrics, nutrition, physical growth, physiology, psychology, psychophysiology, psychiatry, and sociology are used in conducting the seriatim developmental study.

The department of physical growth is one of several divisions of the Institute. It is responsible for the collection of data and for research in the areas of body structure, growth progress and health. Fels children (as those in the study are called) visit the physical growth laboratory at regular intervals, where the procedures include medical and dental examination, health and nutritional history, body measurements and observations, nude photographs, and a comprehensive series of roentgenograms of various parts of the body.

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[115]Earle L. Reynolds, "The Distribution of Subcutaneous Fat in Childhood and Adolescance," Monographs of the Society for Research in Child Development, Vol. XV. Serial No. 50, No. 2, 1950, p. 12.

At this same visit, these children also take part in the programs of such other departments as psychology, psychophysiology, biochemistry, etc.

The subjects were nude when the height and crown-heel measures were taken. The standing height measures were taken with a wall mounted instrument that uses a sliding arm on a scale calibrated in millimeters. A scale calibrated in millimeters with a sliding arm fastened to the table was used to take the crown-heel measures. The subject lay horizontally on a table when these measures were taken. A trained physical anthropometrist took these measures of the children. The child was placed in exactly the same position each time he or she was measured thereby reducing the error of measurement due to the technique employed. The instruments used for measurement cannot readily be moved and were located in one room. Thus there was a minimum amount of error that can be attributed to the instruments.

It is impossible to take standing height measures of a child who can't stand. Therefore, until the child was several years old no attempt was made to measure his standing height. Instead the child was placed horizontally on the table and the crown-heel length was measured. At a later age, when both measures were taken, in most cases, this crown-heel length showed that the children were somewhat longer than they were tall. After the child was about six years old, crown-heel measures were no longer taken. Standing height measures were then taken as long as the child remained in the study.

The Fels Children were given a number when entering the study. The first person to enter the study was given number one, the tenth person, number ten, etc. Hence, it is usually true that the smaller the number of the case, the more height measures there were available on that subject (many of these being after maturity) since some subjects were followed until they were 24 years old. The numbers assigned by Fels to identify the children and allow them to remain anonymous were used to identify the child in this study. However, an F (for female) was added to the number if the case was a girl and an M (for male) if the case was a boy.

All cases that could meet the following criteria were selected from the Fels group for use in this study.

1. There had to be continuous height measurements from birth to maturity taken at semi-annual intervals from within the first three months of life to maturity (as determined by two below). Cases were not chosen if more than two years of continuous measurements were missing in the total pattern of height growth from birth to maturity, or a total of two and one-half years of measurements.*

2. As an indication of maturity, the roentgenograms were used. For this purpose the epiphyses of the humerus had to be fused.**

Of the 300 Fels Children, the data on 31 boys and 46 girls met the above criteria and hence were used in this study.

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*Those cases where one to three of the semi-annual measures are missing are identified in this study by a * before the case number.

**The author was taught to make this judgment by S. Garns, the head of the Physical Growth Department at Fels.

Method

In order to show the true individual continuous pattern of cyclic height growth from birth to maturity, a mathematical method was used to determine the pattern of growth. This method made applicable by Holmgren and Rusch was originally devised to help different people write similar mathematical equations when using the Courtis Technique to describe growth. In essence, the straight line of best fit is determined mathematically by the individual data and then the plotted measurements are compared to the straight line. In applying this procedure to the Fels data the following steps were taken.

1. A criteria was set up for determining height maturity. This was done for two reasons: [A] Garns has shown that growth in standing height continues after skeletal growth is complete and height growth is a composite of many measurable growth aspects. [B] By including continuous measurements after tho height measurements have stopped increasing, the slope of the straight linc decreases or becomes farther away from the increasing height measures. Thus it becomes increasingly difficult when examining the graphs empirically to determine where the cycles of height growth occur. Figure 3 shows how the straight line becomes further from the data during the years when the child is growing if measures beyong height maturity are used in determining the

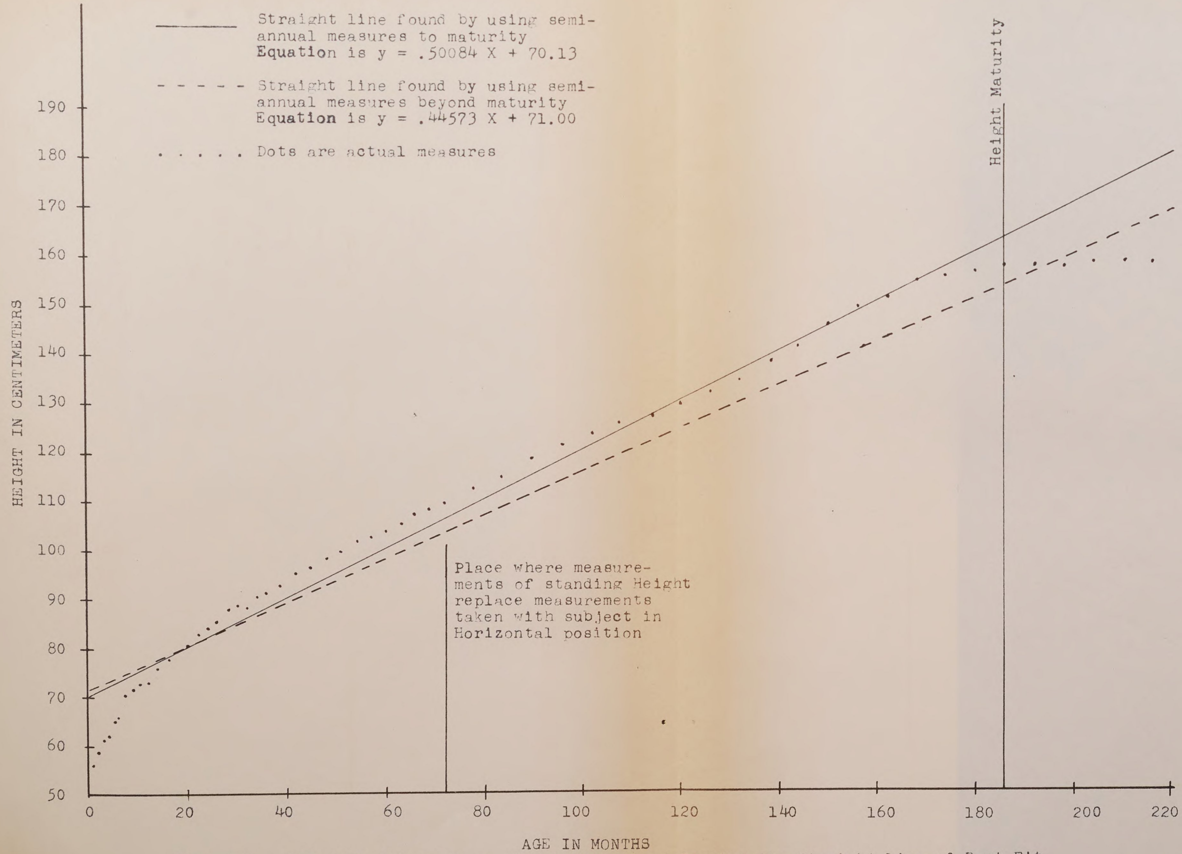

Figure 3. Case 75F. A Comparison of Two Methods of Finding the Straight Line of Best Fit.

straight line of best fit. This criteria for height maturity was: the individual six month interval measurements must increase by one or more centimeters per year. When this failed to happen the individual was considered mature for purposes of using the measurements for determining the straight line of best fit. In several instances the available measures did not show that the subject had reached height maturity according to this definition of height maturity. In these cases the last continuous height measure was considered the point of height maturity. These individual cases are identified by a ^{o} sign before the case number.

2. Measures other than those taken at six month intervals from birth to the above criteria of height maturity were eliminated for purposes of determining the straight line of best fit. There were an abundance of measures available the first several years of life, but after about the age of six, height measures were only taken semi-annually. By using more measurements per unit for one part of the growth period than for another part of the growth period, the period from which more measurements were used for a given unit of time would have more of an influence in determining the line of best fit. An example of this is shown in Figure 4.

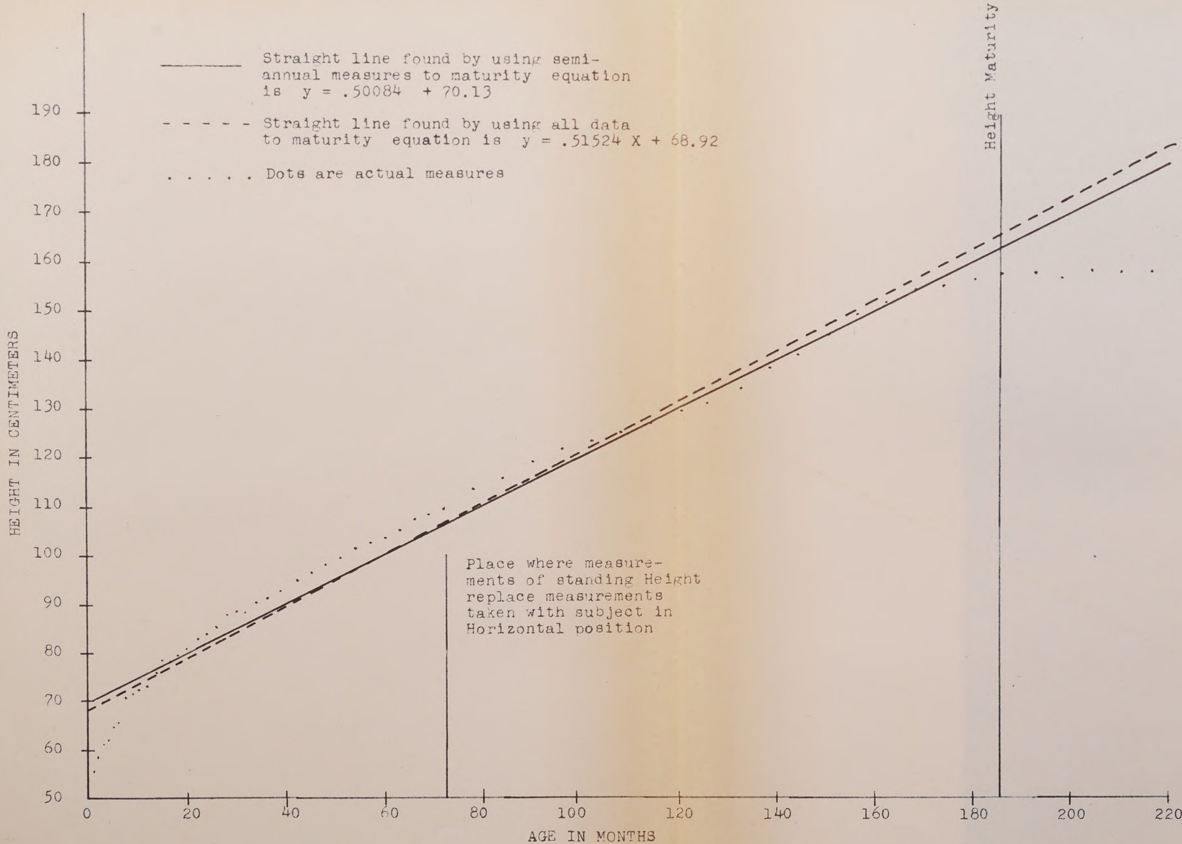

Figure 4. Case 75F. A Comparison of Two Methods of Finding the Straight Line of Best Fit.

Figure 5, again using Case 75F, was constructed to show a comparison of two straight lines of best fit using two slightly different amounts of data to determine these lines. This was done because a few cases had several semi-annual measurements missing, but not enough to eliminate them from the study according to the criteria of selection, described previously in the selection of Fels children for this study. The straight line of best fit represented by the unbroken line in Figure 5 was determined by using semi-annual measurements from birth to maturity. A period of one and one-half years of measurements, picked at random, were not used from the same data when the other straight line (as represented by the broken line in Figure 5.) of best fit was determined. The negligible affect of small amounts of missing data on the straight line can be seen from examination of this figure.

3. The mathematical expression of this straight line of best fit $y = m x + b$ was next determined. In this equation m equals the slope of the line and b is the starting point when x (time in this instance) equals zero (at birth); y equals the magnitude of the measurement.

A. m for this equation of height growth was determined by the equation $m = \frac{n \Sigma xy - \Sigma x \Sigma y}{n \Sigma x2 - (\Sigma x)^2}$

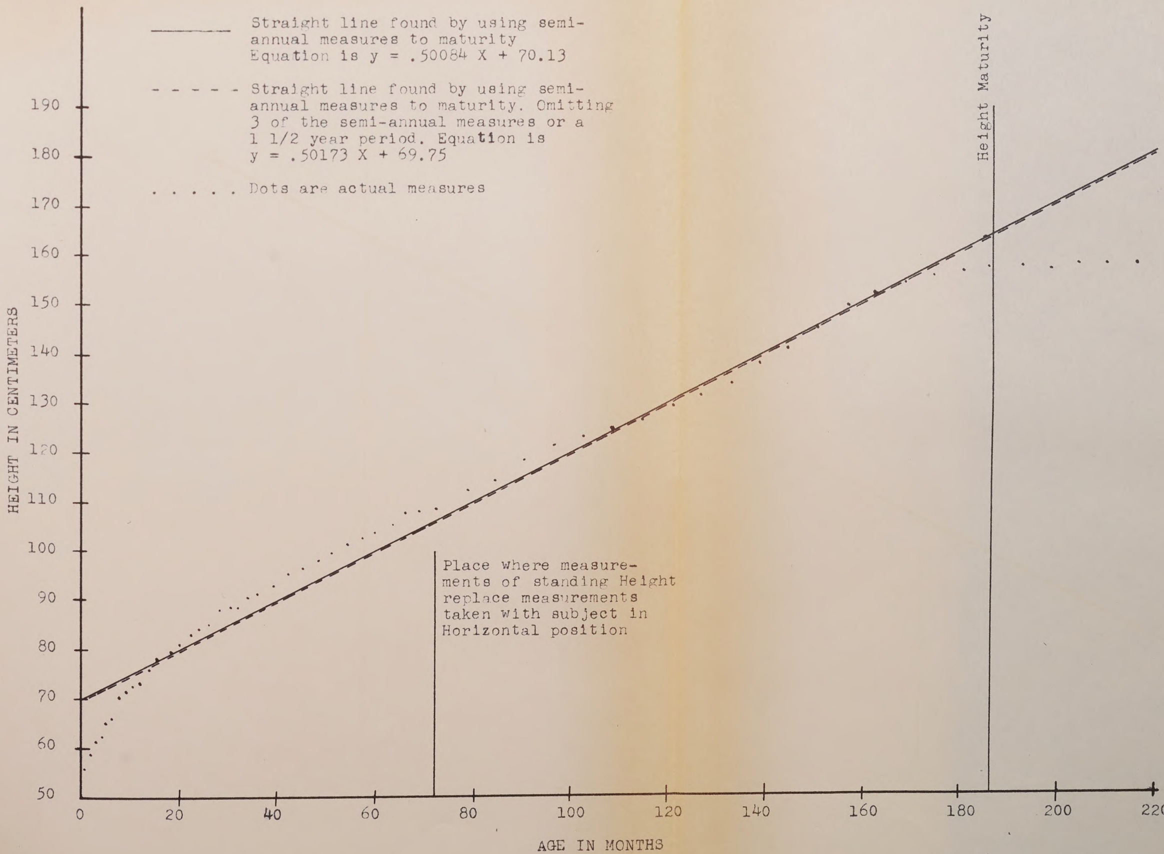

Figure 5. Case 75F. A Comparison of Two Methods of Finding the Straight Line of Best Fit.

In this equation for finding m, n equals the number of height measurements at six month intervals, x equals the time of measurement in months and y equals the height measurement in centimeters.

B. b for the general equation of height growth was determined by the equation $b = \frac{\Sigma x^2 \Sigma y - \Sigma x \Sigma xy}{n \Sigma x^2 - (\Sigma x)^2}$

Again in this equation as in the equation for finding the slop of the line, n equals the number of height measurements at six month intervals from birth to maturity, x equals the time of the measurement in months and y equals the height measurement in centimeters.

C. In order to determine the slope m and the starting point b of the straight line that would best fit the height measurements from birth to maturity, the specific functions of the equations for finding m and b had to be determined.

These specific functions were:

Σx^2 The sum of squares of each time measurement.

$(\Sigma x)^2$ The sum of the times of the measurements, squared.

Σxy The sum of each time, times each measure, squared.

Σx The sum of the times.

Σy The sume of the measurements

n The number of measures.

D. These function were then found and substituted appropriately in the equations for finding the slope and the starting point. The two equations are then solved. This provided the slope and starting point of the general straight line equation or the straight line that best fits the data.

4. In order to graphically present the individual straight line of best fit and the data, two times were chosen that were appropriate for the graph and the equation was solved for y, or the measurement at the chosen times. The straight line was then drawn on the graph of the data through the values of y corresponding to the times chosen. This line represents all the points that would be found by solving the equation for all times.

5. The data were then compared by examination, since they were plotted on the same graph, to this straight line of best fit to determine the number of cycles of height growth from birth to maturity. All measurements were included on the graph to determine the cyclic effect.

6. In order to show the graphic data in an objective mathematical manner, the general straight line equation $y = mx + b$ was solved for each time that corresponded to the time when a height measurement was taken on the

child. The actual measurement was then compared mathematically to the straight line measurement. At all times the straight line measurement obtained by solving the equation was subtracted from the actual measurement at that time. The differences between these measures were expressed in terms of a plus or a minus number of centimeters. A plus number of centimeters indicated that the actual measurement is greater than (or above on the individual graph) the straight line measurement and a minus number of centimeters indicated that the actual measurement was below the straight line at that point of time.

Thus the increase and decrease in centimeters and the change in sign of deviations (the difference between actual measurements and straight line representation) showed the curvilinear nature of individual height growth from birth to maturity and hence the cyclic pattern of height growth in a completely individual, objective, mathematical manner.

CHAPTER IV

ANALYSIS OF THE DATA

The Fels data for the purpose of this study was found to be the most complete available. Height measures were taken at the Fels Research Institute semi-annually (more frequently during the early years) from birth to maturity. Considerable patience and accurate measuring instruments were used in securing these horizontal and standing height measures. However, more frequent height measurements on these children would have contributed considerably to a study of this type.

Analysis of this data on an individual longitudinal bases has revealed much about the individual cyclic pattern of growth. However, some cycles appear to be only a year or less in length. Whether this is due to seasonal difference in growth rate or to the diurnal variation has yet to be established on an individual longitudinal bases.

Measurements at six month intervals are not frequent enough to give us a true picture of seasonal cyclic growth. Long bone growth has been shown to be more rapid during one season than another and since long bone growth is one of the morphological components of height growth it seems reasonable to hypothicate that during certain seasons height growth may be more rapid than during other seasons.

No attempt is made at Fels to check the diurnal variation in height growth. An attempt is made, however, to measure all children in the mornings so that the diurnal variation of the morphological components of height, if such a factor exists, may be influencing the height measure a constant amount.

Certainly there is no place in the world where there are as many accurate, continuous, height measures on such a large number of children from birth to maturity as there are at Fels. More frequent measurements on the same children would be needed, however, to provide the material from which a similar analysis of seasonal cyclic growth and diurnal variation could be made.

Some of the data concerned with the height measures of the girls and boys are found in Appendices A and B. The cases are listed in Column One according to the number assigned by Fels. Column Two represents the total number of height measures of that boy or girl. Column Three is the age to the nearest tenth of a month at which the first height measure was taken and Column Four is the age to the nearest tenth of month at which the last height measure was recorded. Column Five shows the periods, if longer than six months, during which there was no recording of height growth measures. Column Six is the age of height maturity (according to the previous definition of height maturity). Column Seven is the age in months and tenths of a month at which time continuous standing height measures were recorded for that child.

A summary of the material presented in Appendices A and B is shown in Table I. The group means and the range of scores show the similarity between the groups of boys and girls in the total number of measures, the age of the first and the last measure, and the age when permanent height measures were begun.

The age of height maturity, which is the only factor in this table resulting from individual growth, shows that boys as a group reach height maturity at a later chronological age than do this group of girls. However, analysis of Appendix B provides an example of a boy who reaches height maturity before 173.6 months of age or the mean for the group of girls. Many boys are shown by Appendix B to reach height maturity before the chronological age of 197.9 months or the top age of height maturity of one girl in this group of girls. Thus Appendices A and B and Table I illustrate that although boys, as a group, reach height maturity at a later chronological age than girls taken as a group, there are many individual boys who reach height maturity at an earlier chronological age than do some girls.

The plotted height measurements of each child and the straight line that best fits the data are shown in Figures 6 through 82. The vertical line drawn at approximately 72 months of age represents the time at which the measurements were changed from horizontal position measures to standing height measures. Therefore, all dots to the left of that line, unless otherwise indicated, represent the length of the subject and all measures to the right of the line represent the standing height of the boy or the girl.

TABLE I

SUMMARY OF THE DATA

Data Characteristics	Girls N = 46		Boys N = 31	
	Mean	Range	Mean	Range
Total No. of Measures	53	34-60	56.5	48-60
Age of Last 1st Meas.	.6	0-2.5	.5	0-3.0
Age of Last Measure	218.7	178.7 - 288.6	229.0	192.0-288.1
Age of Ht. Maturity	173.6	150.3 - 197.9	199.9	168.2-216
Age Permanent St. Ht. Measures Begin	40.5	26.0 - 78.0	38.6	28.0- 69.0

Obviously the standing height of a child could not be measured until the child has learned to stand. The Fels measures of length were discontinued when the subject was somewhere between the age of six and ten years. Hence, a time had to be selected when, for purposes of this investigation, the horizontal position measures would no longer be used and standing height measures would take their place. For almost all subjects there was recorded, continuous standing height measures from the age of six on to maturity. Therefore, six

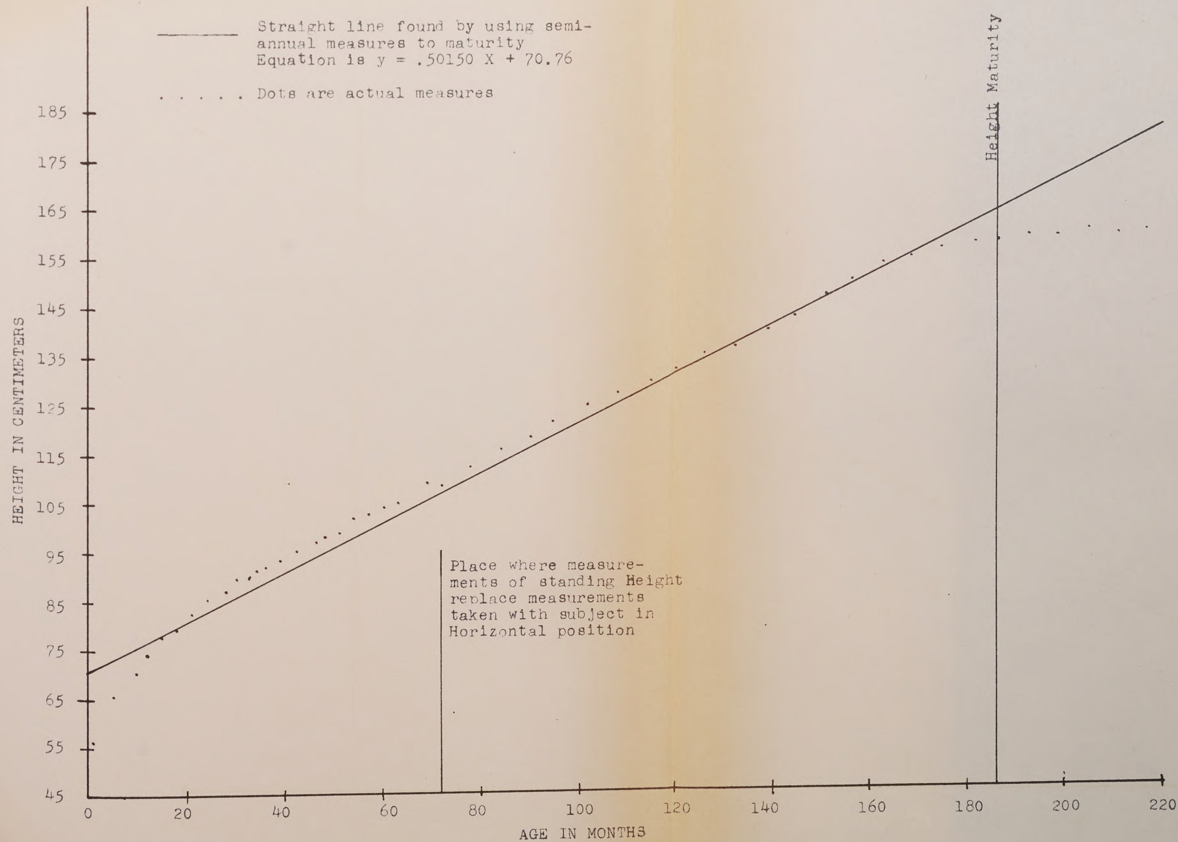

Figure 6. Case 25F. Height Measures and the Straight Line of Best Fit.

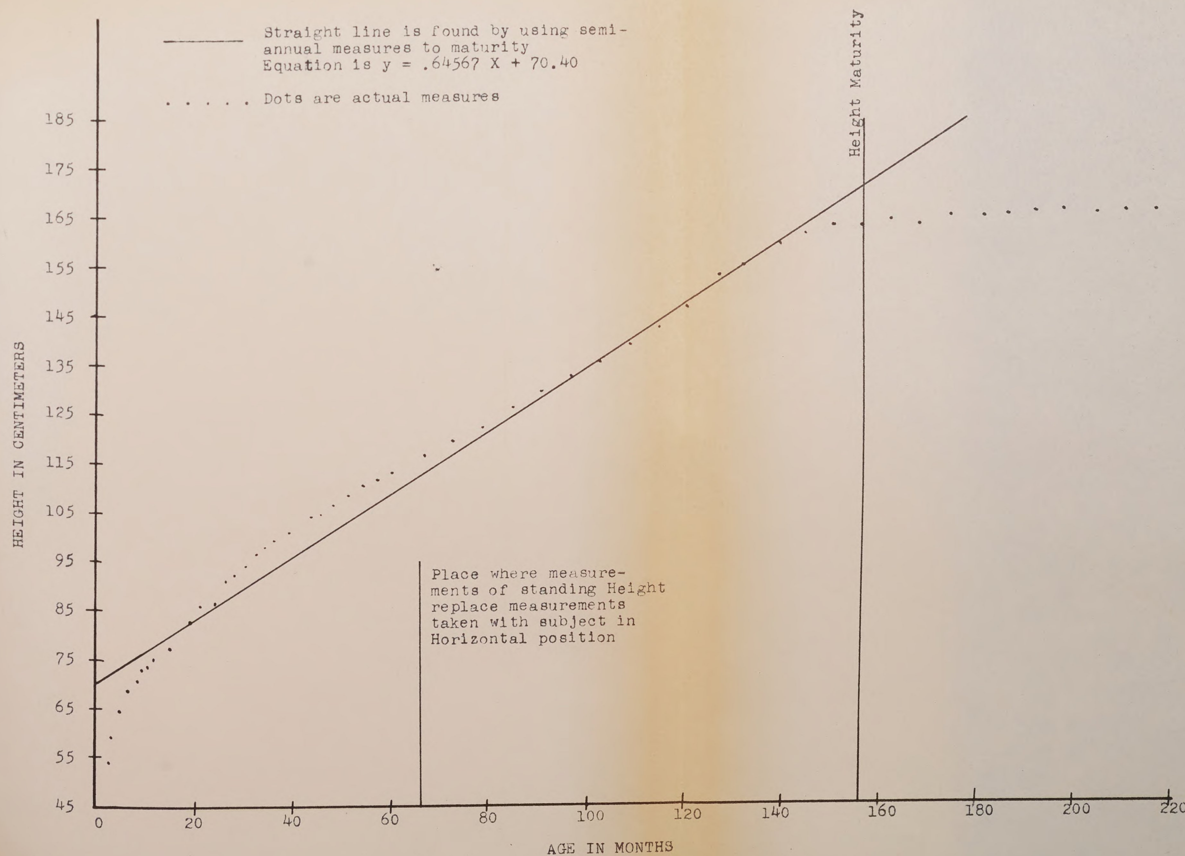

Figure 7. Case 28F. Height Measures and the Straight Line of Best Fit.

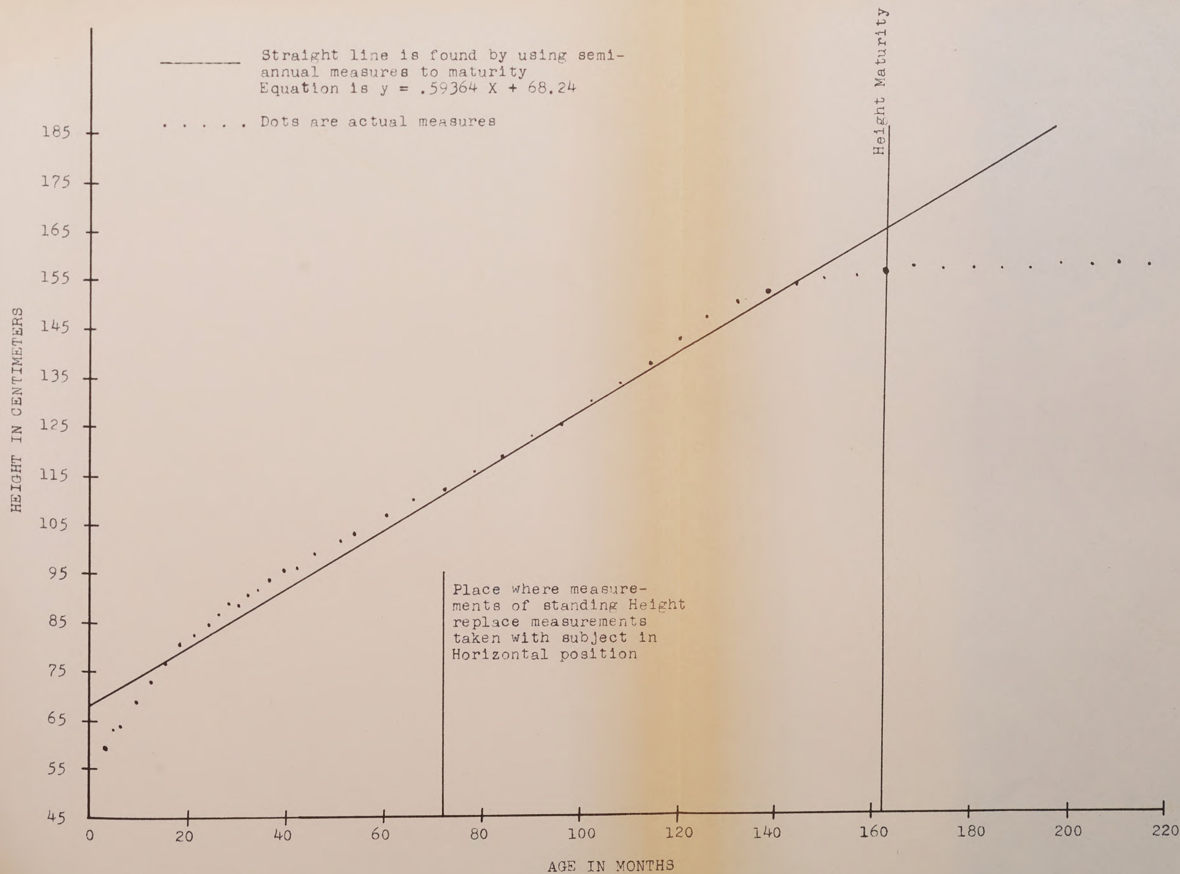

Figure 8. Case 37F. Height Measures and the Straight Line of Best Fit.

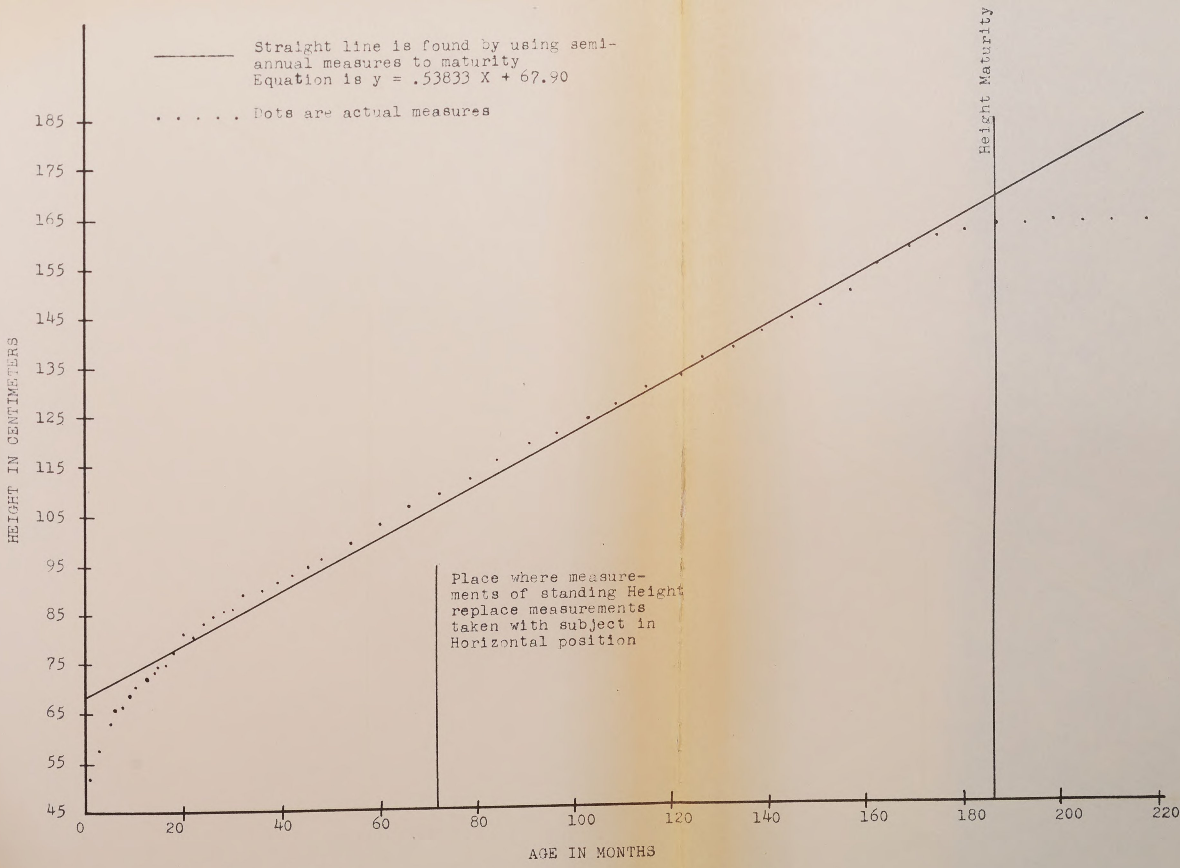

Figure 9. Case 59F. Height Measures and the Straight Line of Best Fit.

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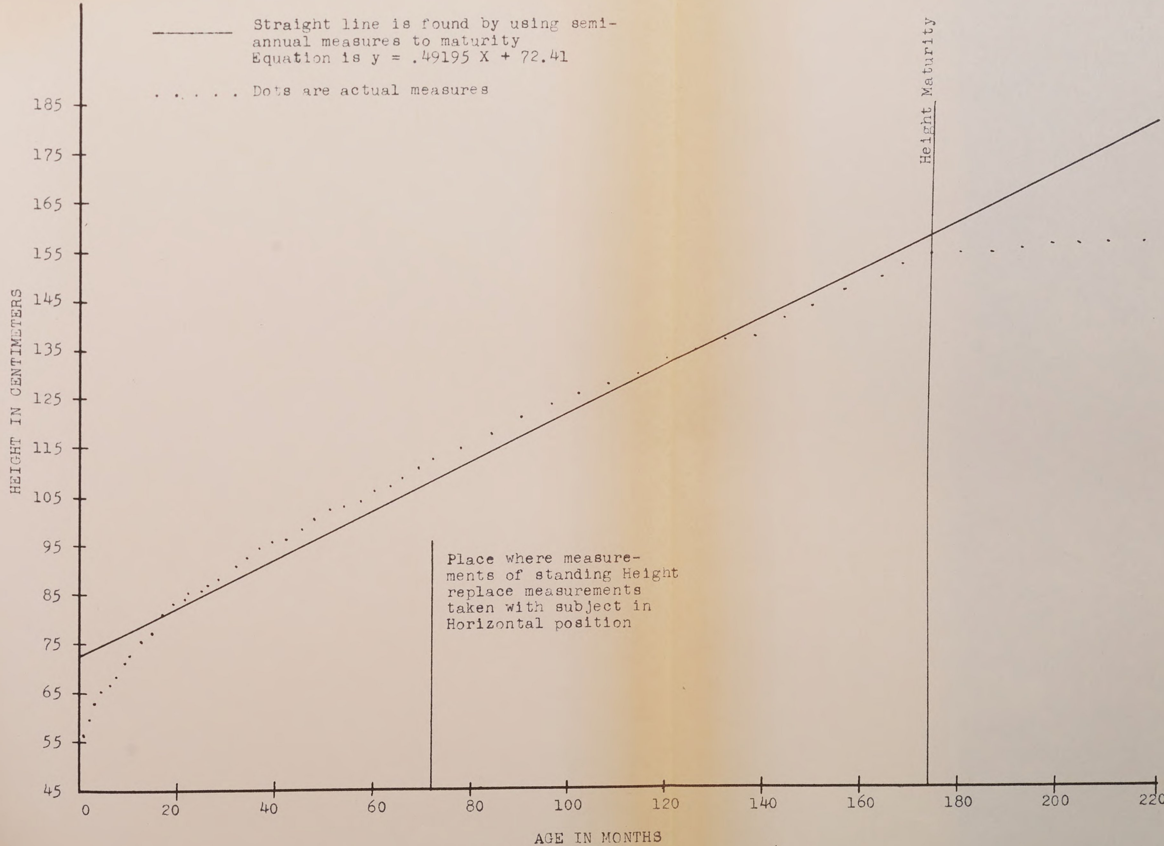


Figure 10. Case 66F. Height Measures and the Straight Line of Best Fit.

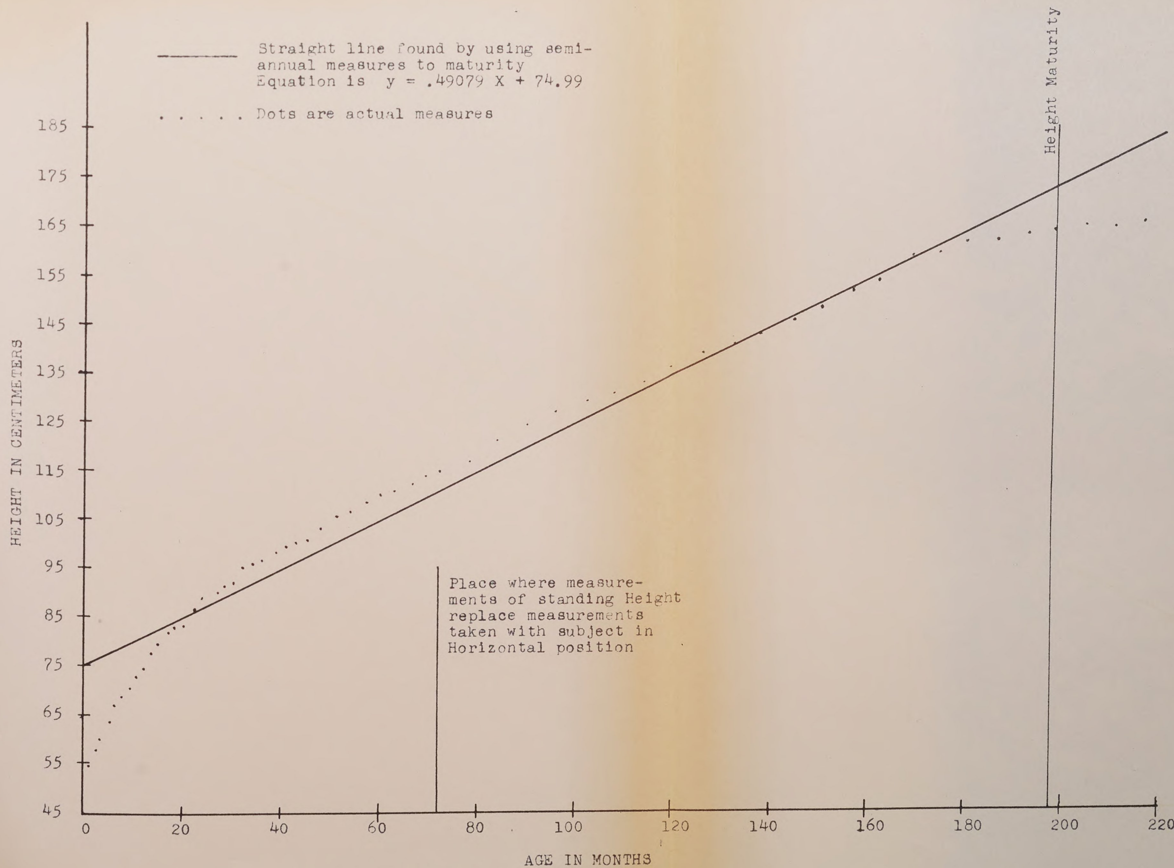


Figure 11. Case 67F. Height Measures and the Straight Line of Best Fit.

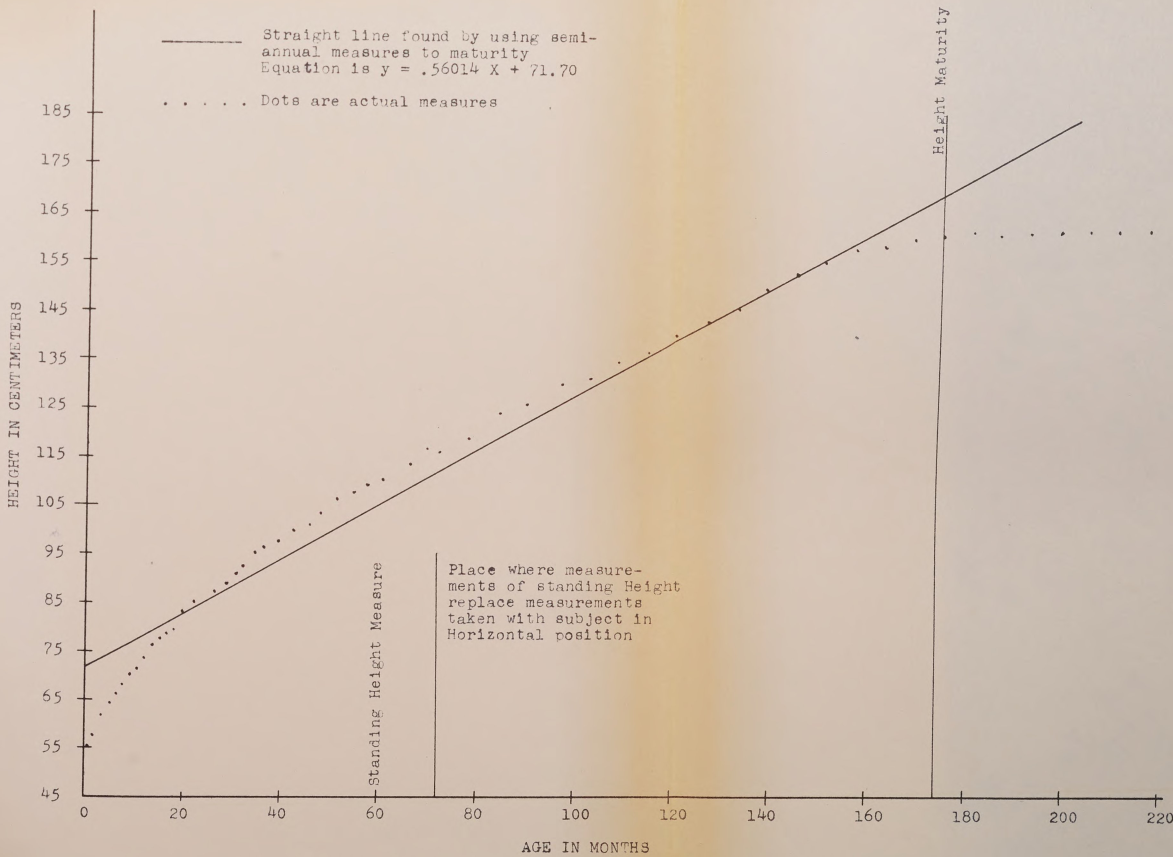


Figure 12. Case 72F. Height Measures and the Straight Line of Best Fit.

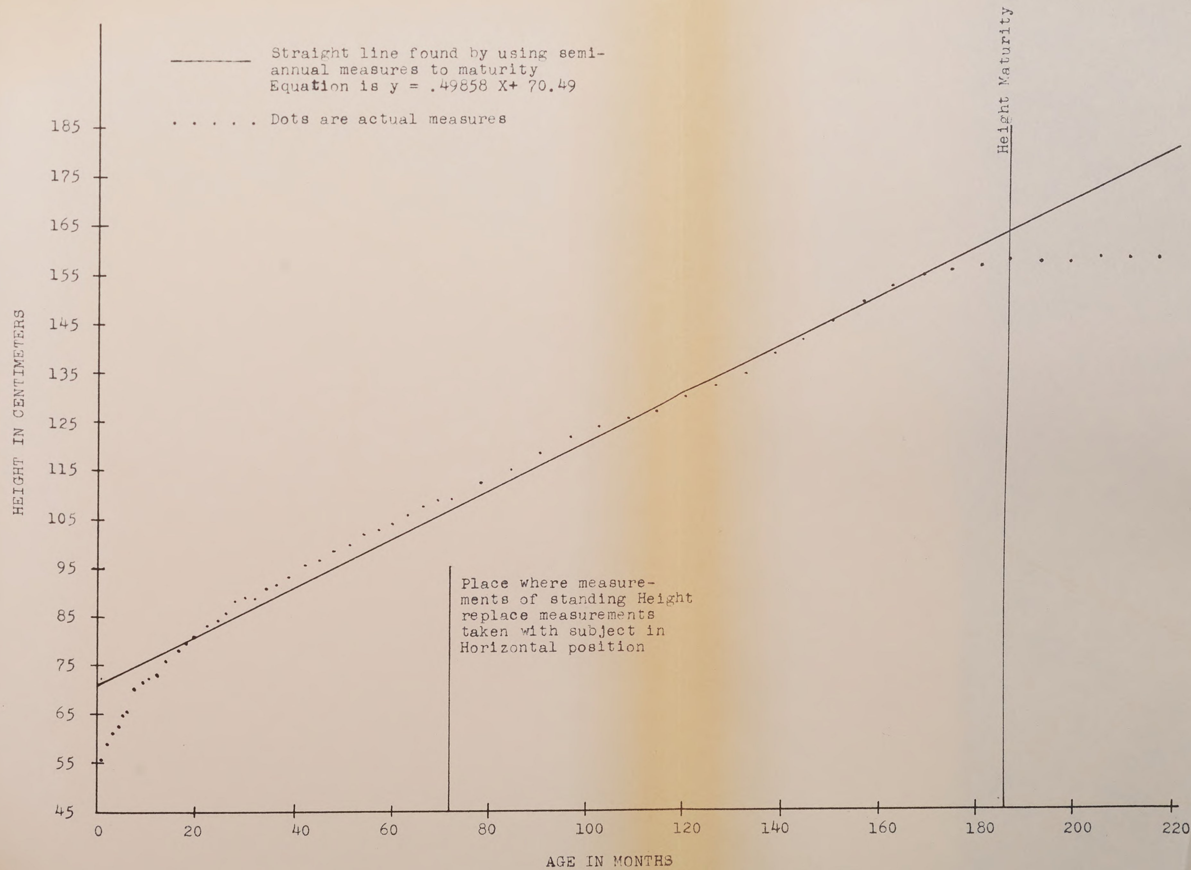


Figure 13. Case 75F. Height Measures and the Straight Line of Best Fit.

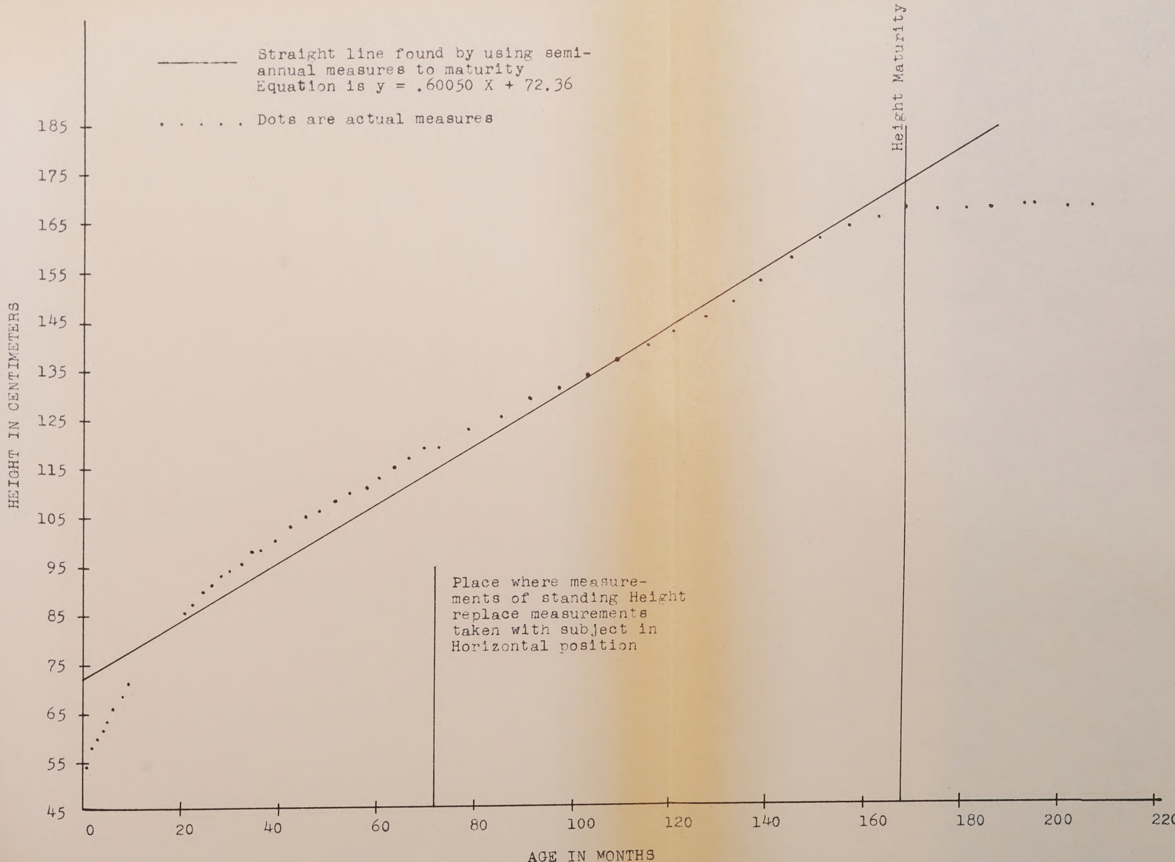


Figure 14. Case 76F*. Height Measures and the Straight Line of Best Fit.

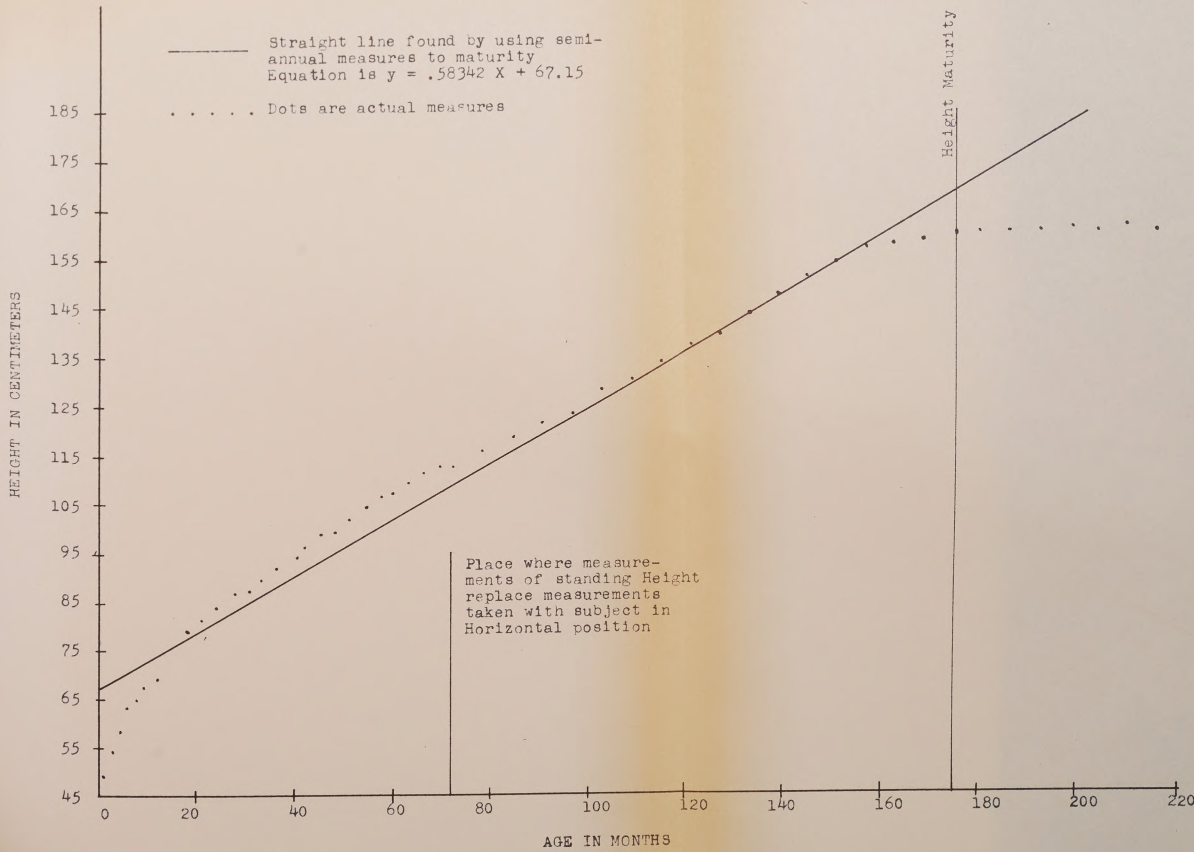


Figure 15. Case 82F. Height Measures and the Straight Line of Best Fit.

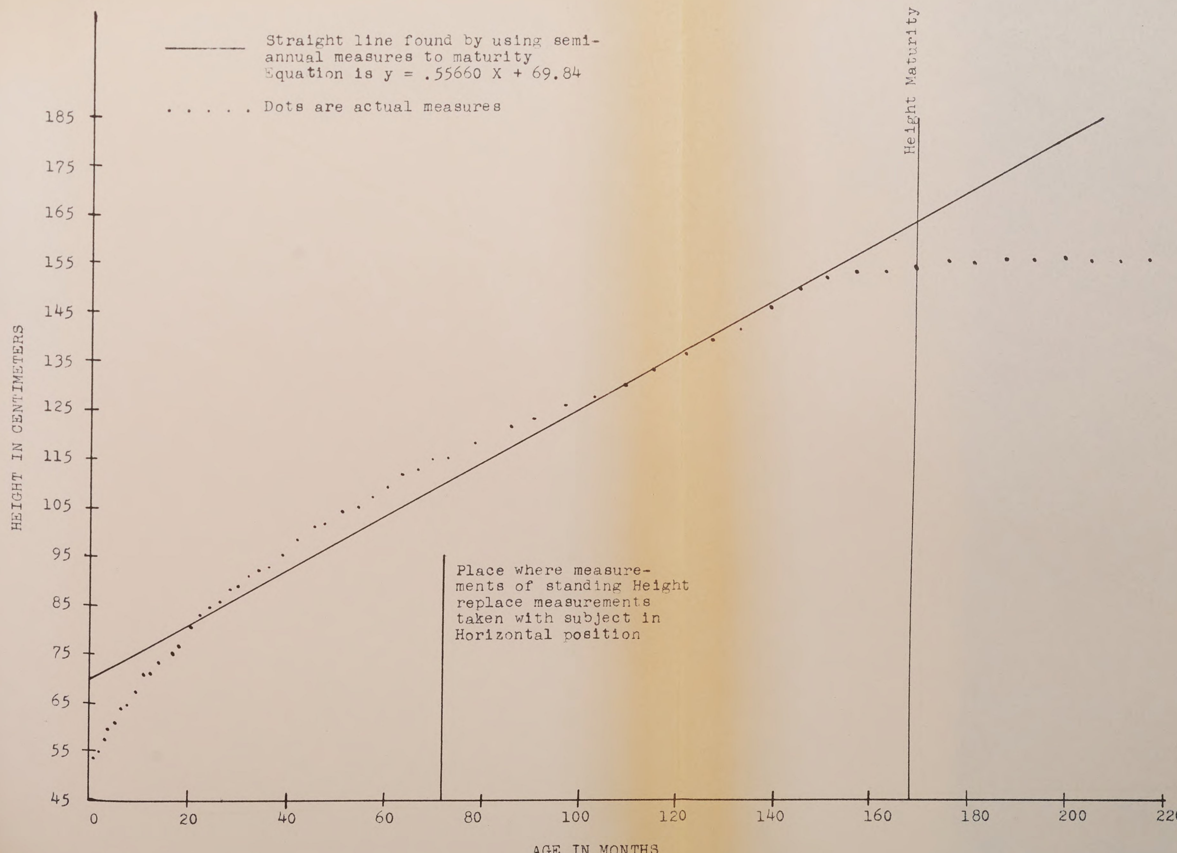


Figure 16. Case 83F. Height Masures and the Straight Line of Best Fit.

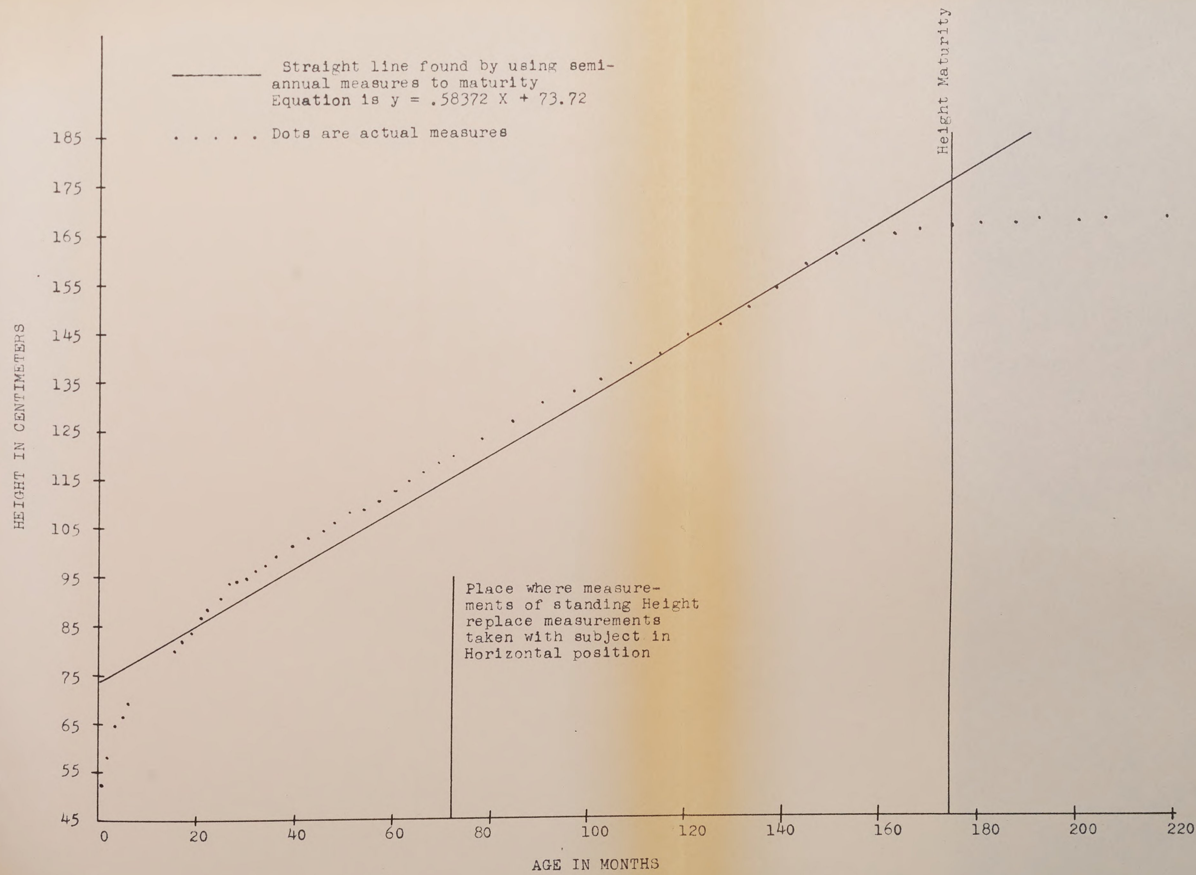


Figure 17. Case 88F*. Height Measures and the Straight Line of Best Fit.

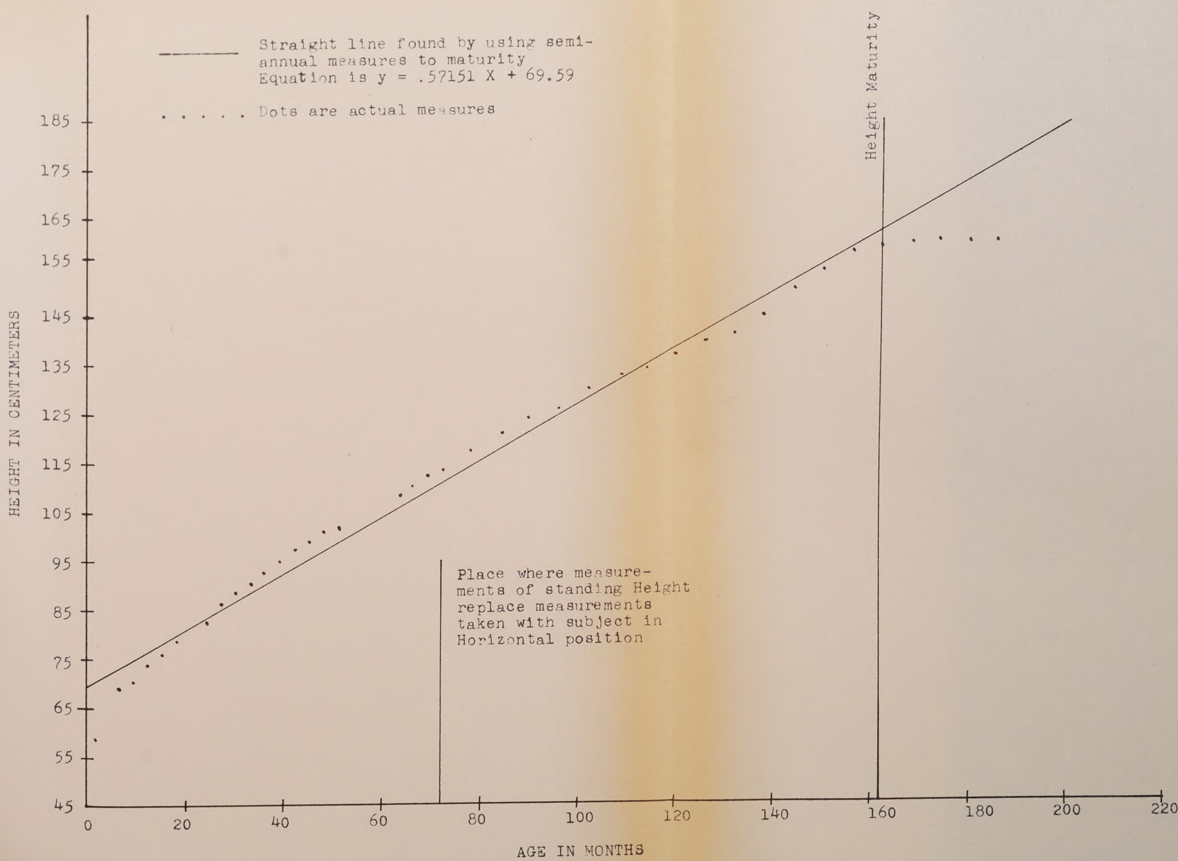


Figure 18. Case 94F*. Height Measures and the Straight Line of Best Fit.

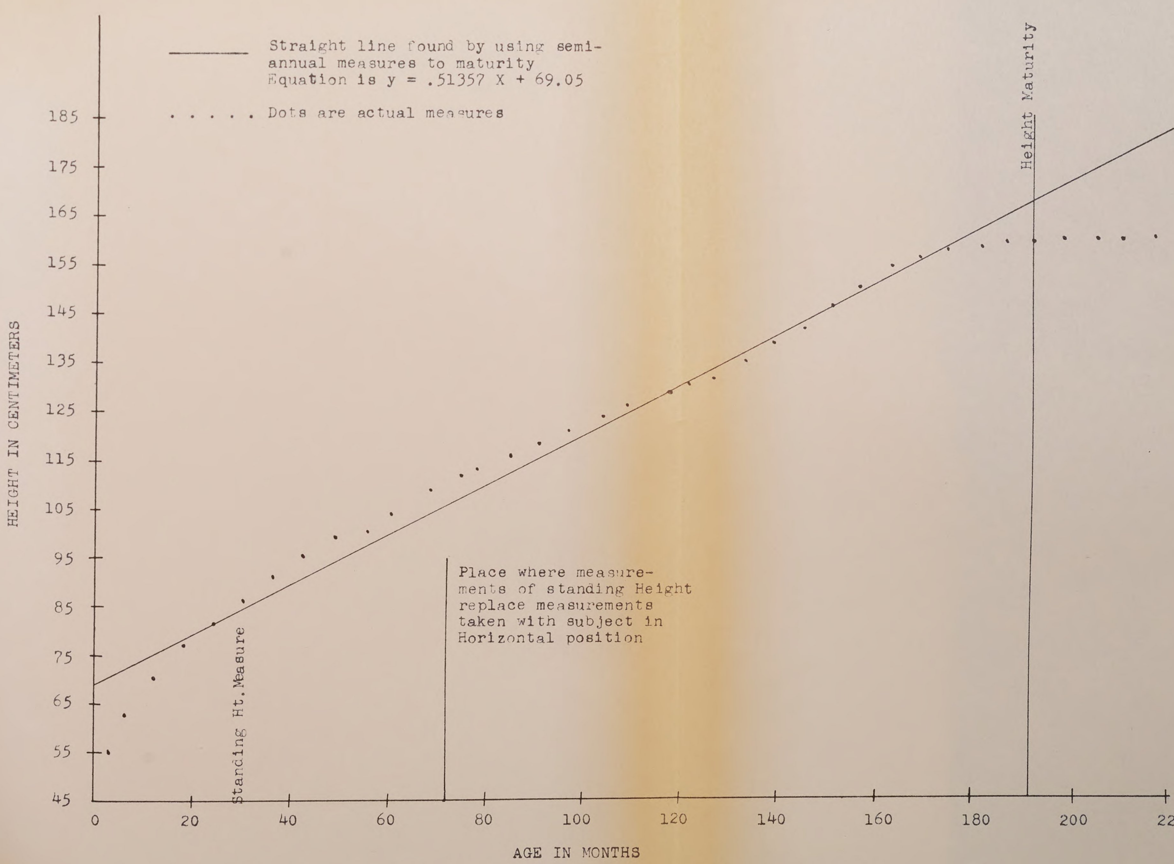


Figure 19. Case 96F. Height Measures and the Straight Line of Best Fit.

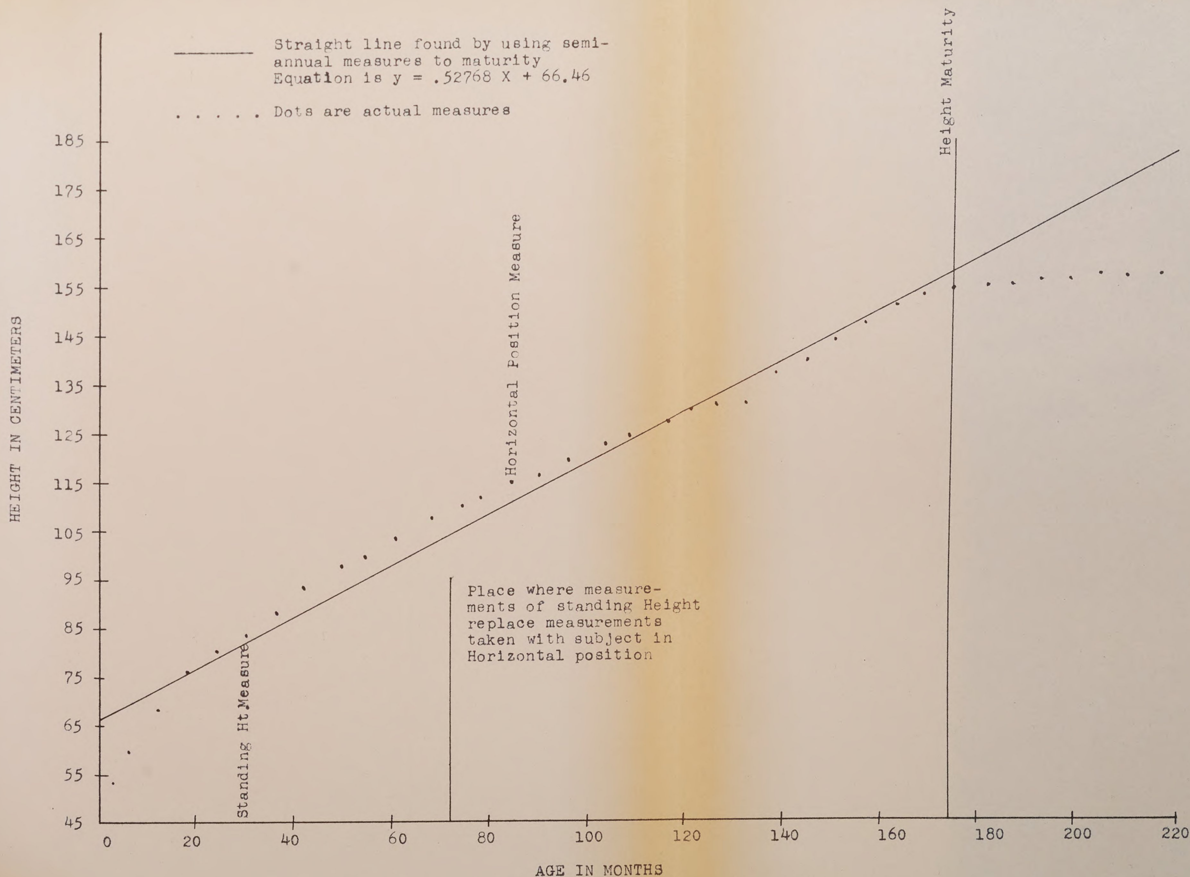


Figure 20. Case 97F. Height Measures and the Straight Line of Best Fit.

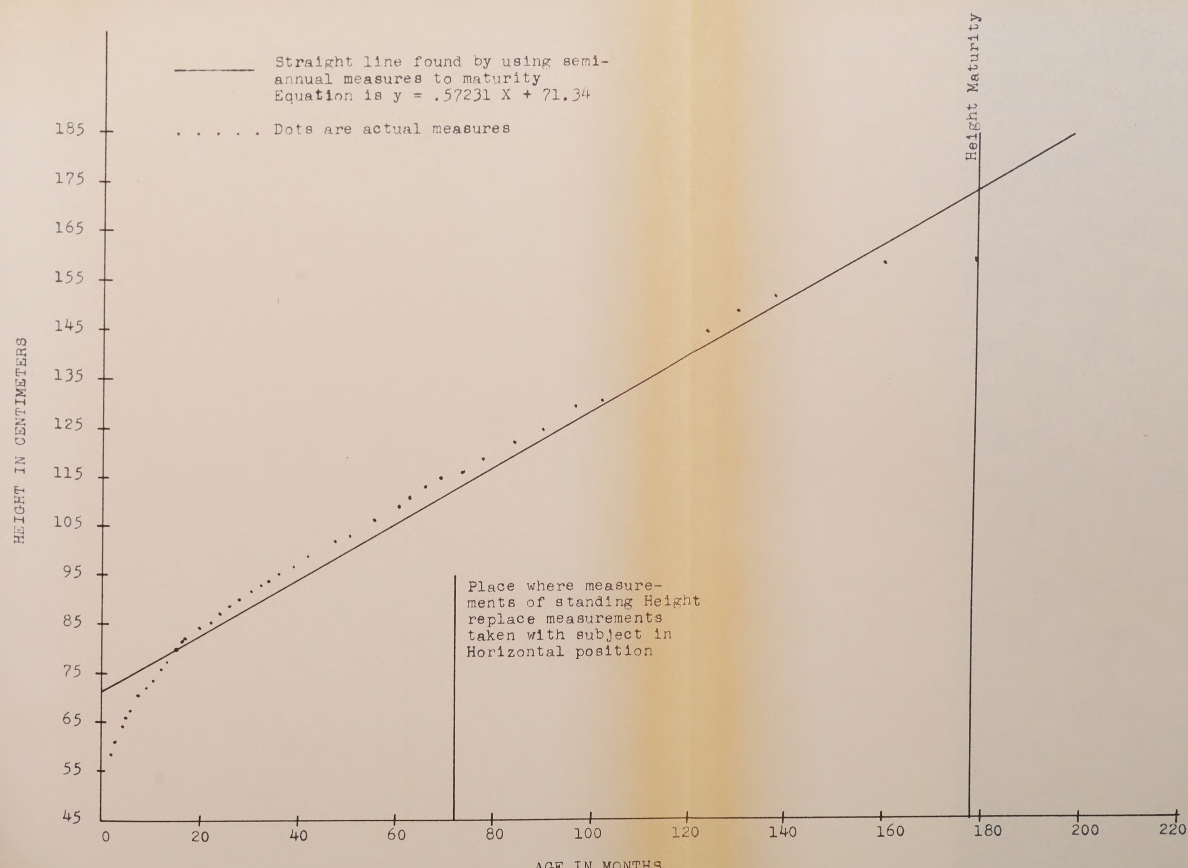


Figure 21. Case 111F*°. Height Measures and the Straight Line of Best Fit.

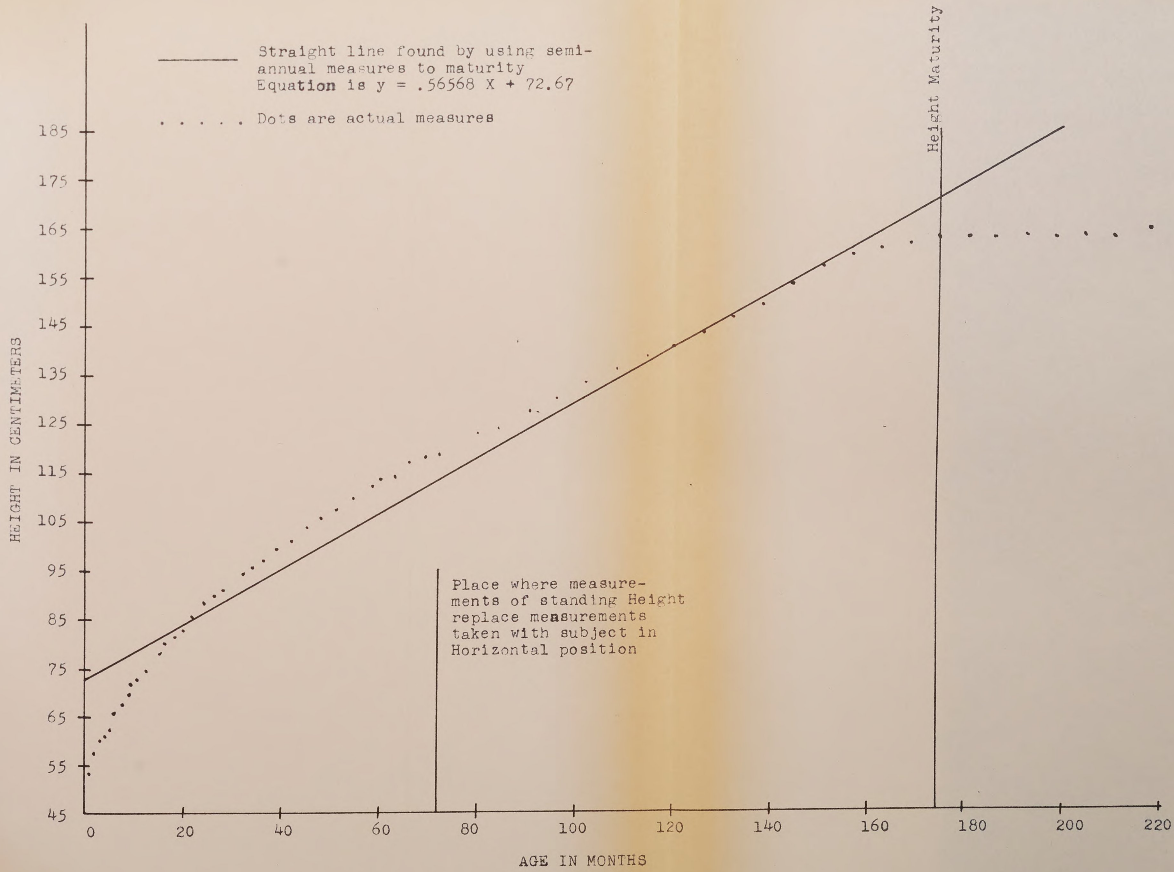


Figure 22. Case 117F. Height Measures and the Straight Line of Best Fit.

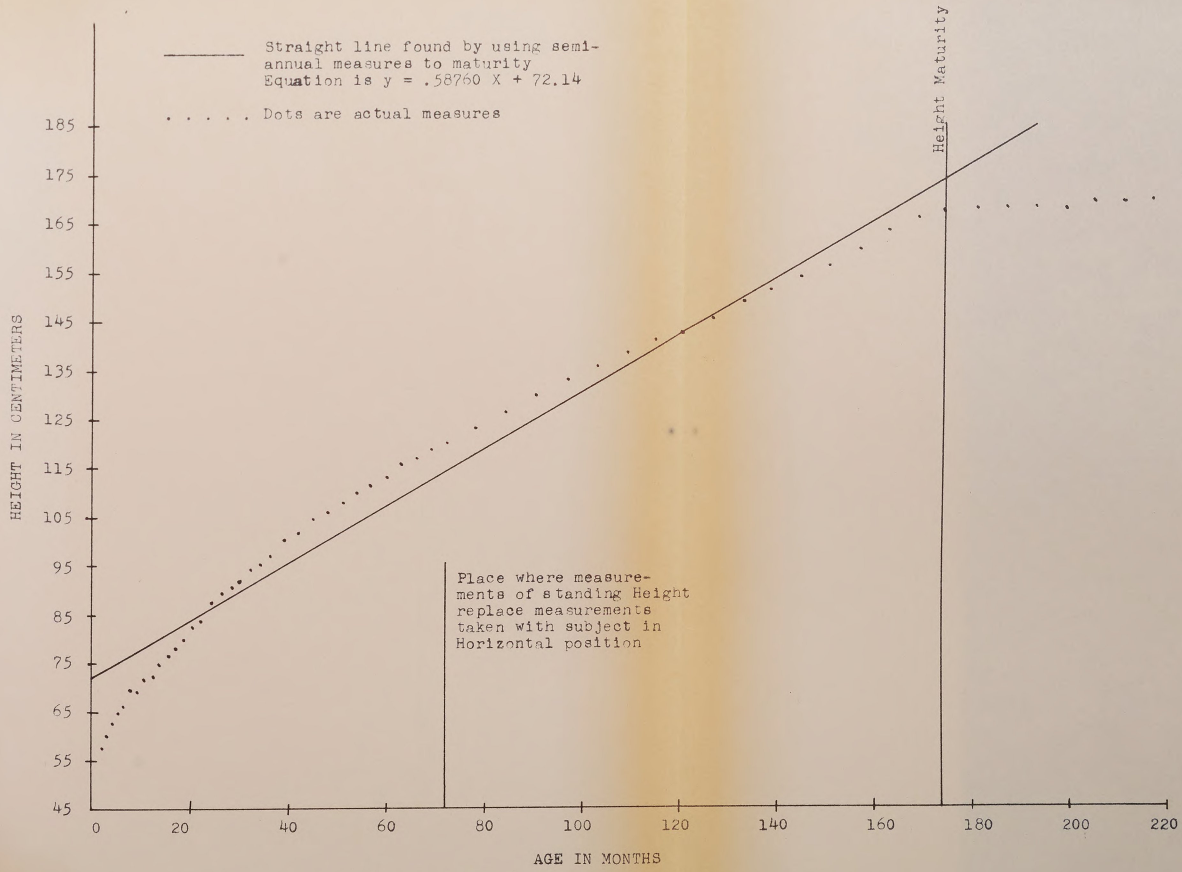


Figure 23. Case 120F. Height Measures and the Straight Line of Best Fit.

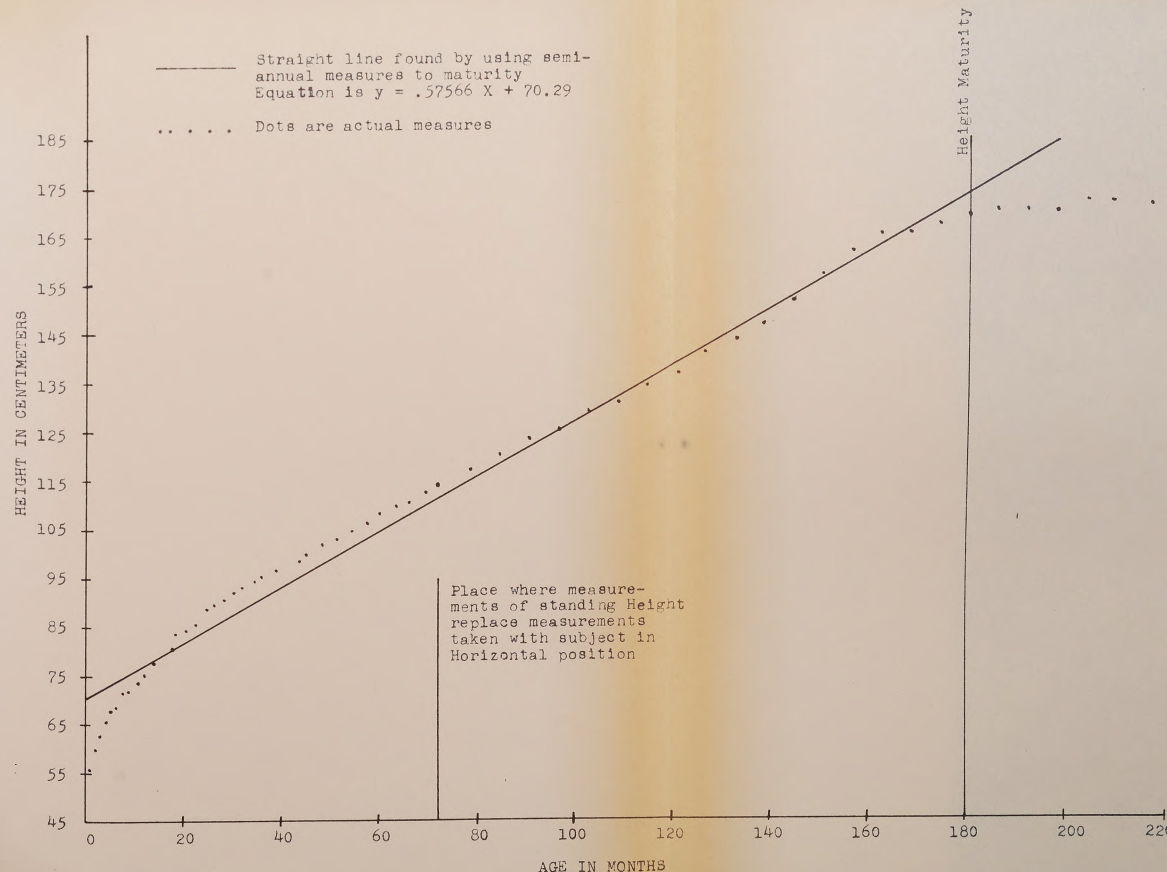


Figure 24. Case 126F. Height Measures and the Straight Line of Best Fit.

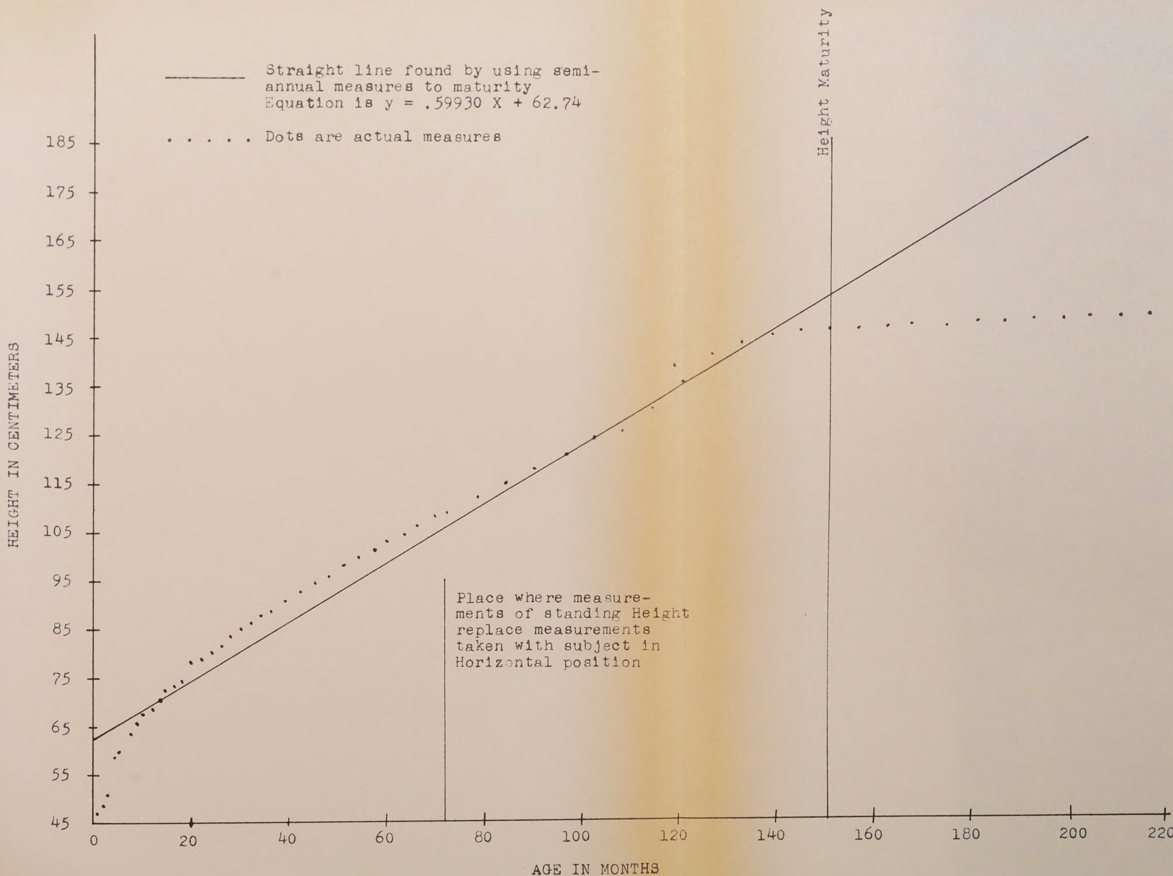


Figure 25. Case 127F. Height Measures and the Straight Line of Best Fit.

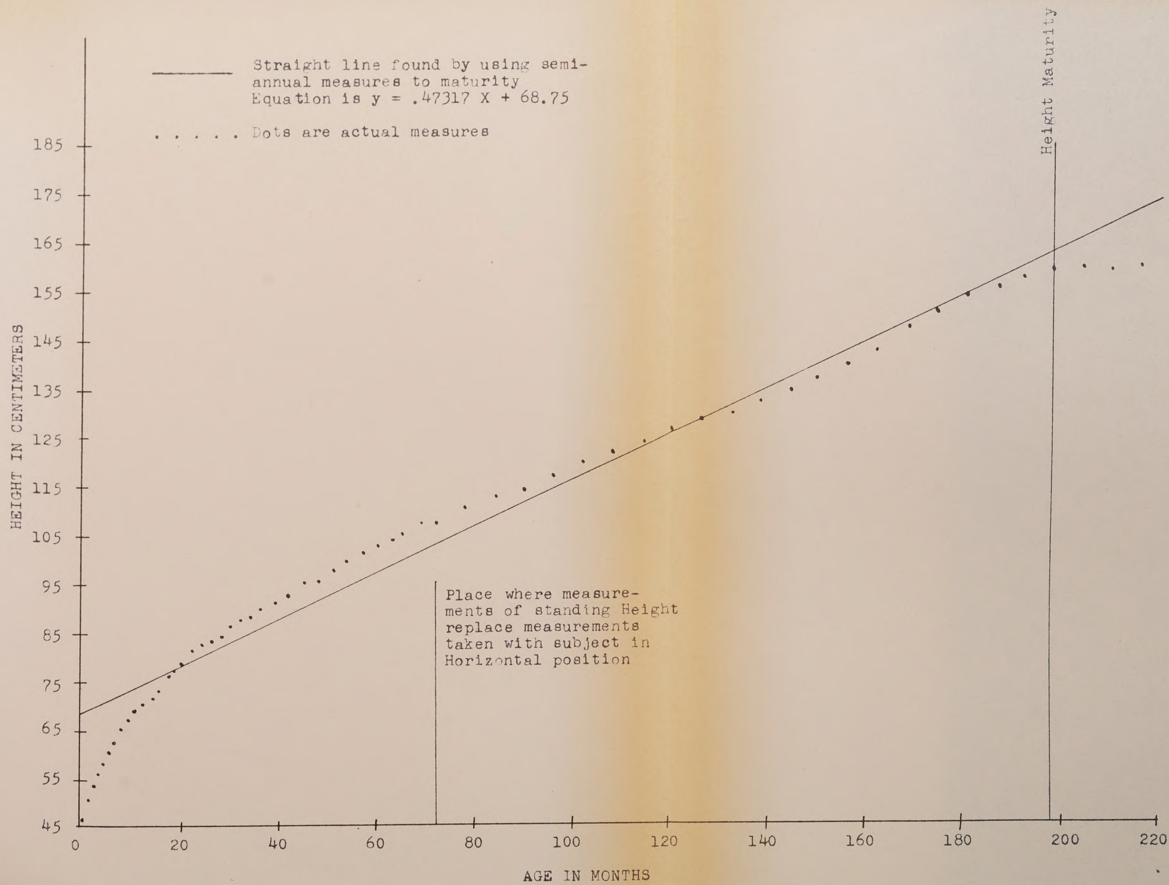


Figure 26. Case 137F. Height Measures and the Straight Line of Best Fit.

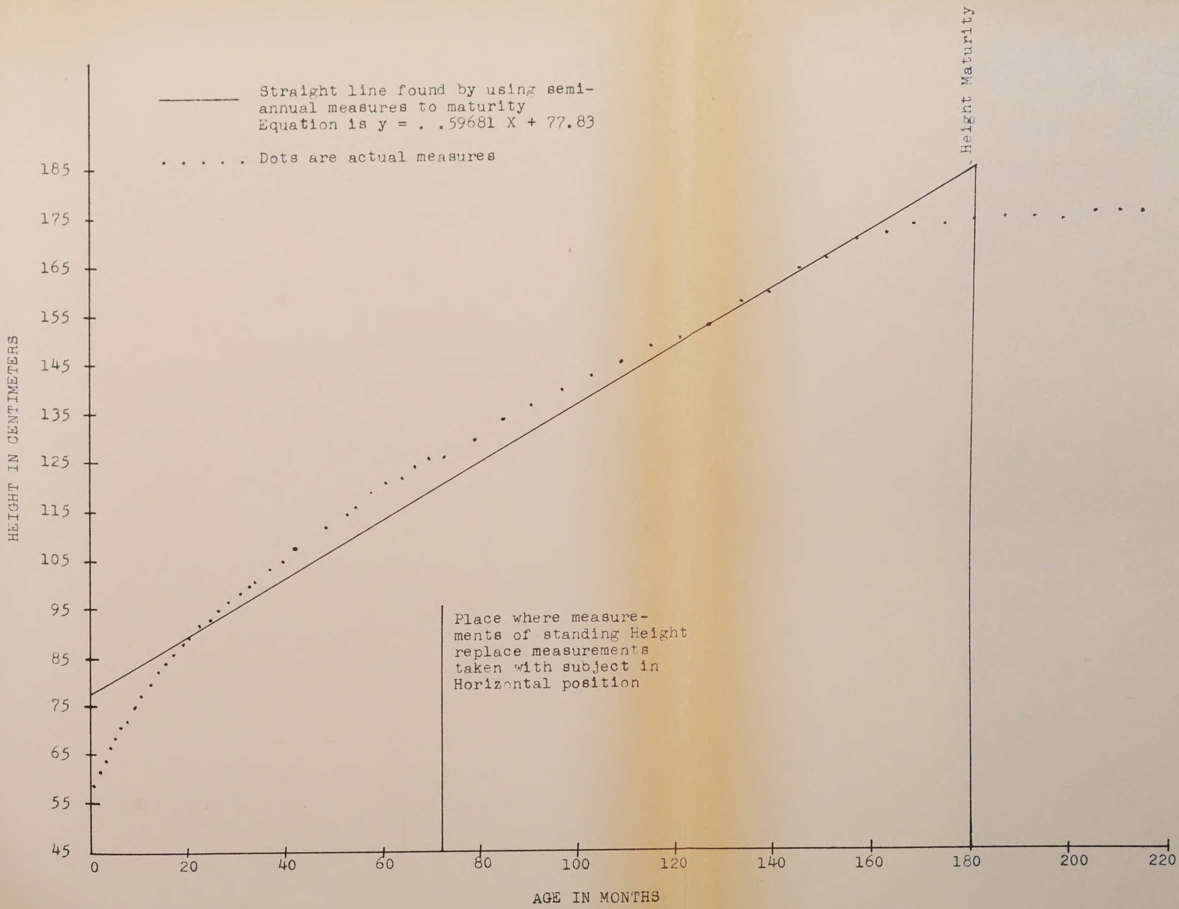


Figure 27. Case 140F. Height Measures and the Straight Line of Best Fit.

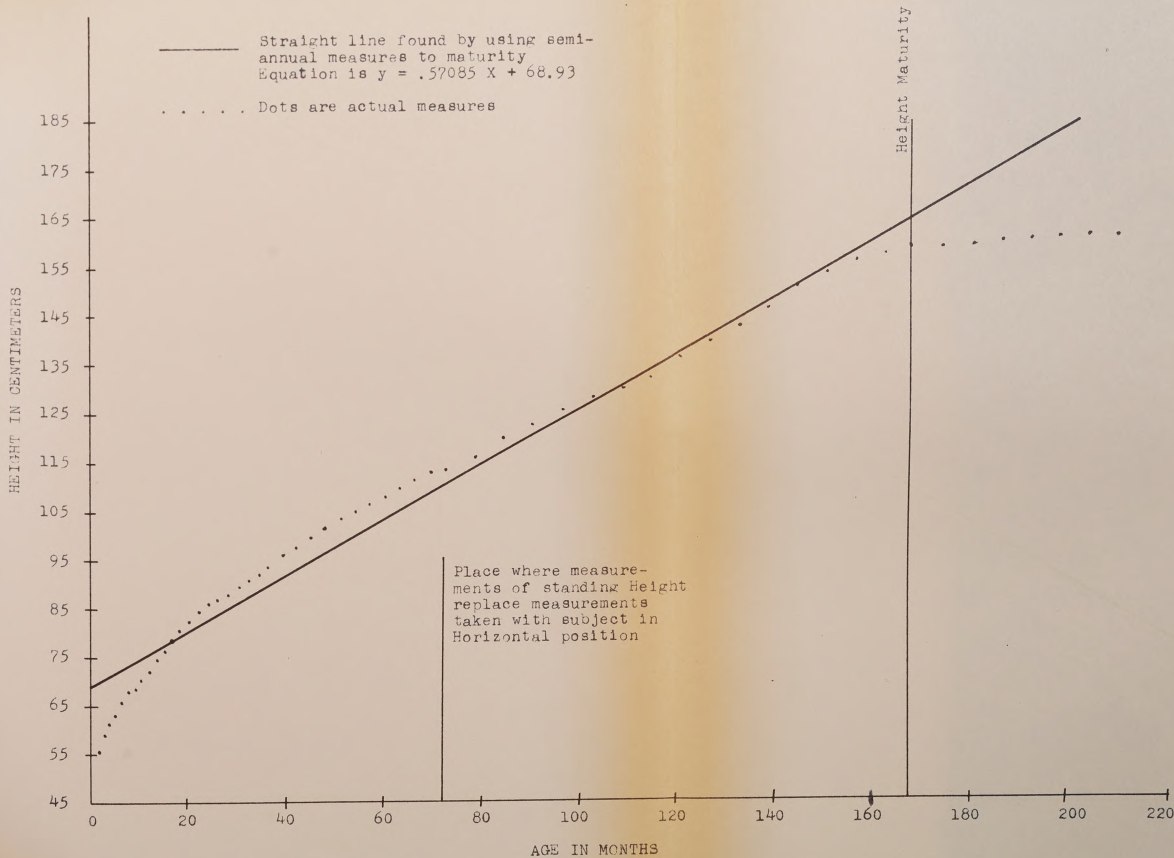


Figure 28. Case 142F. Height Measures and the Straight Line of Best Fit.

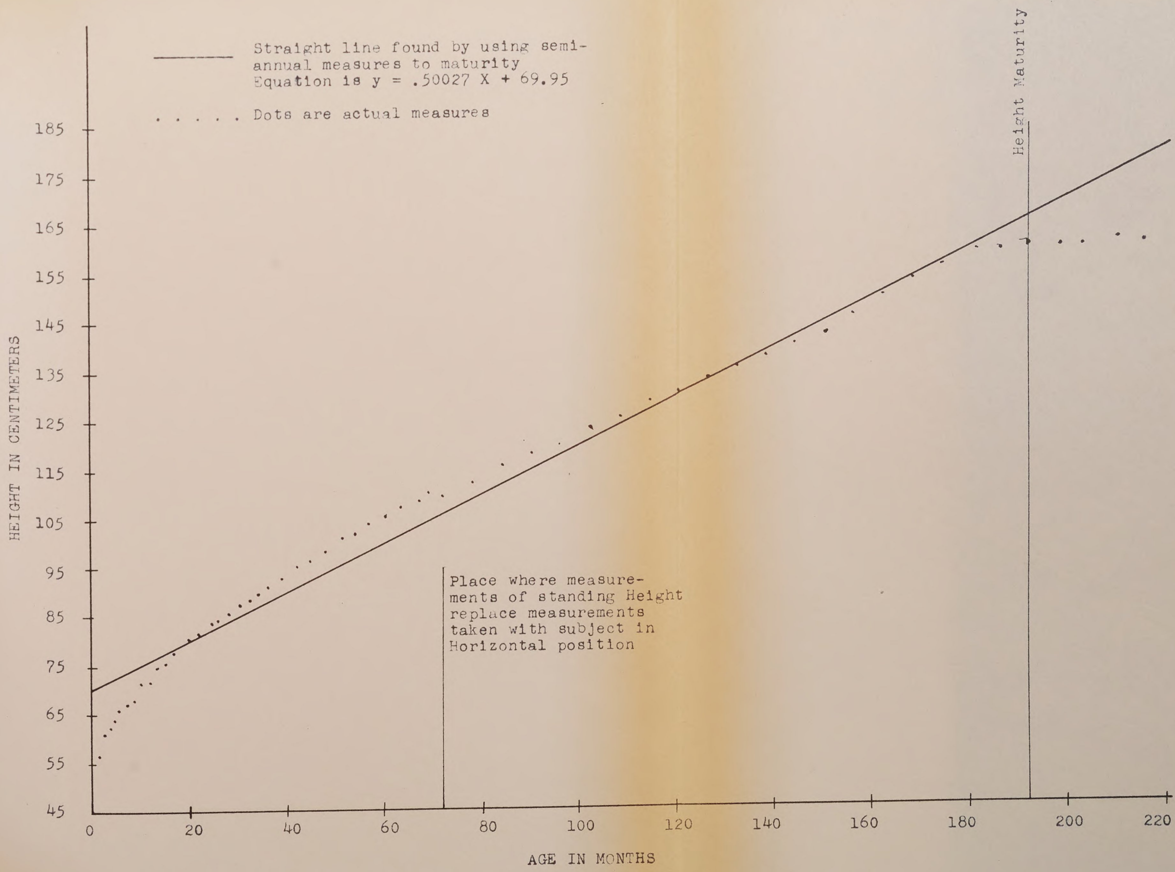


Figure 29. Case 144F. Height Measures and the Straight Line of Best Fit.

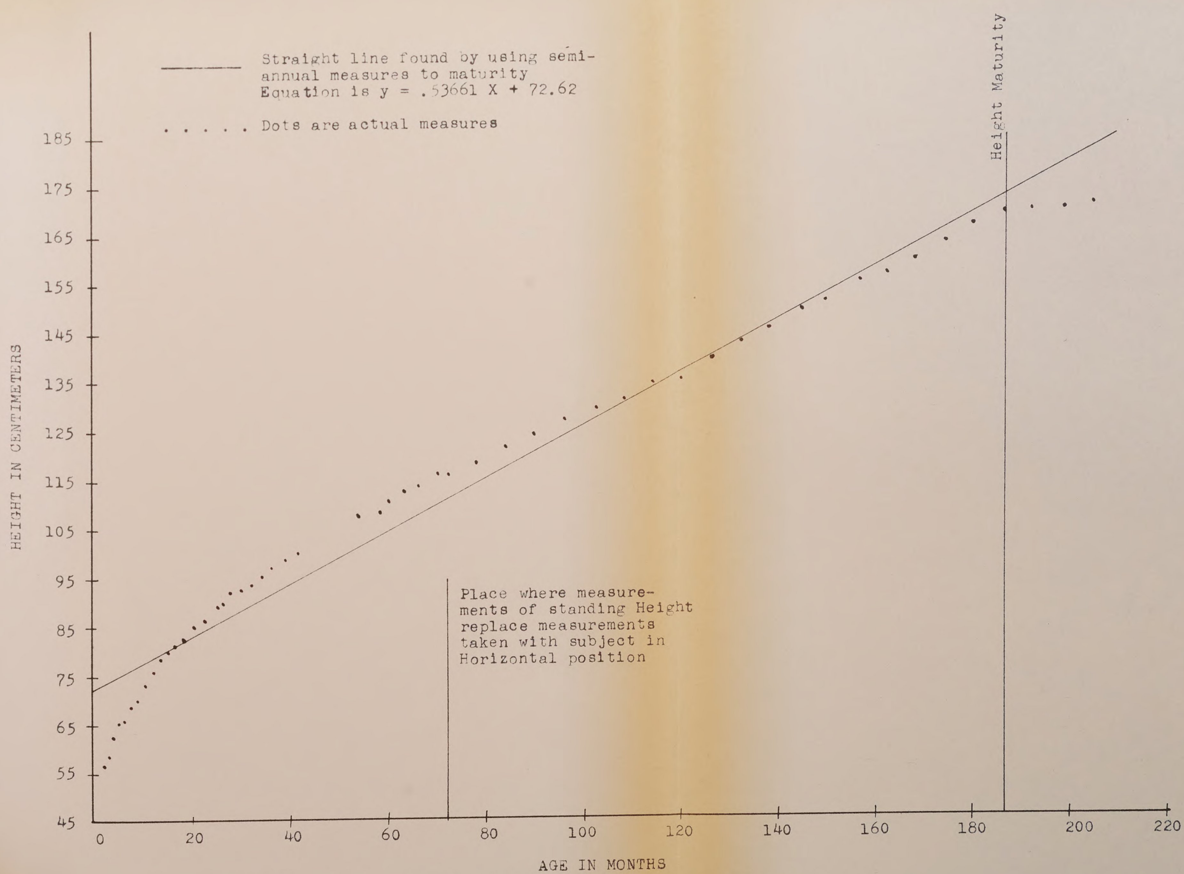


Figure 30. Case 145F*. Height Measures and the Straight Line of Best Fit.

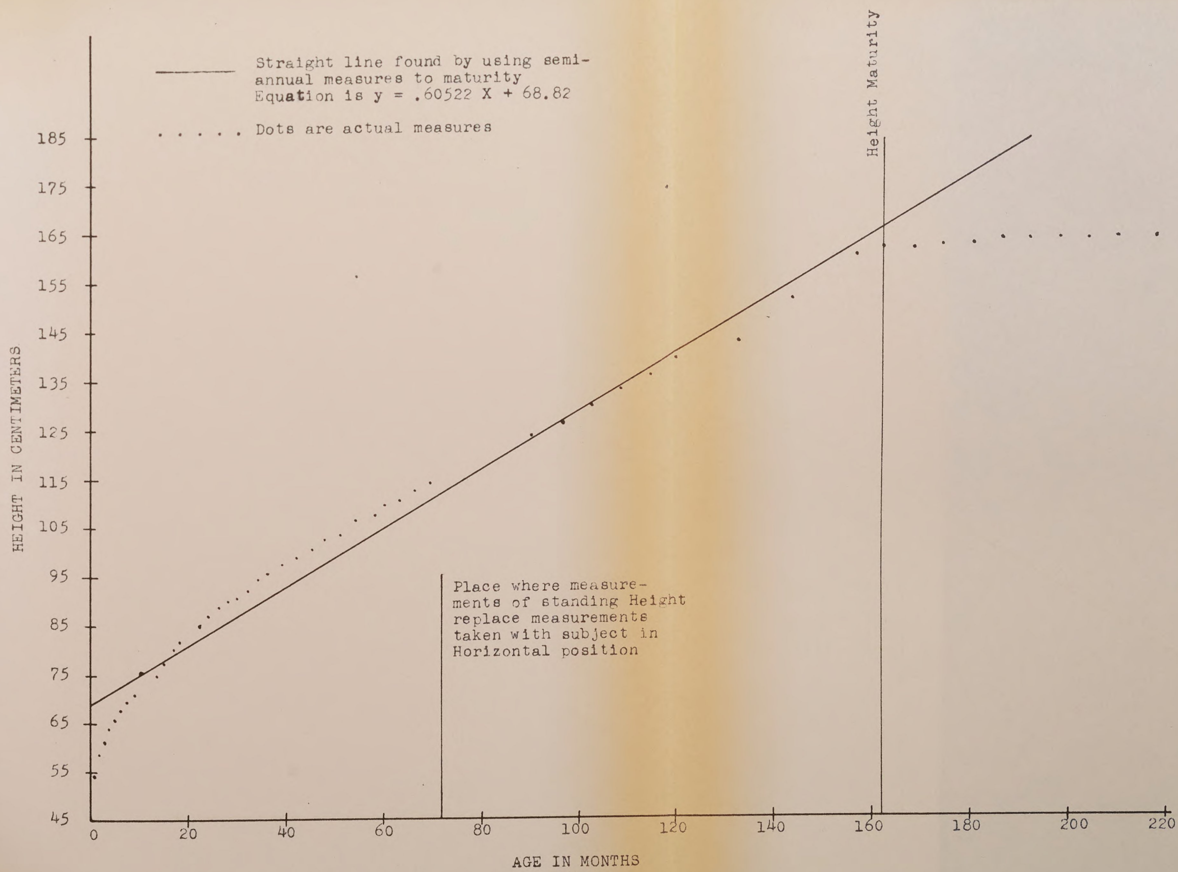


Figure 31. Case 146F*. Height Measures and the Straight Line of Best Fit.

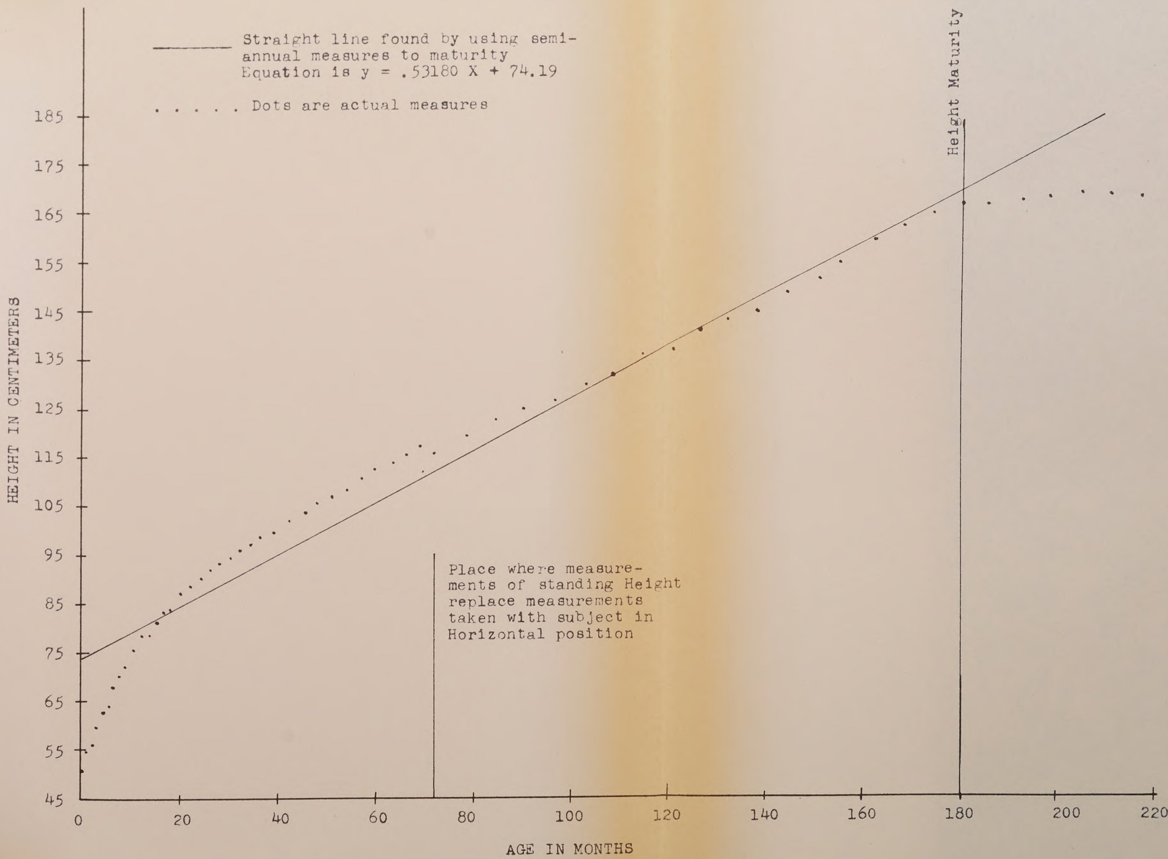


Figure 32. Case 148F. Height Measures and the Straight Line of Best Fit.

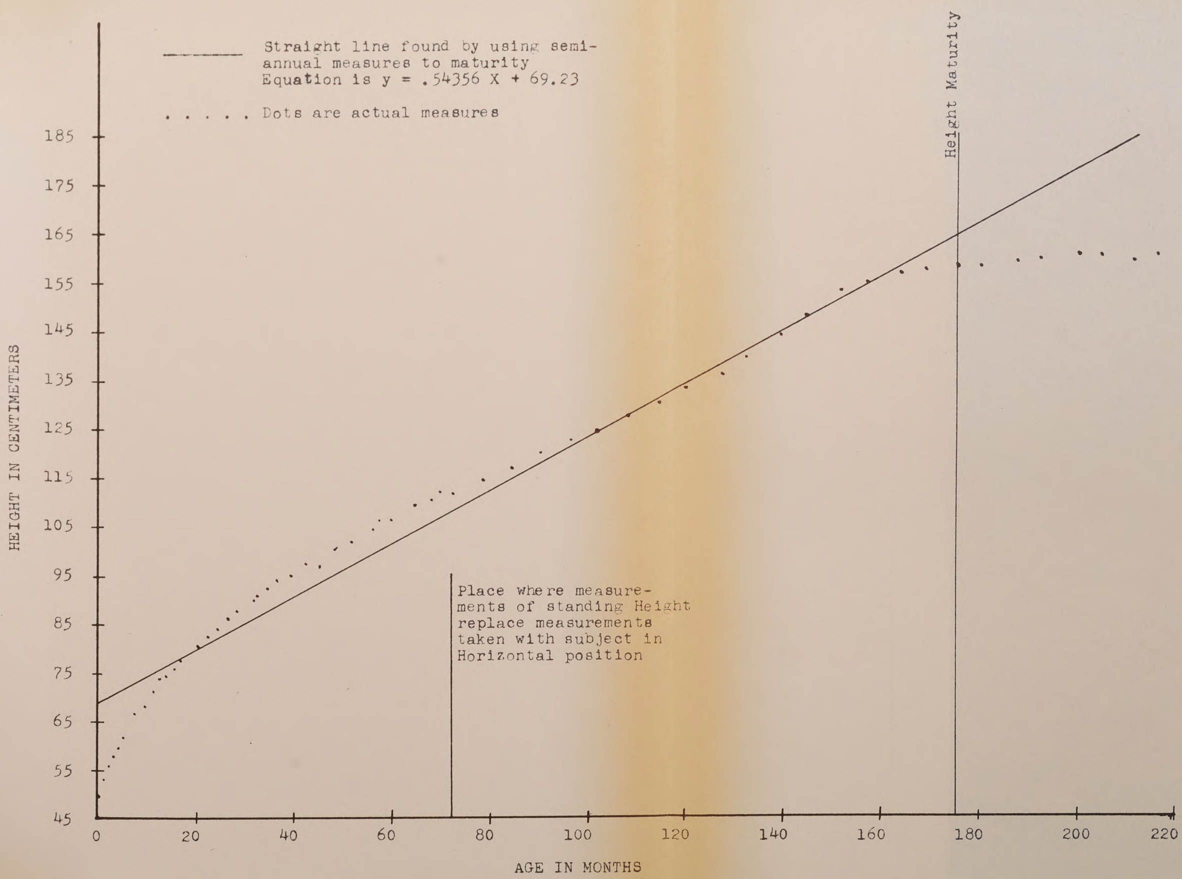


Figure 33. Case 150F. Height Measures and the Straight Line of Best Fit.

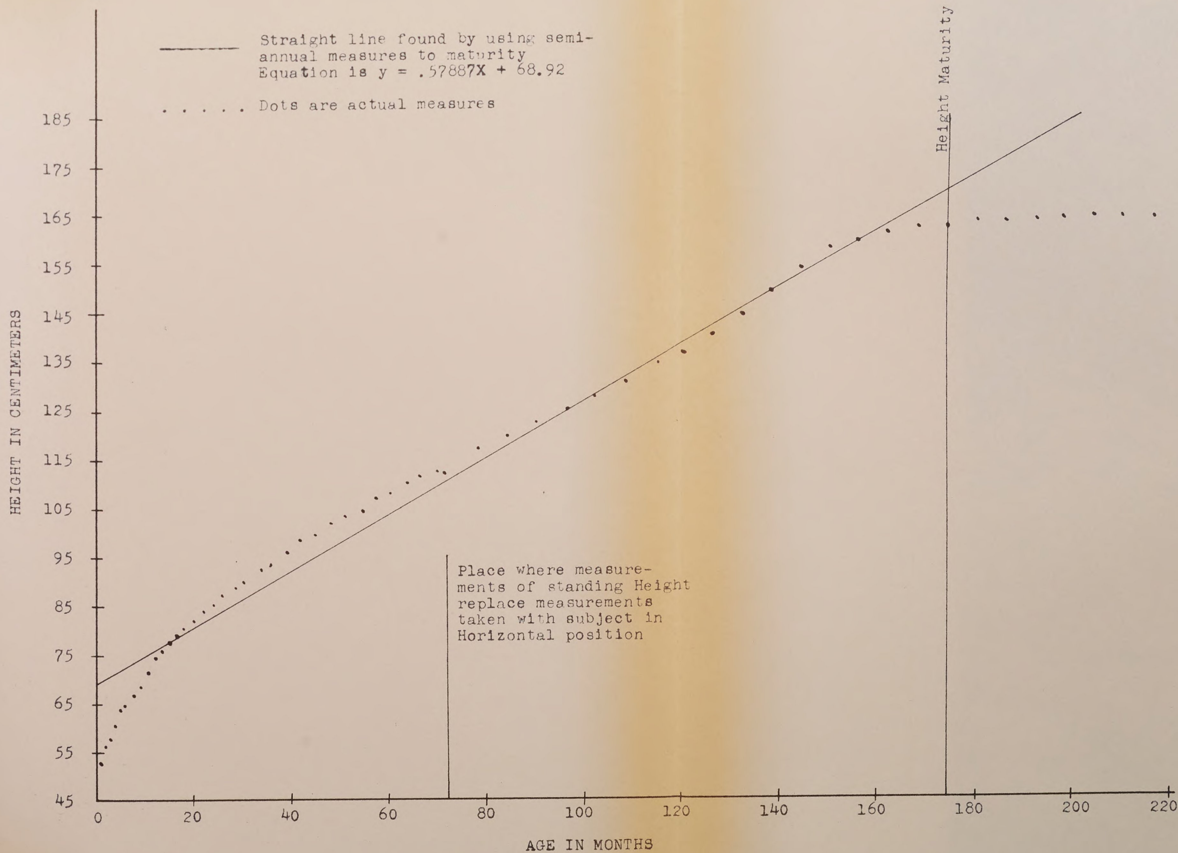


Figure 34. Case 151F. Height Measures and the Straight Line of Best Fit.

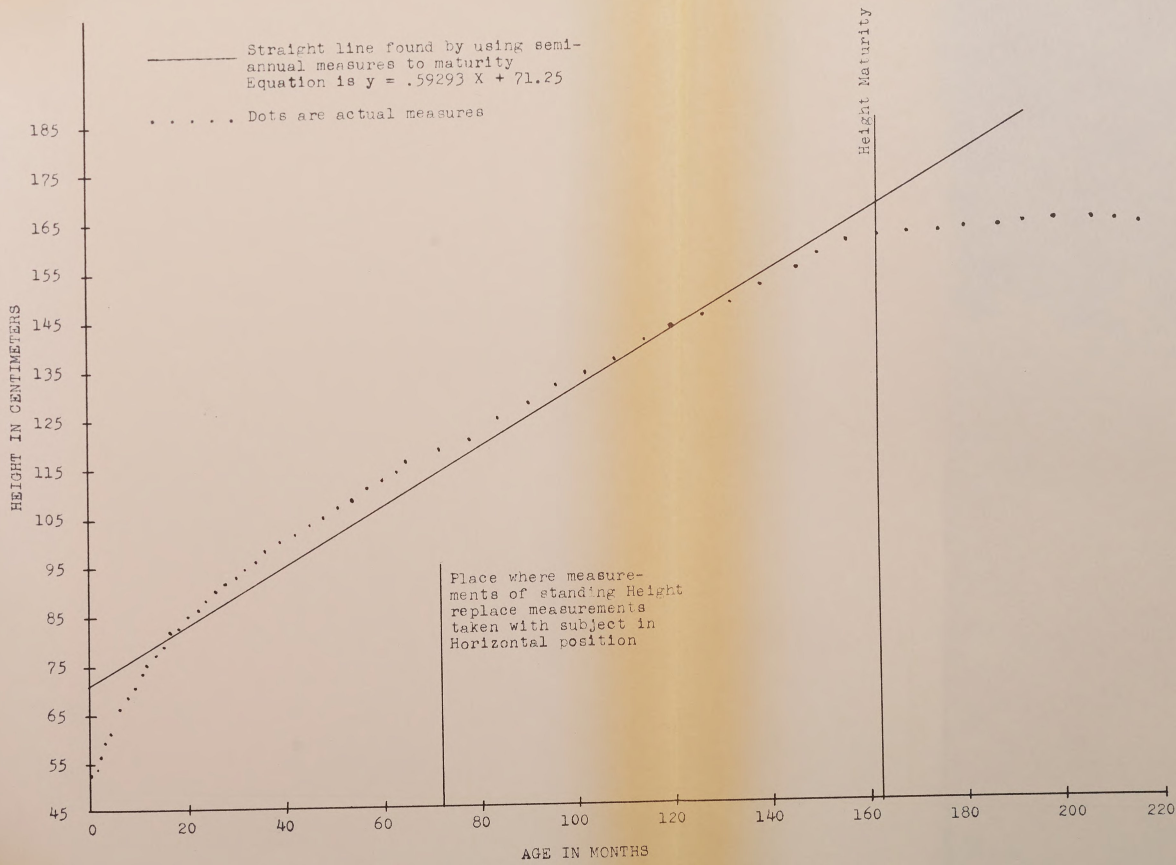


Figure 35. Case 165F. Height Measures and the Straight Line of Best Fit.

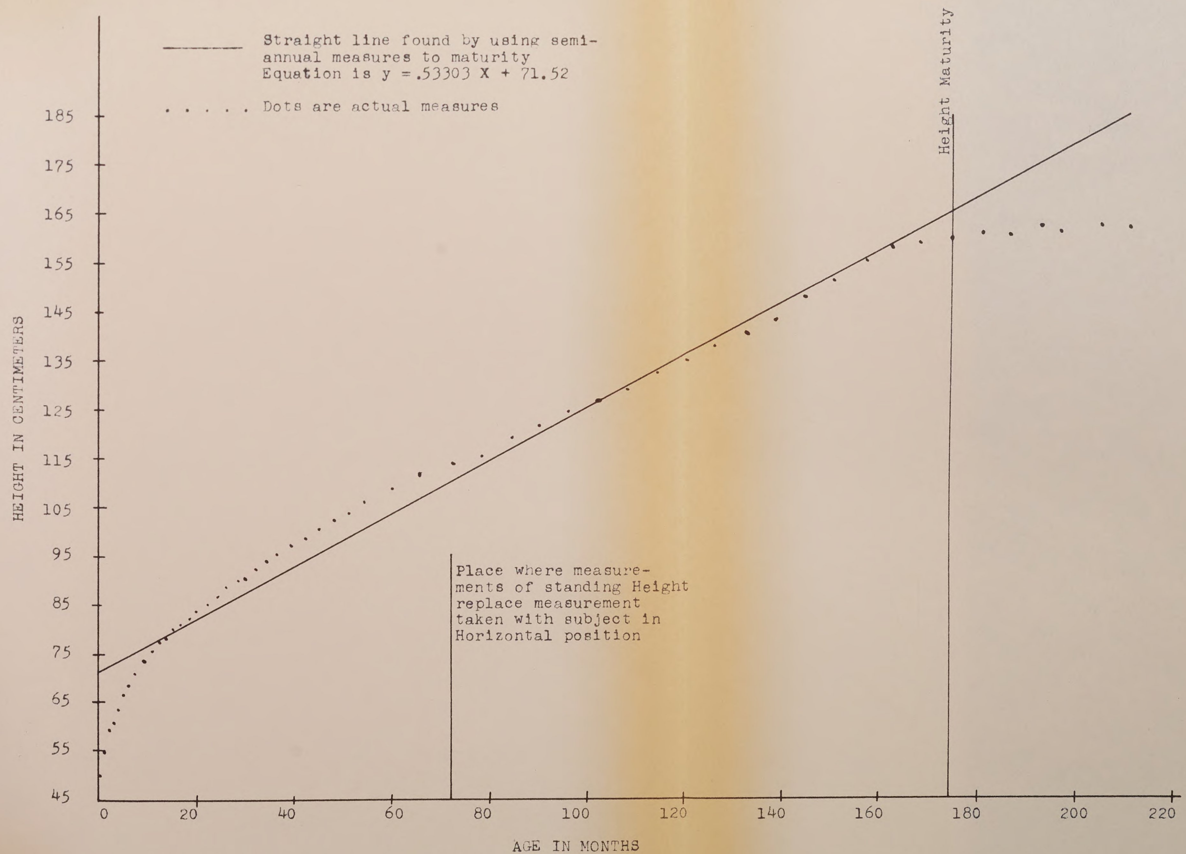


Figure 36. Case 170F. Height Measures and the Straight Line of Best Fit.

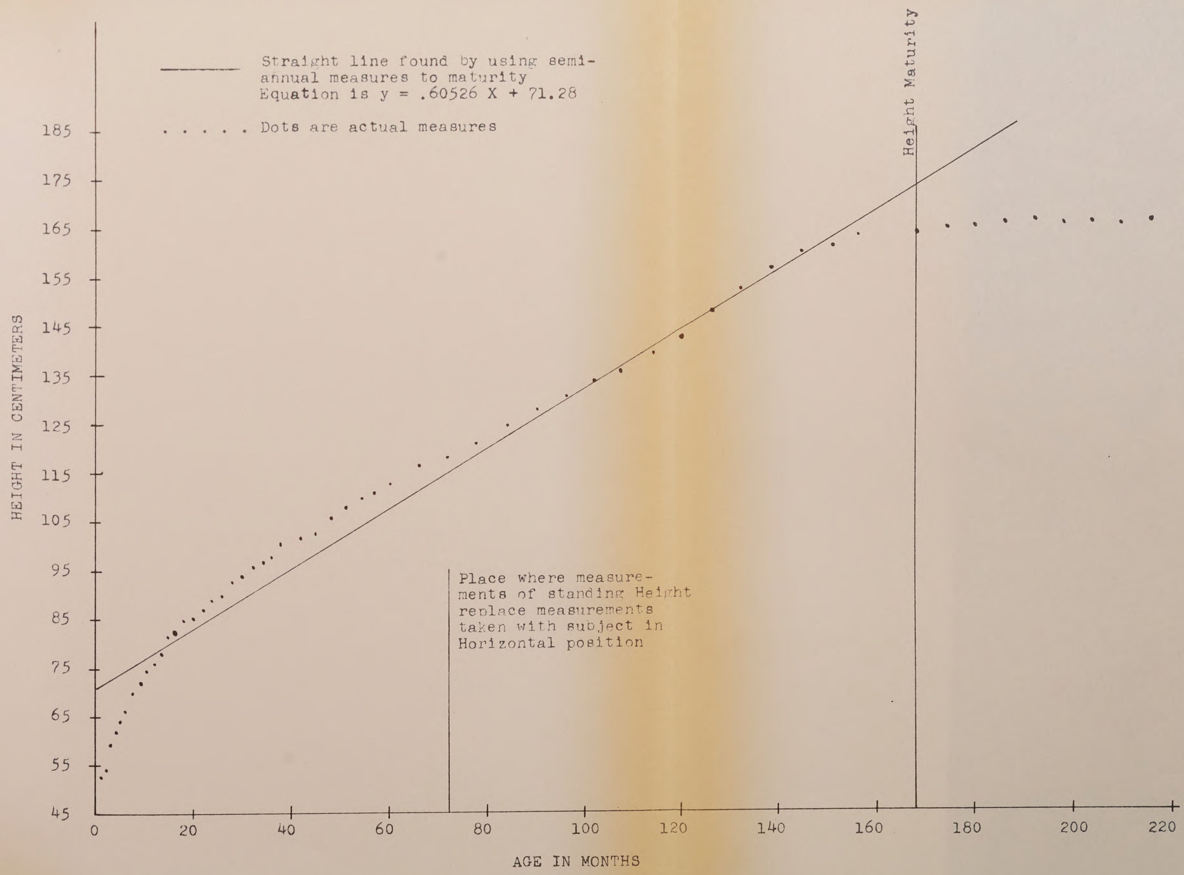


Figure 37. Case 171F*. Height Measures and the Straight Line of Best Fit.

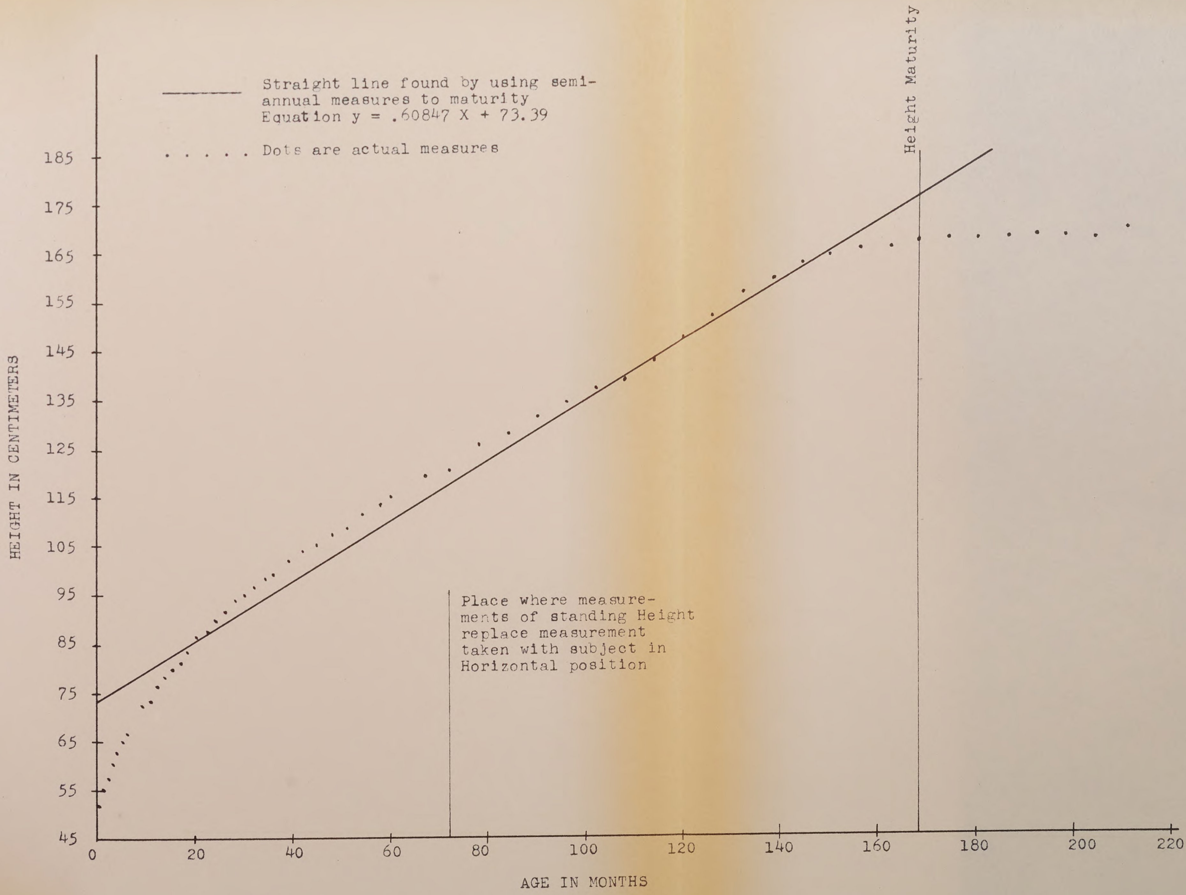


Figure 38. Case 176F. Height Measures and the Straight Line of Best Fit.

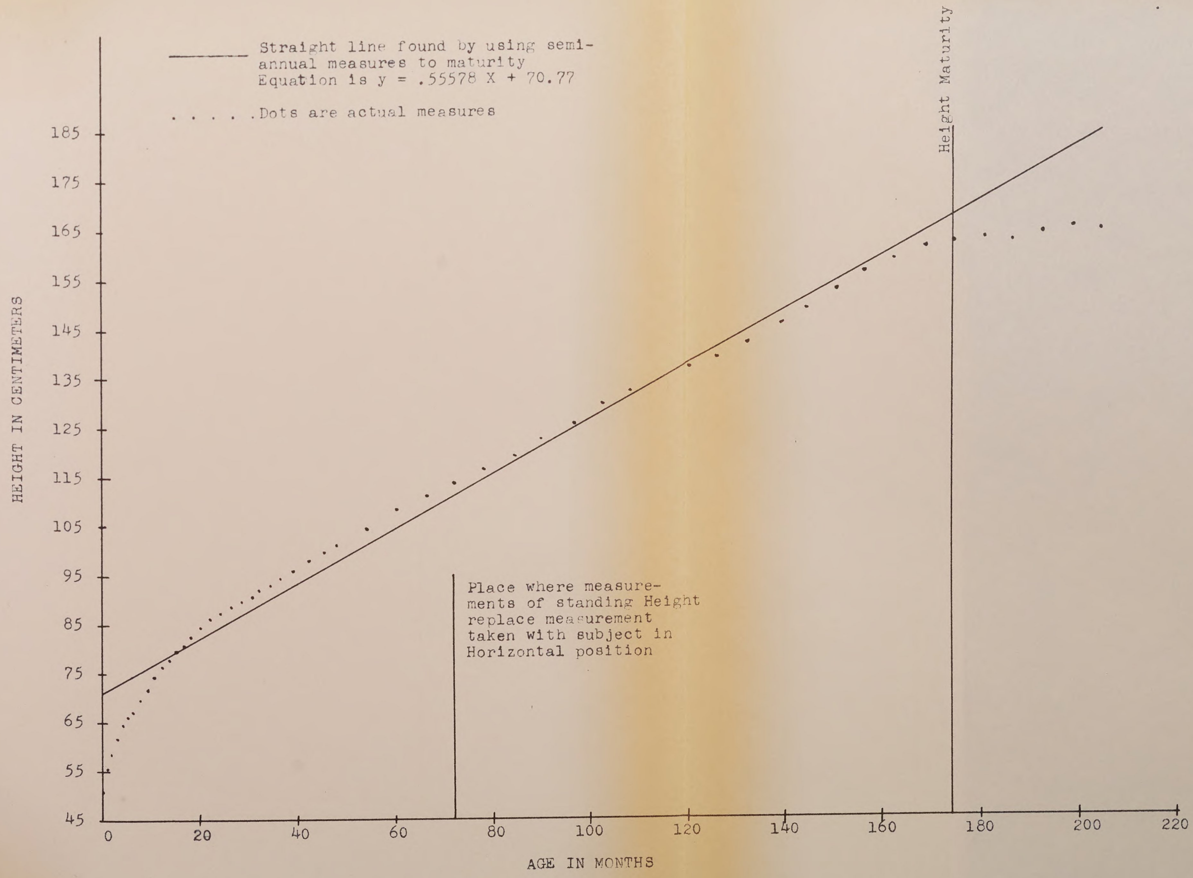


Figure 39. Case 179F. Height Measures and the Straight Line of Best Fit.

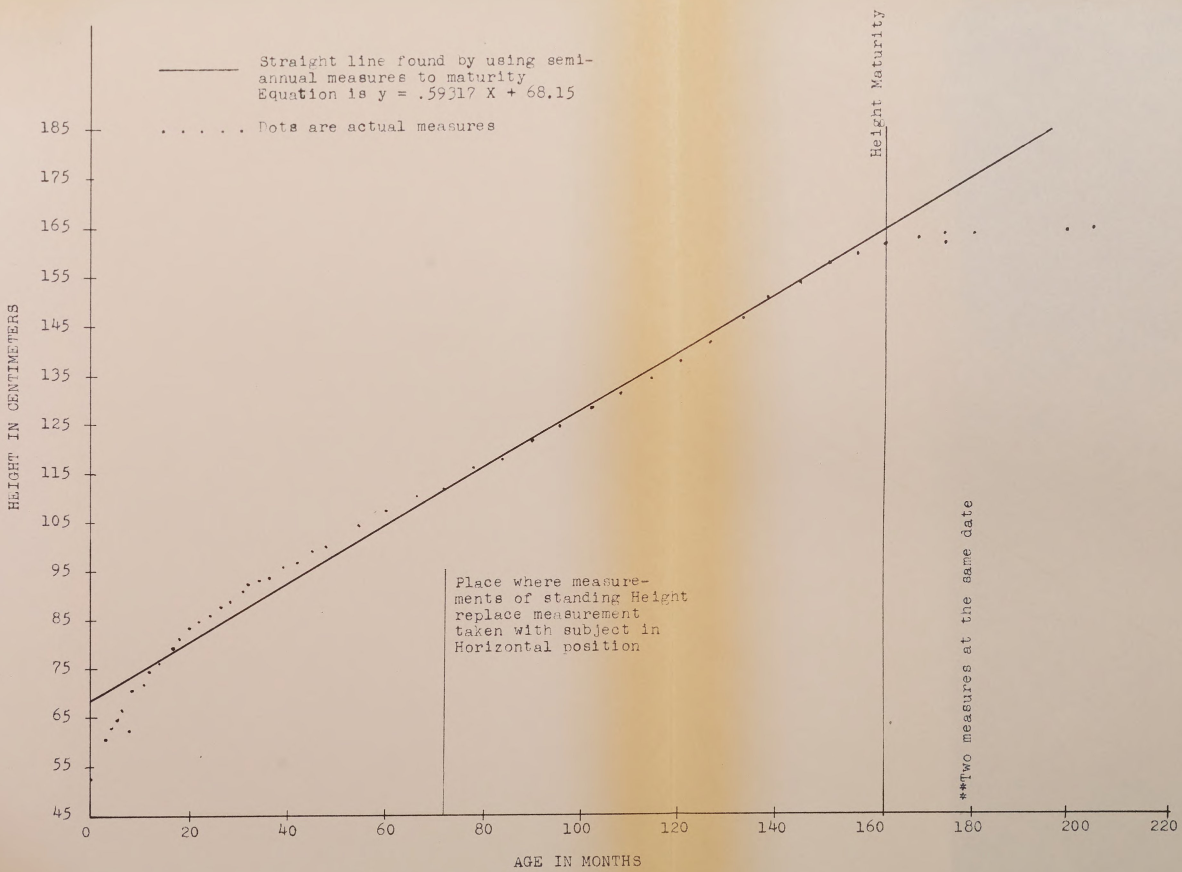


Figure 40. Case 182 F. Height Measures and the Straight Line of Best Fit.

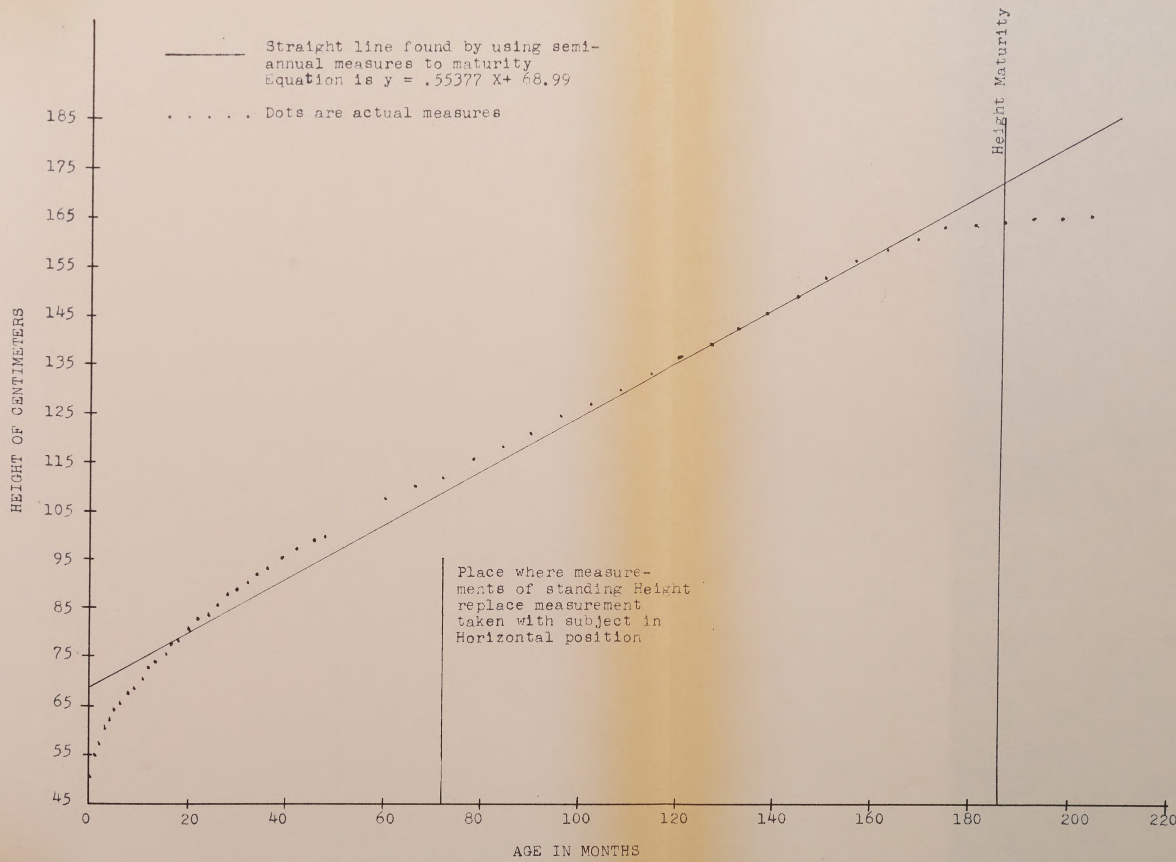


Figure 41. Case 185F*. Height Measure and the Straight Line of Best Fit.

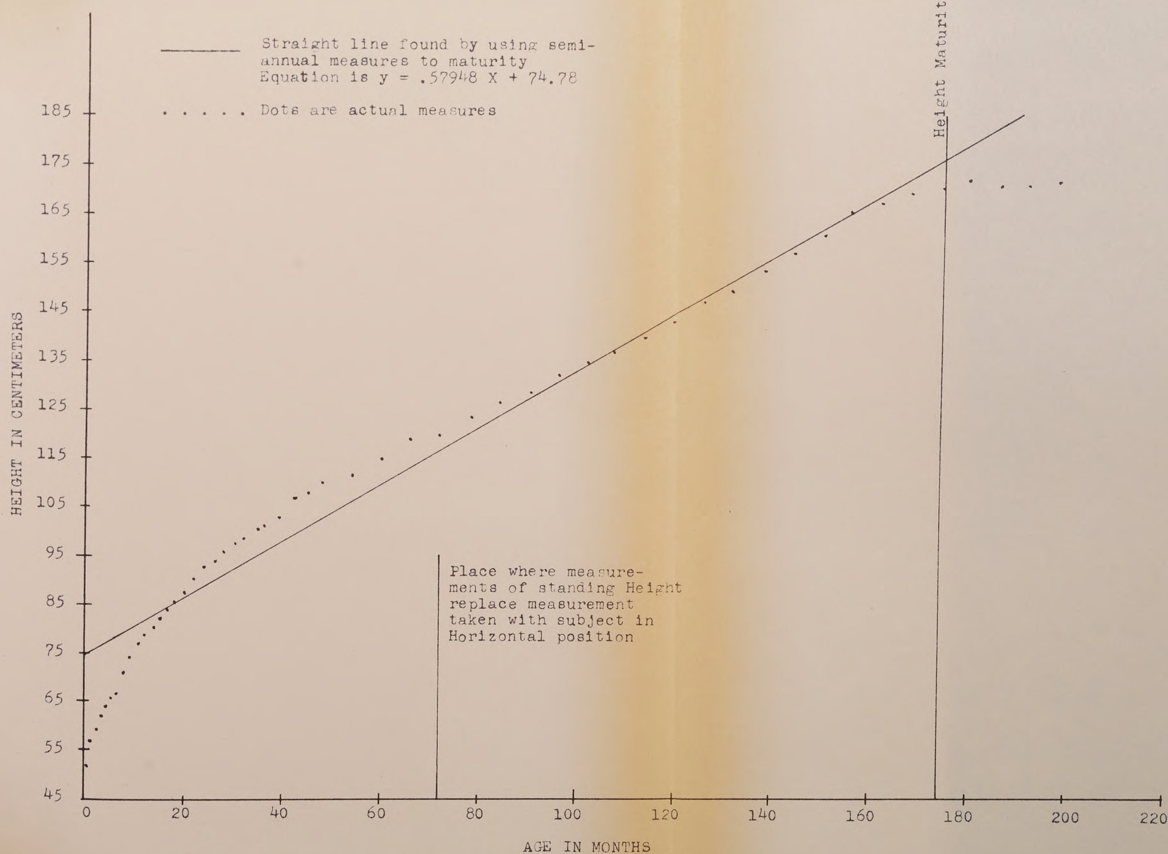


Figure 42. Case 188F. Height Measures and the Straight Line of Best Fit.

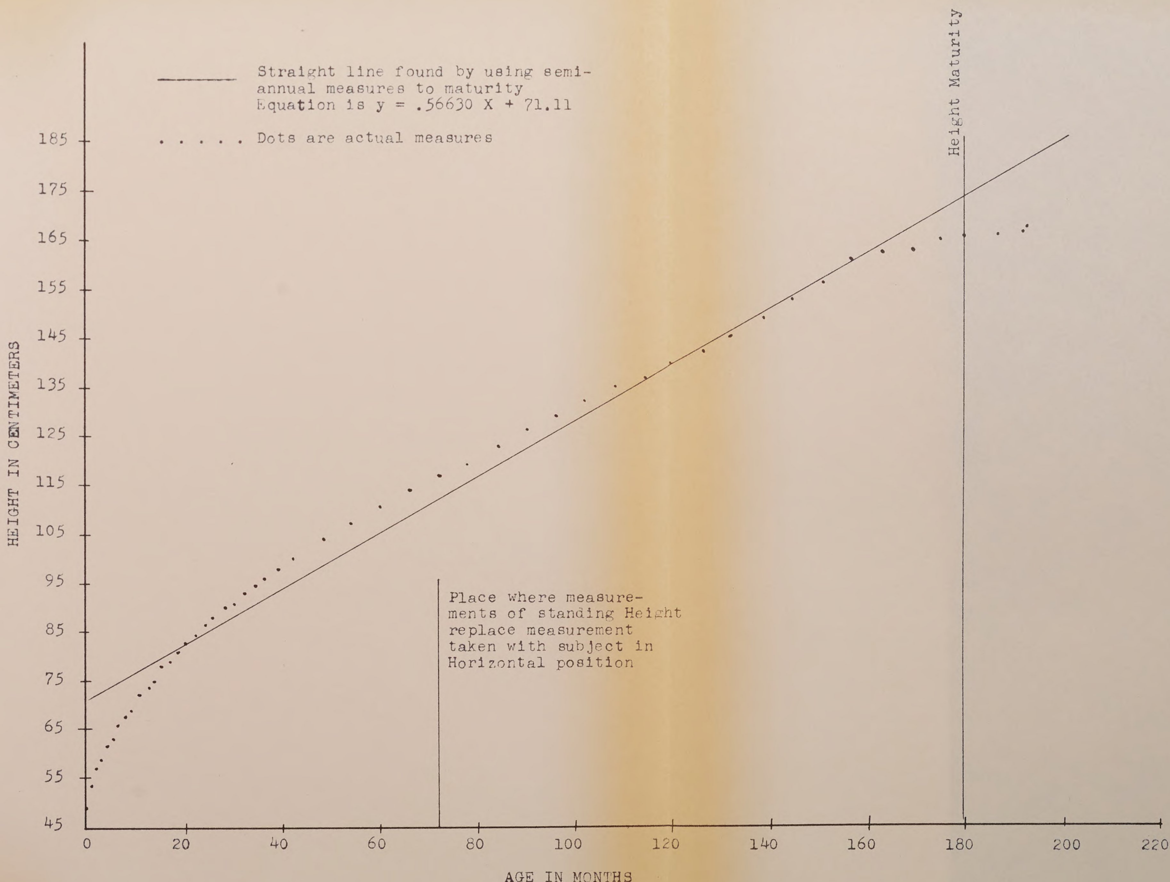


Figure 43. Case 191F. Height Measures and the Straight Line of Best Fit.

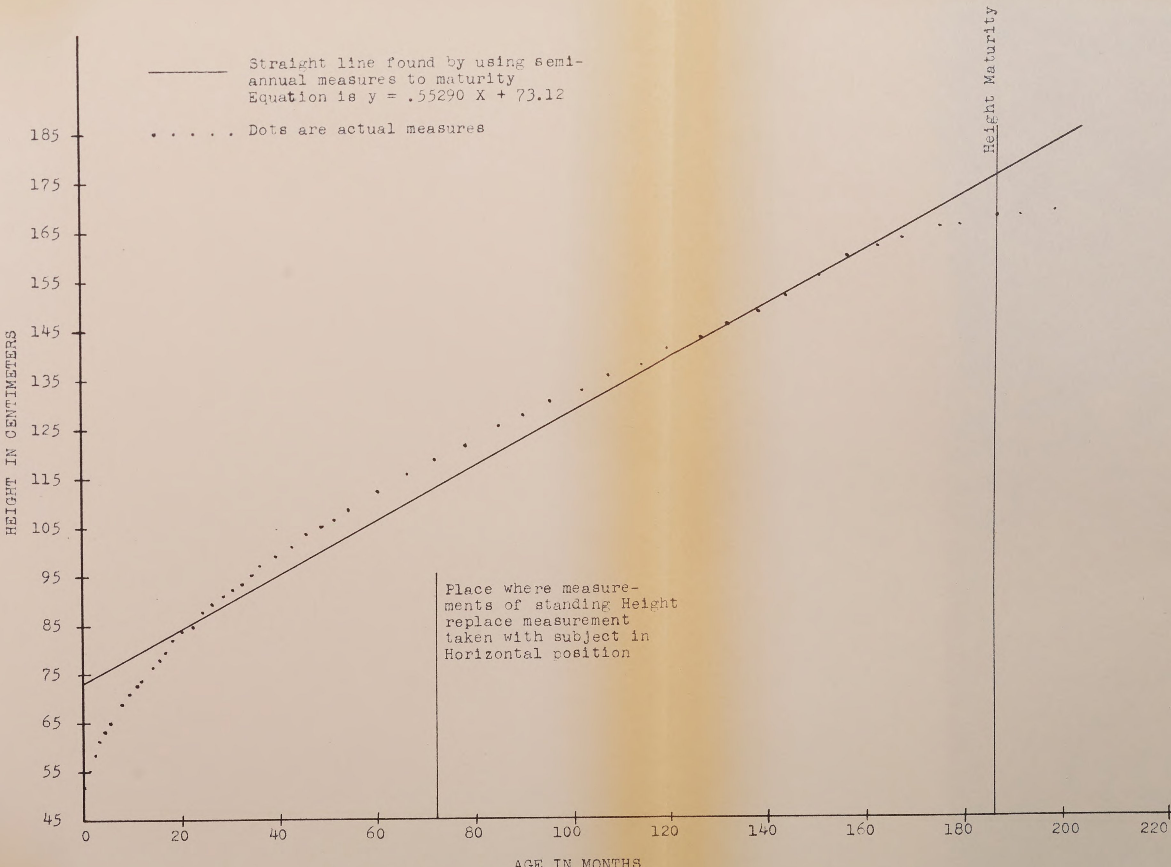


Figure 44. Case 193F. Height Measures and the Straight Line of Best Fit.

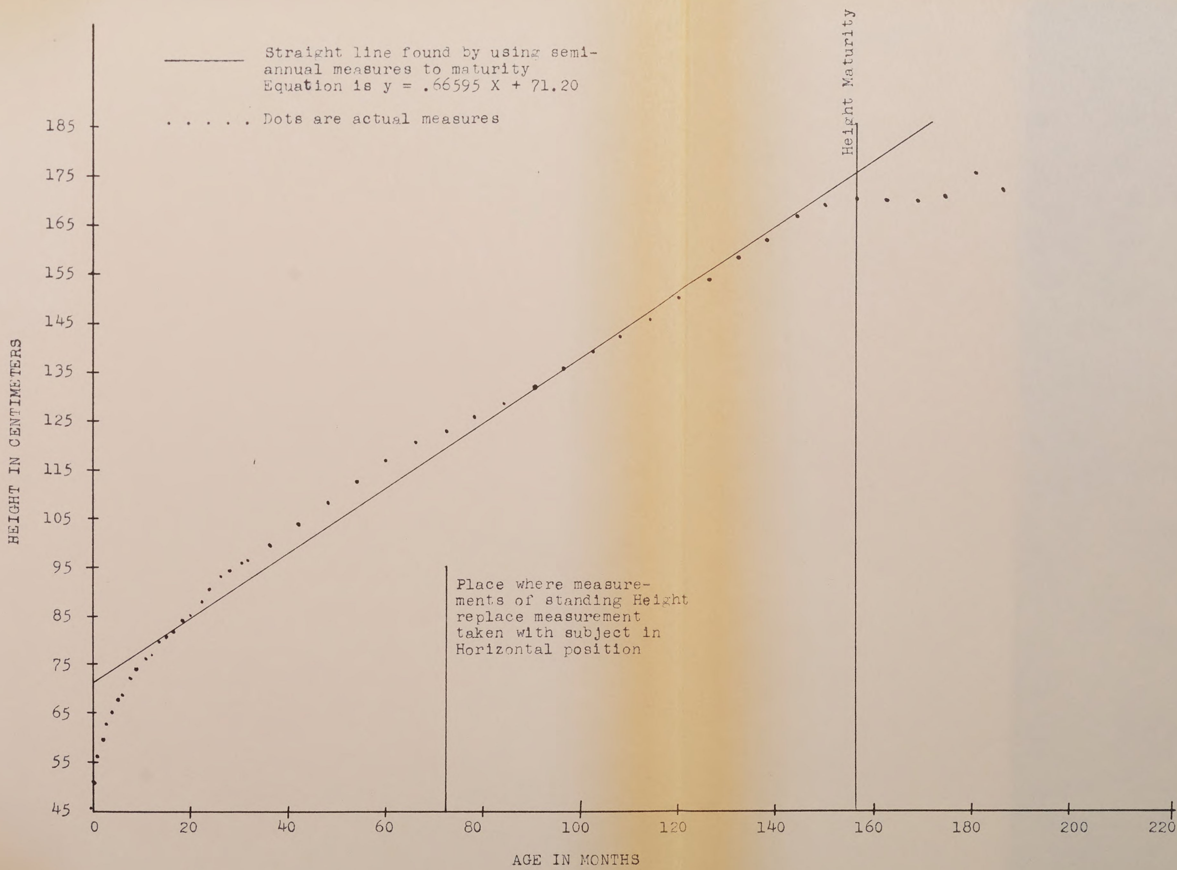


Figure 45. Case 204F. Height Measures and the Straight Line of Best Fit.

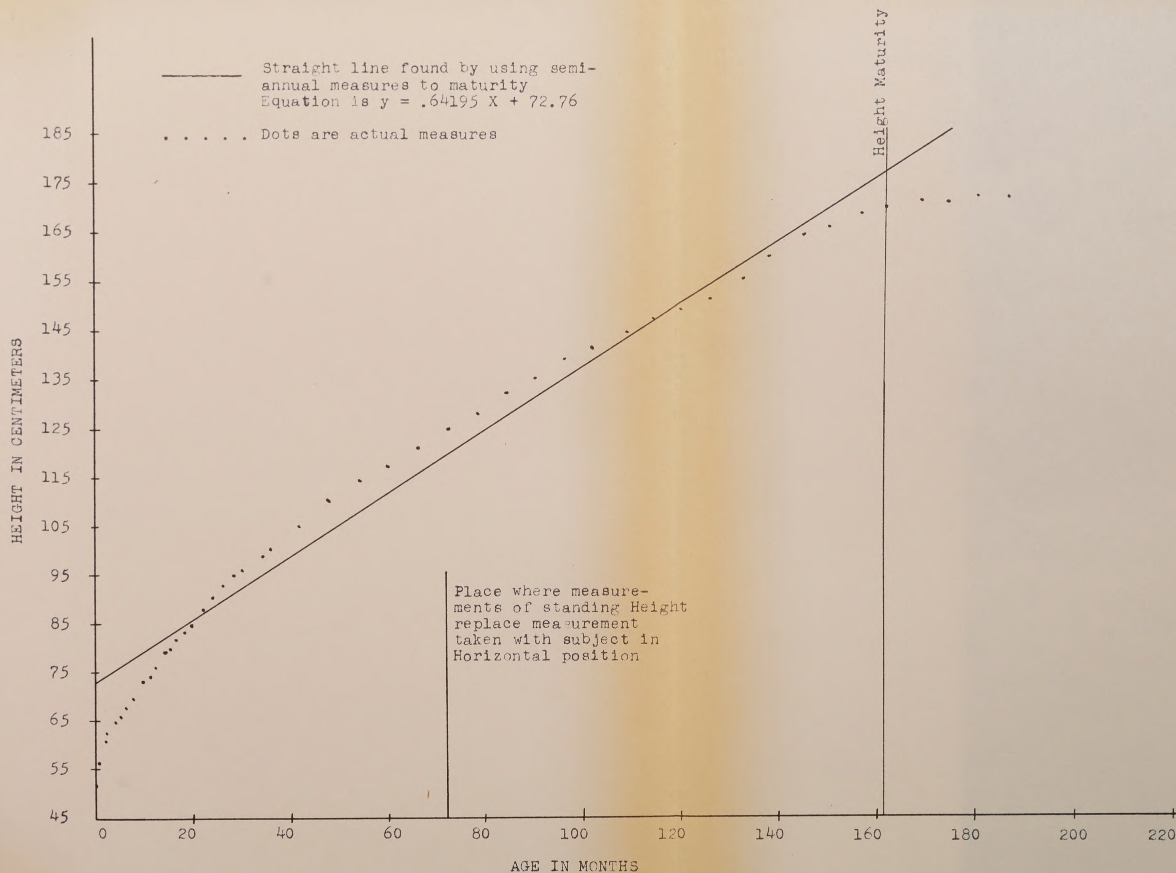


Figure 46. Case 205F. Height Measures and the Straight Line of Best Fit.

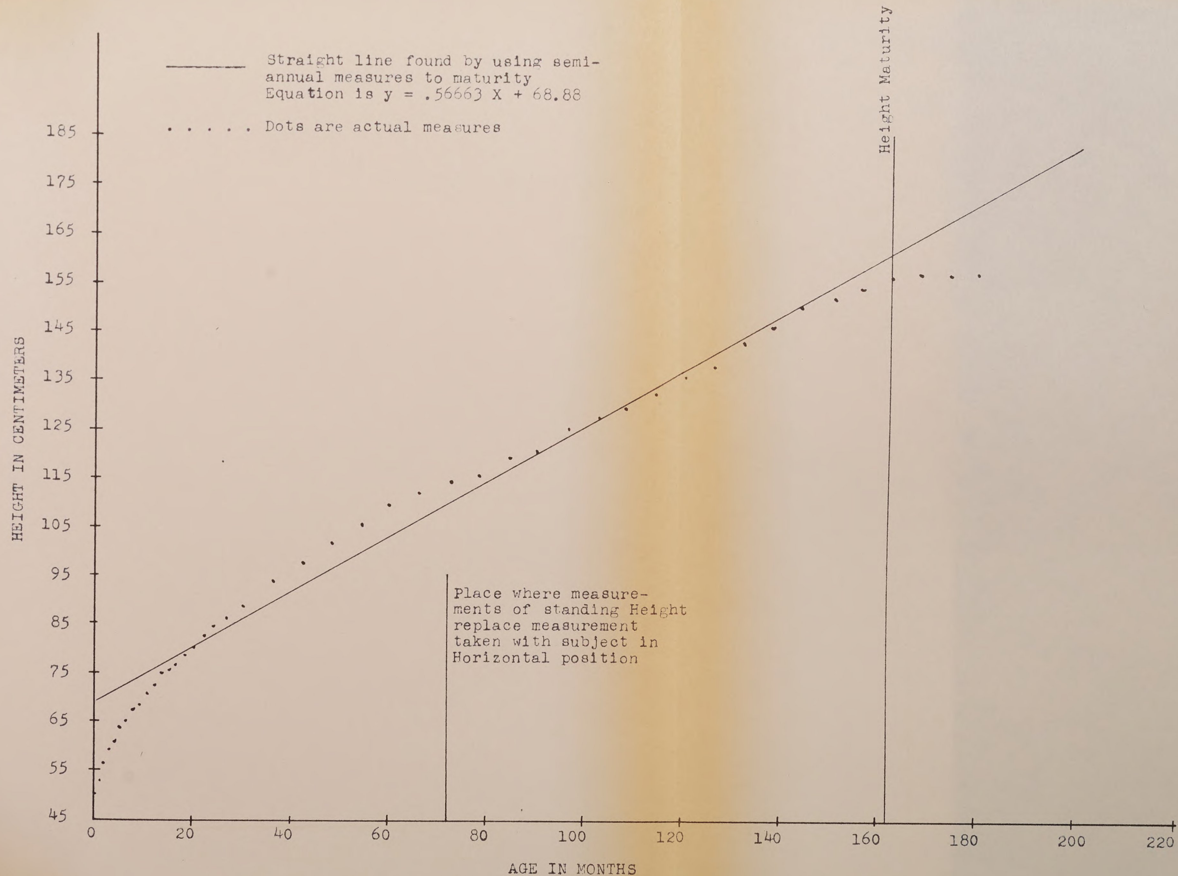


Figure 47. Case 211F. Height Measures and the Straight Line of Best Fit.

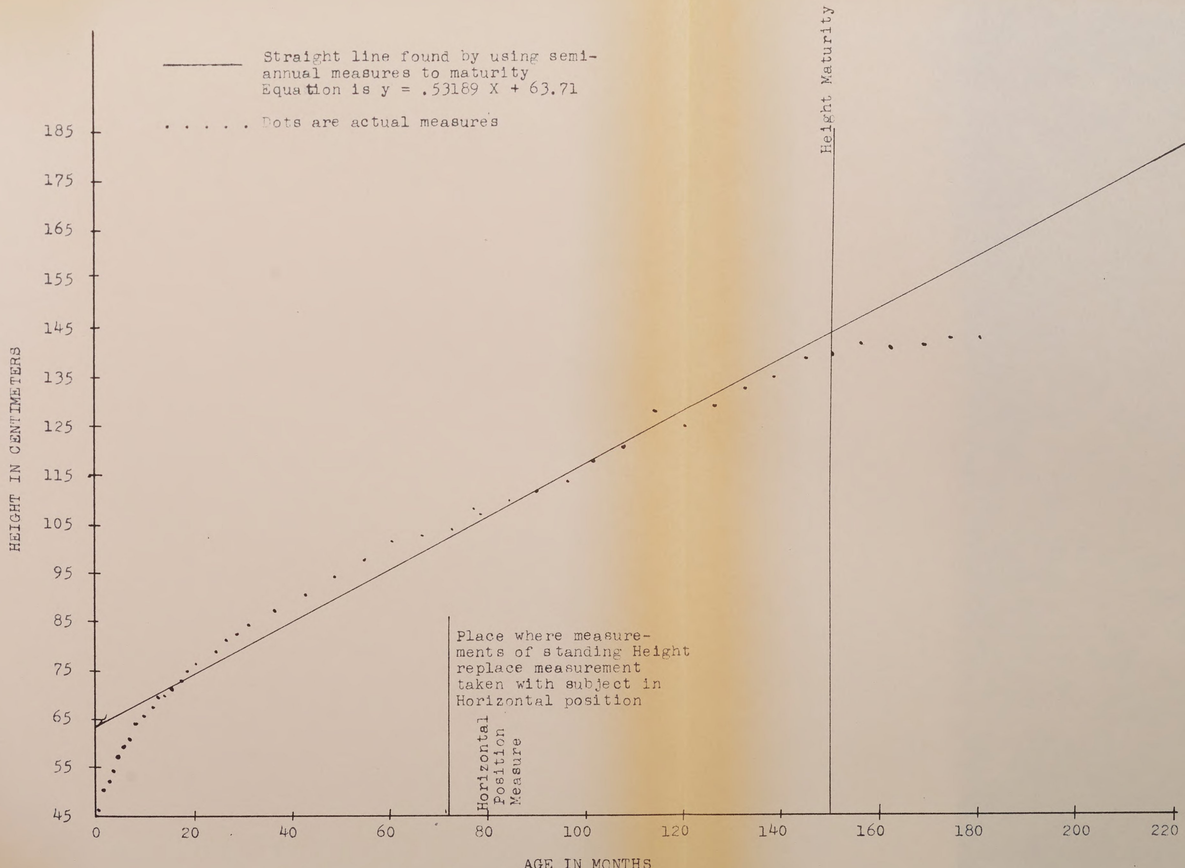


Figure 48. Case 214F. Height Measures and the Straight Line of Best Fit.

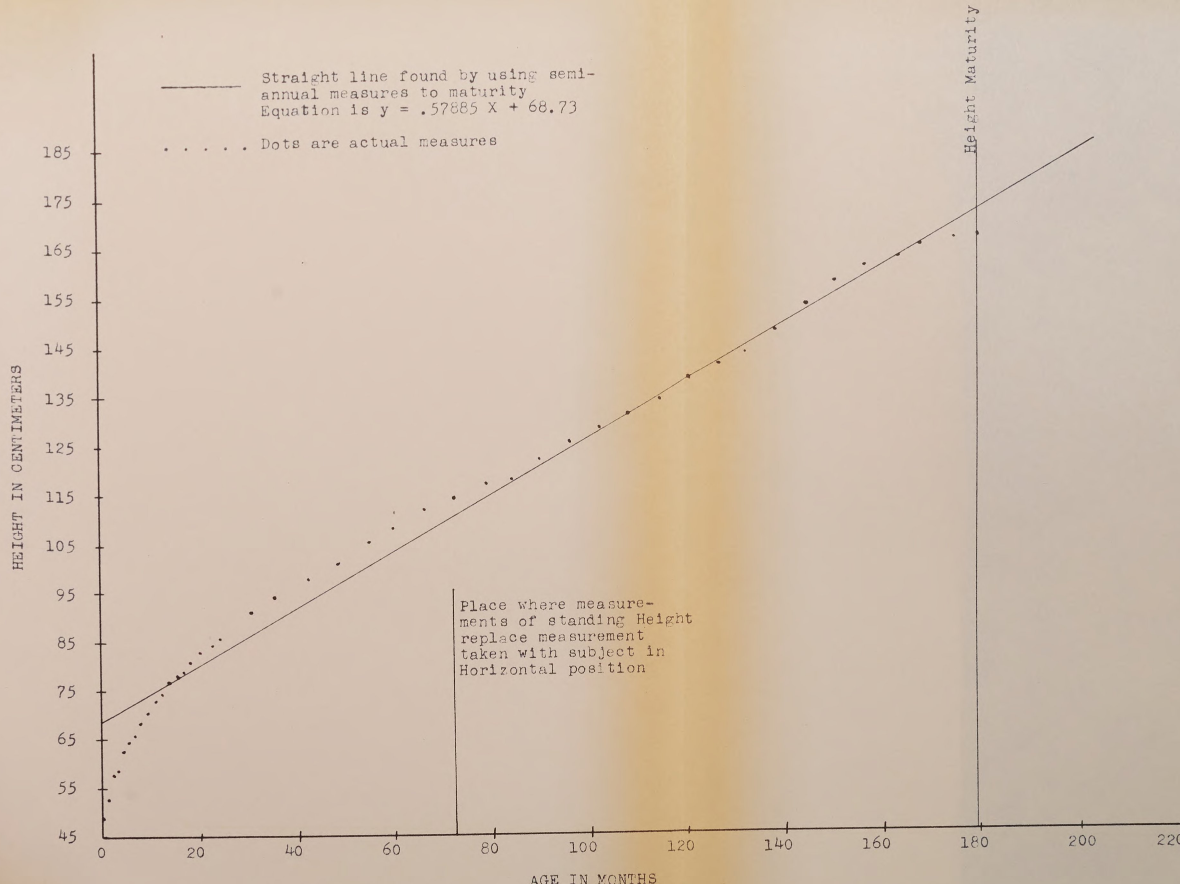


Figure 49. Case 217F°. Height Measures and the Straight Line of Best Fit.

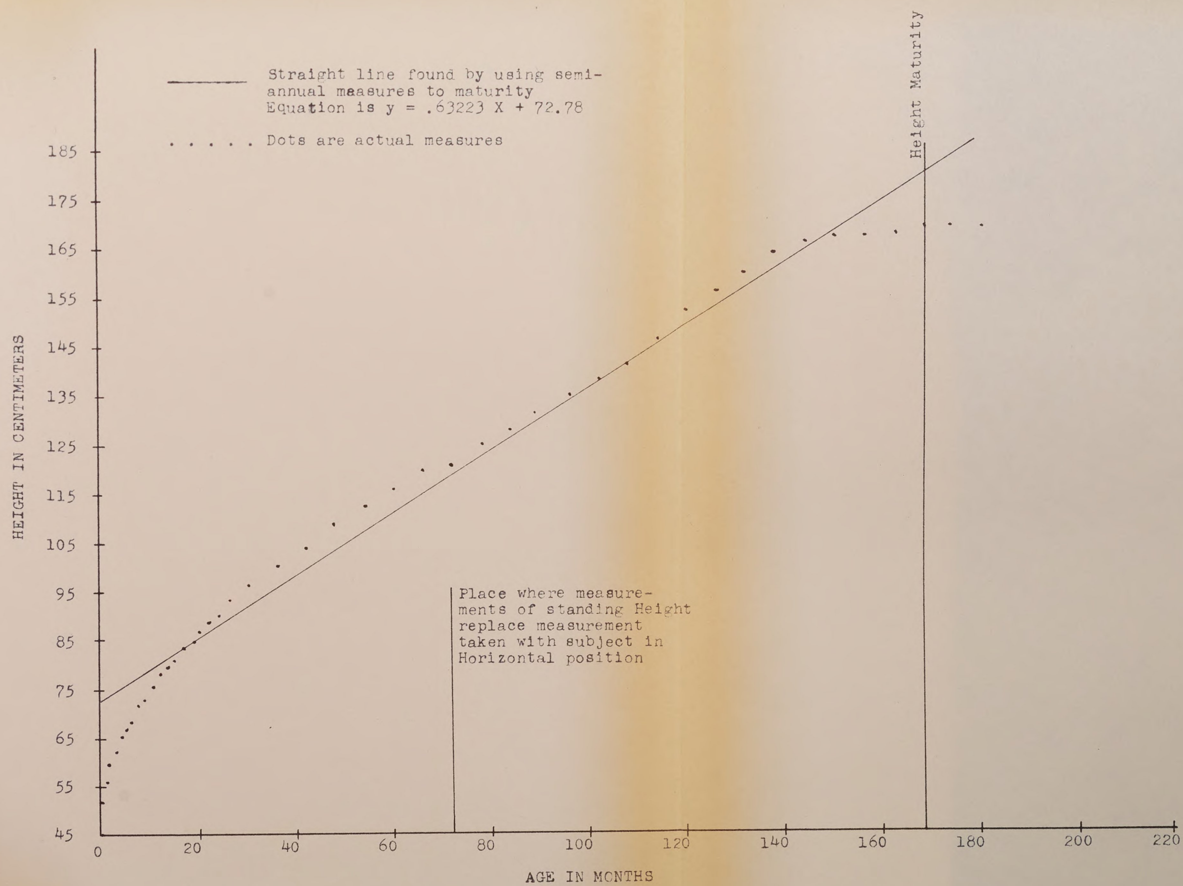


Figure 50. Case 220F. Height Measures and the Straight Line of Best Fit.

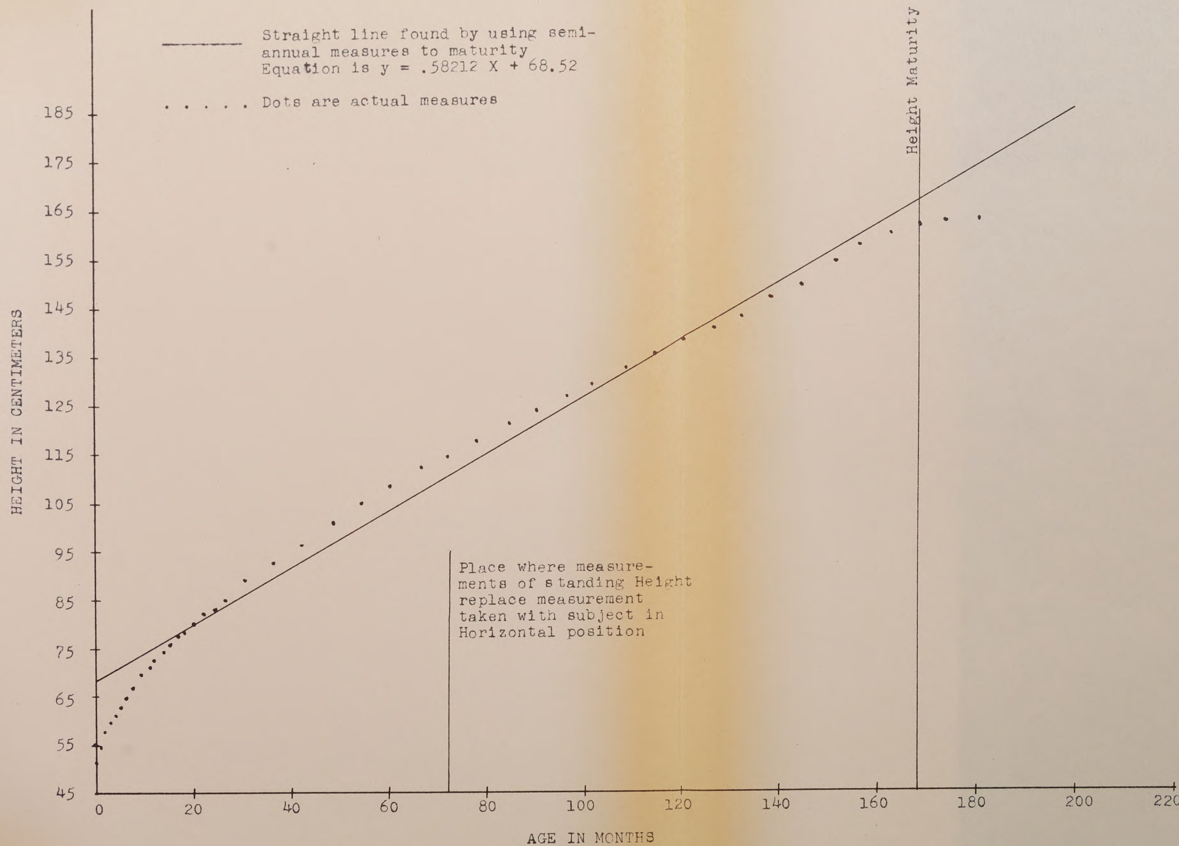


Figure 51. Case 221F. Height Measures and the Straight Line of Best Fit.

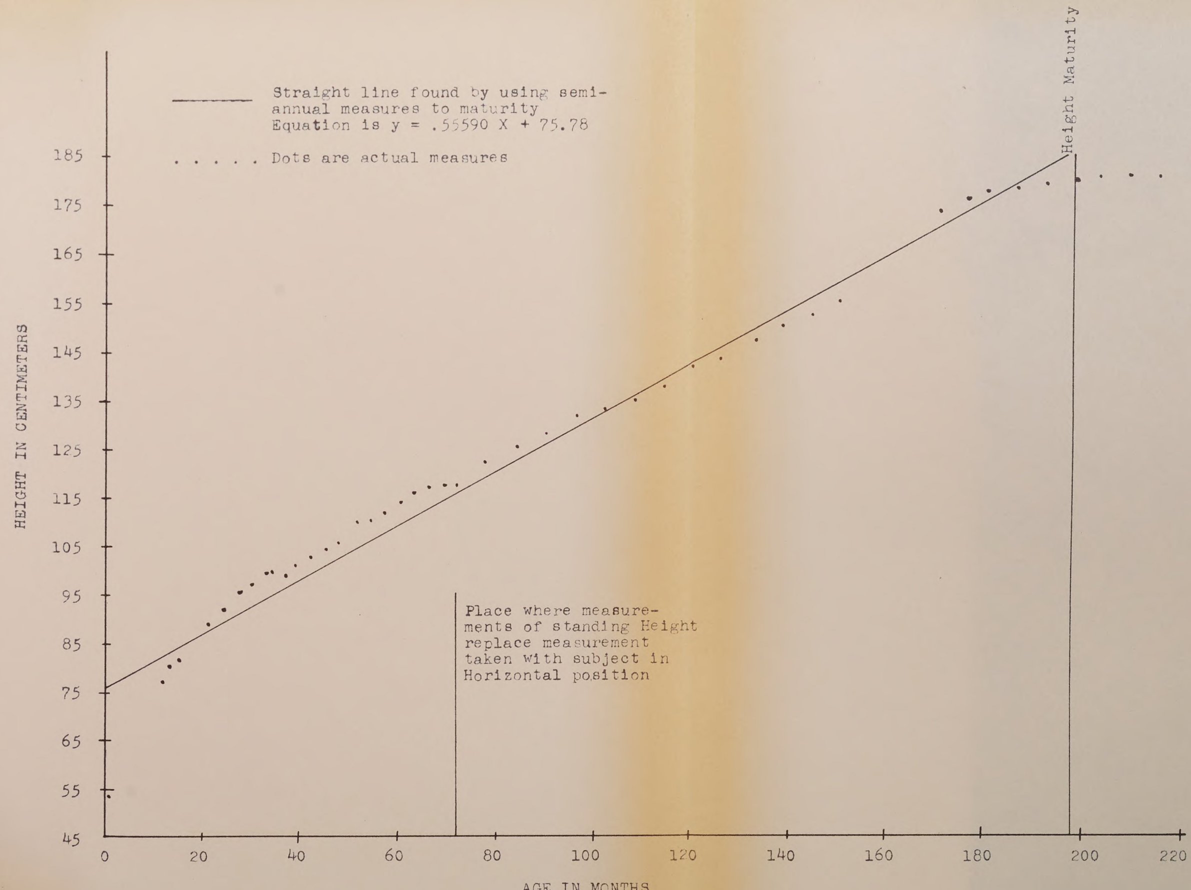


Figure 52. Case 10M*. Height Measures and the Straight Line of Best Fit.

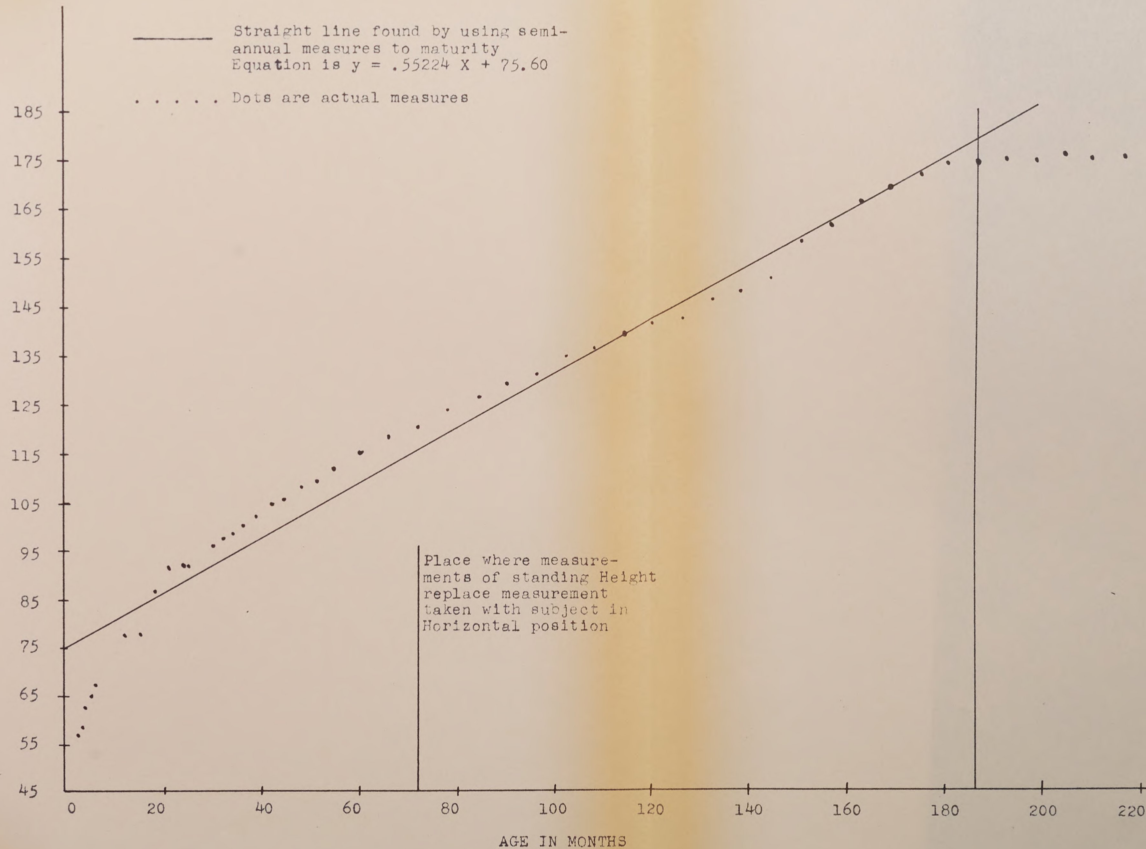


Figure 53. Case 49M. Height Measures and the Straight Line of Best Fit.

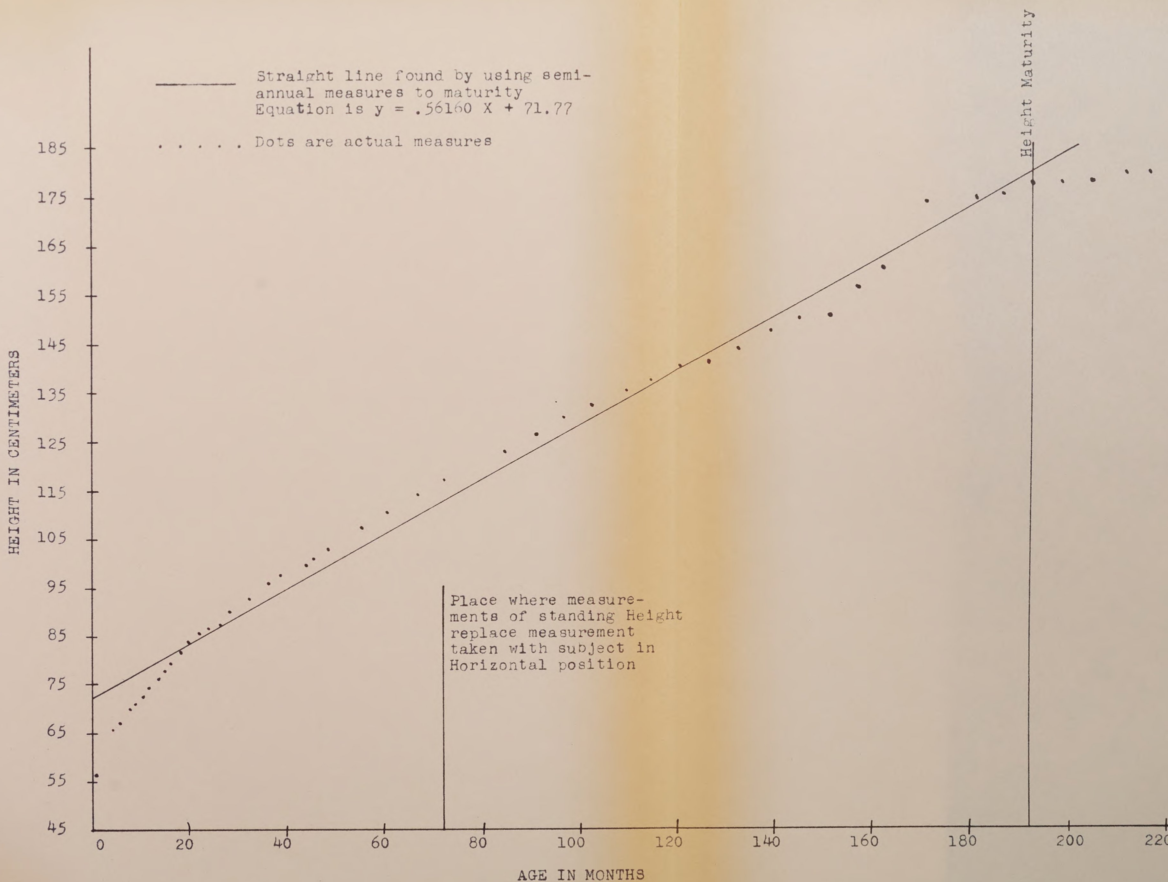


Figure 54. Case 54M*. Height Measures and the Straight Line of Best Fit.

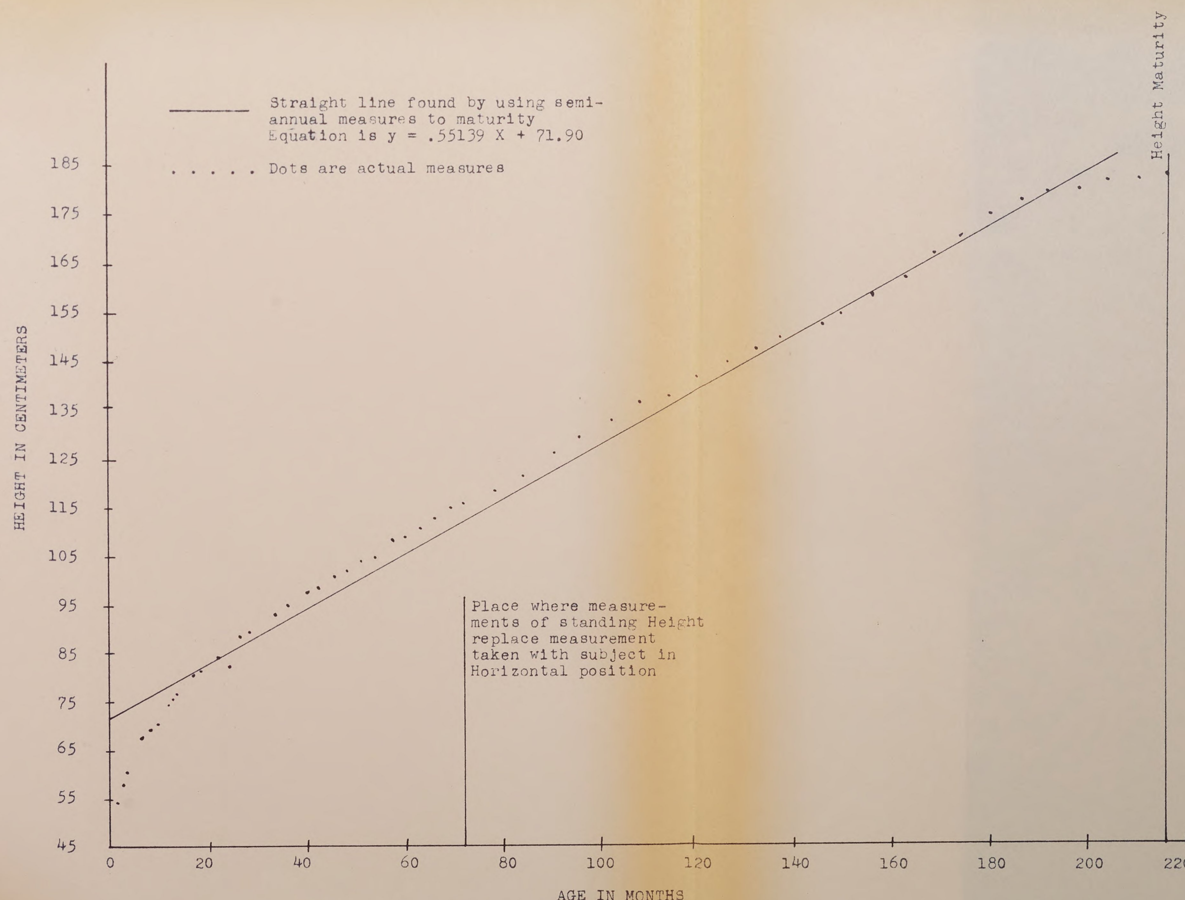


Figure 55. Case 55M°. Height Measures and the Straight Line of Best Fit.

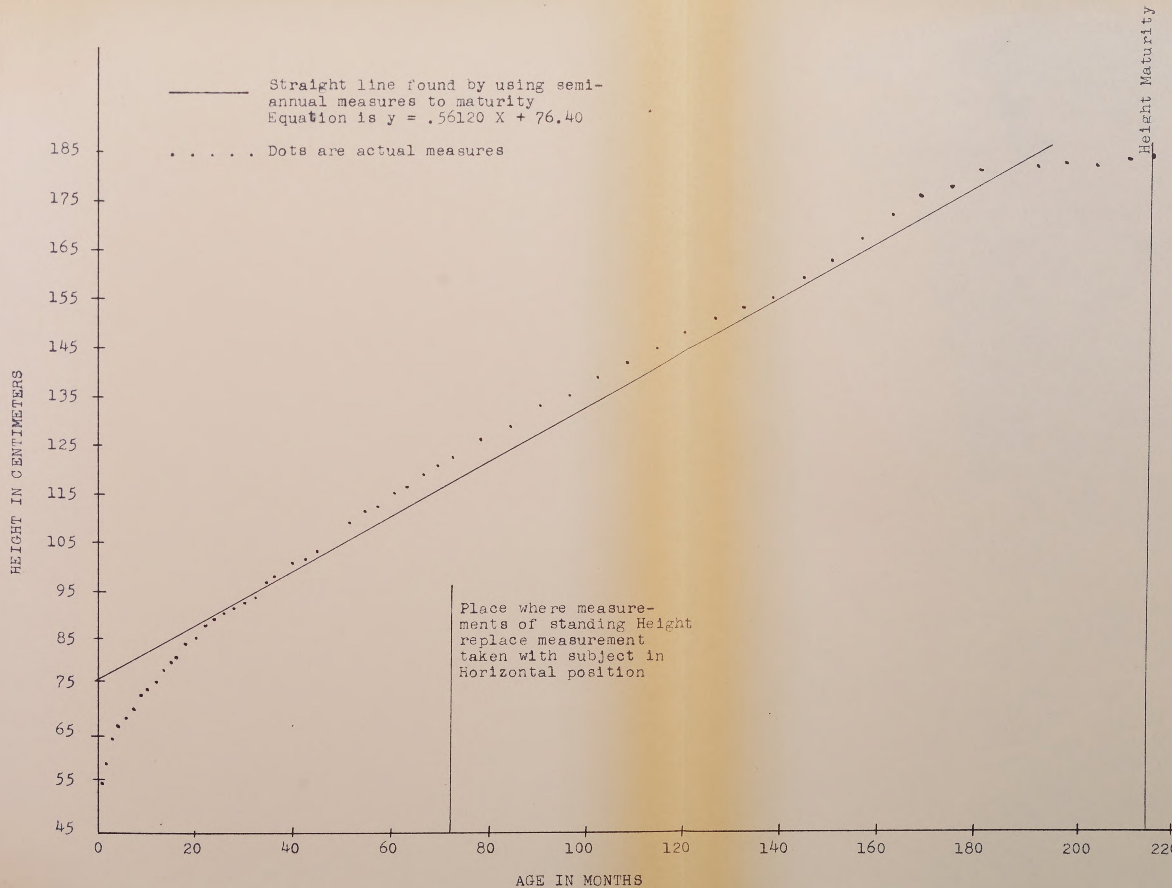


Figure 56. Case 71M*.° Height Measures and the Straight Line of Best Fit.

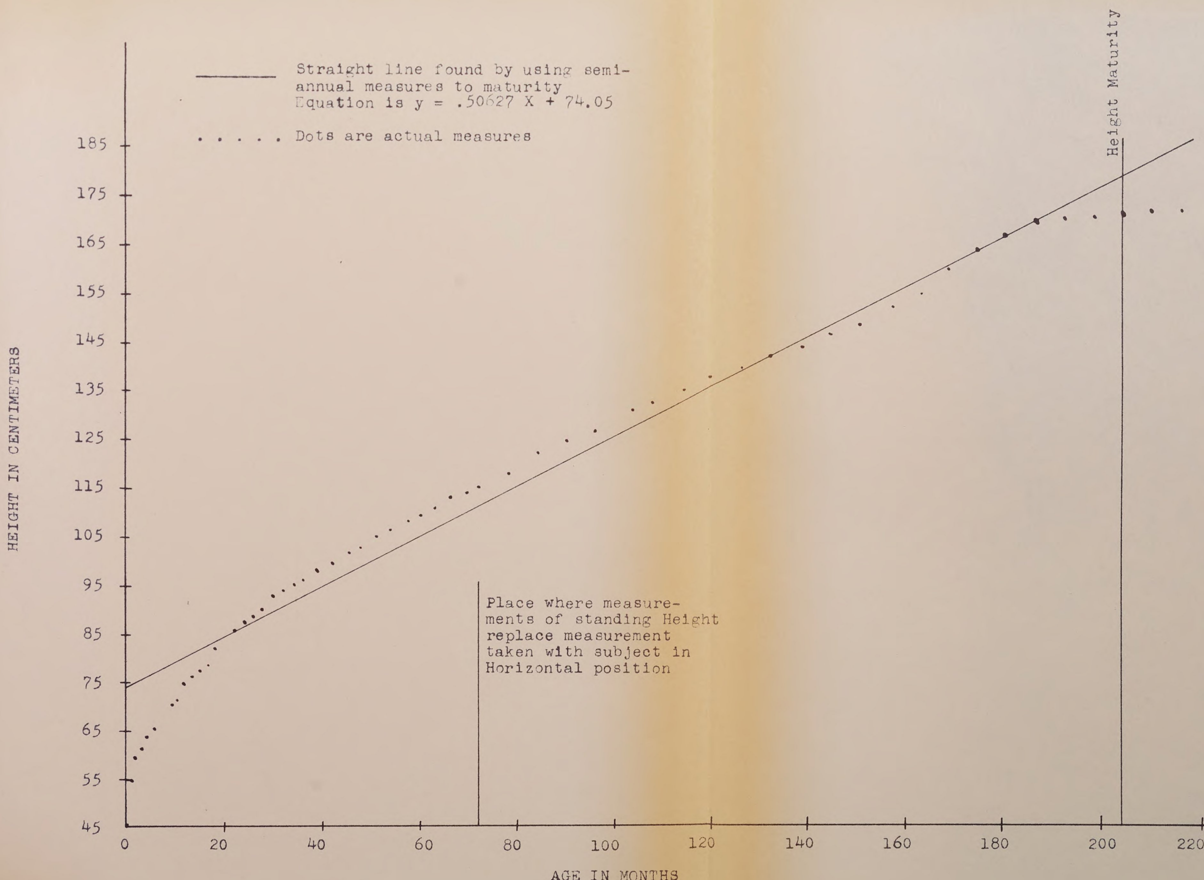


Figure 57. Case 74M. Height Measures and the Straight Line of Best Fit.

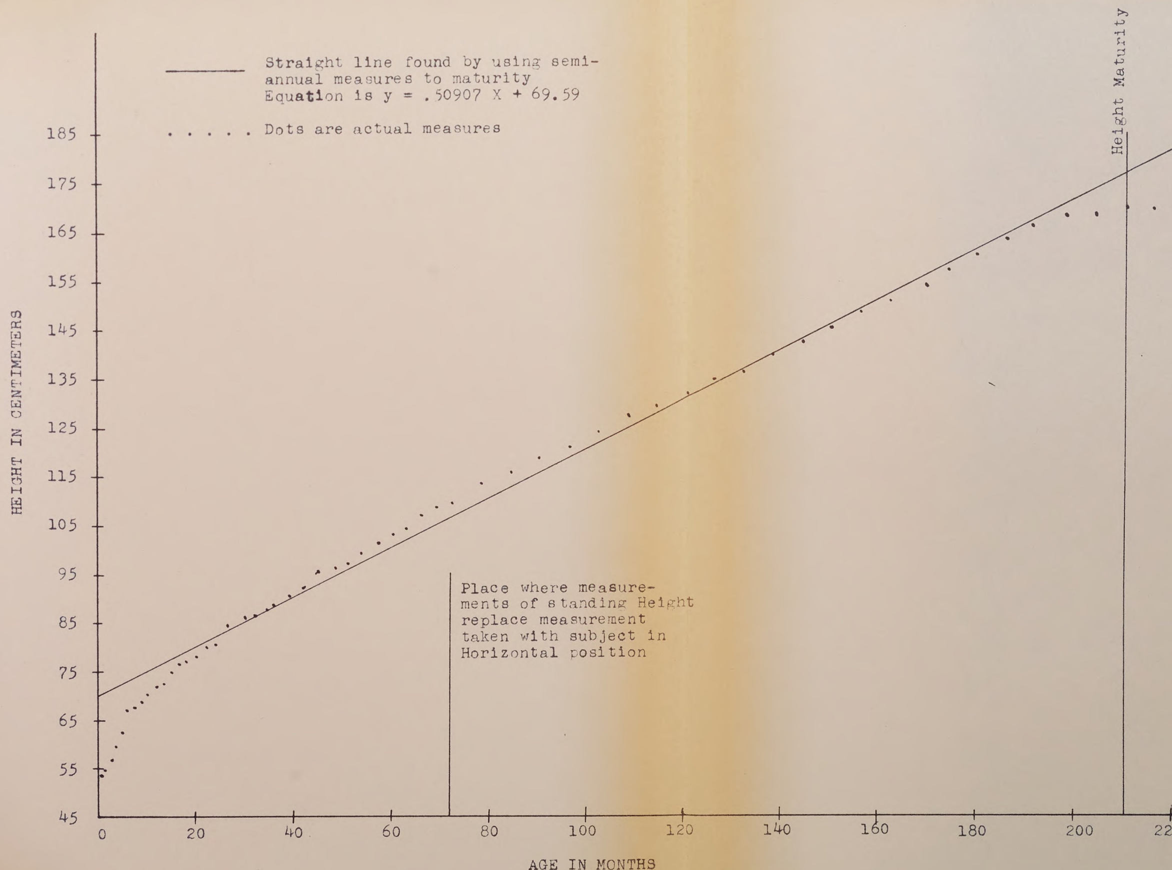


Figure 58. Case 77M. Height Measures and the Straight Line of Best Fit.

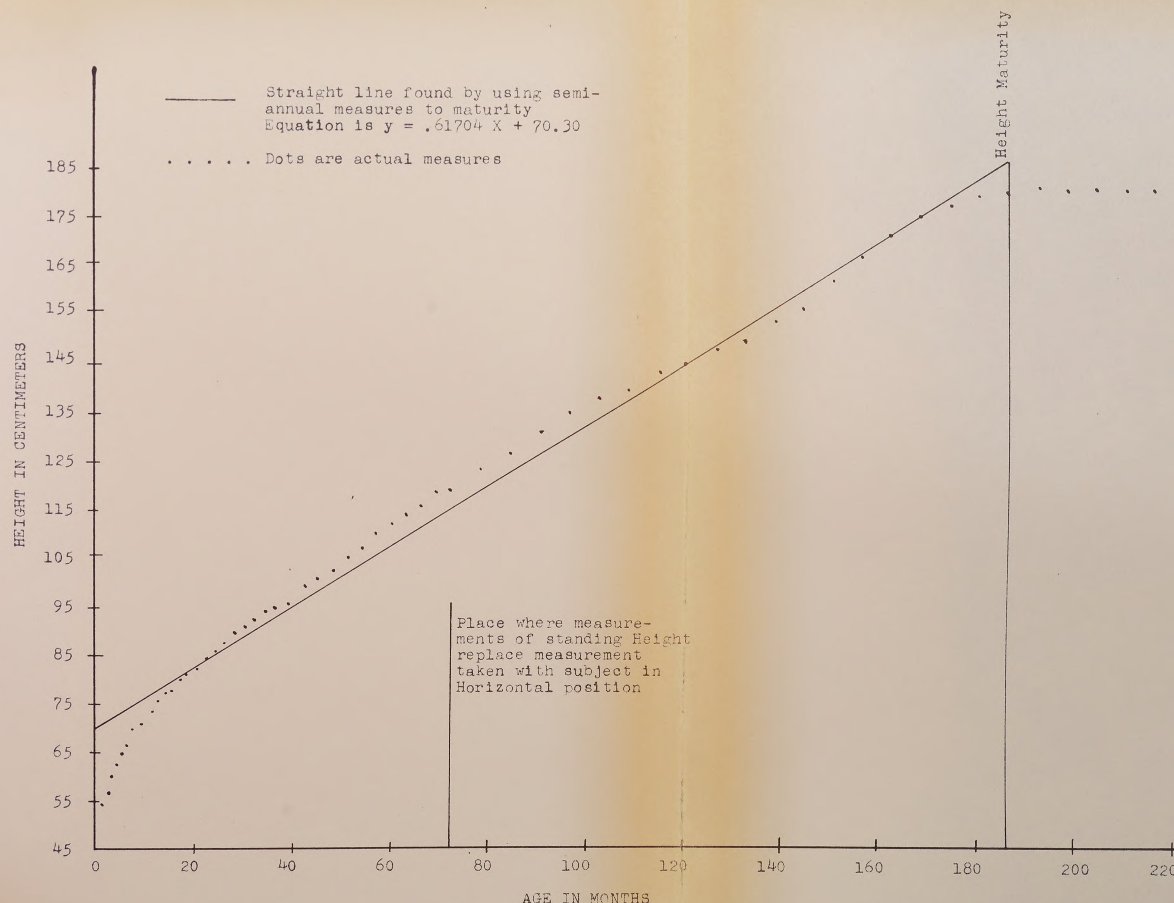


Figure 59. Case 78M. Height Measures and the Straight Line of Best Fit.

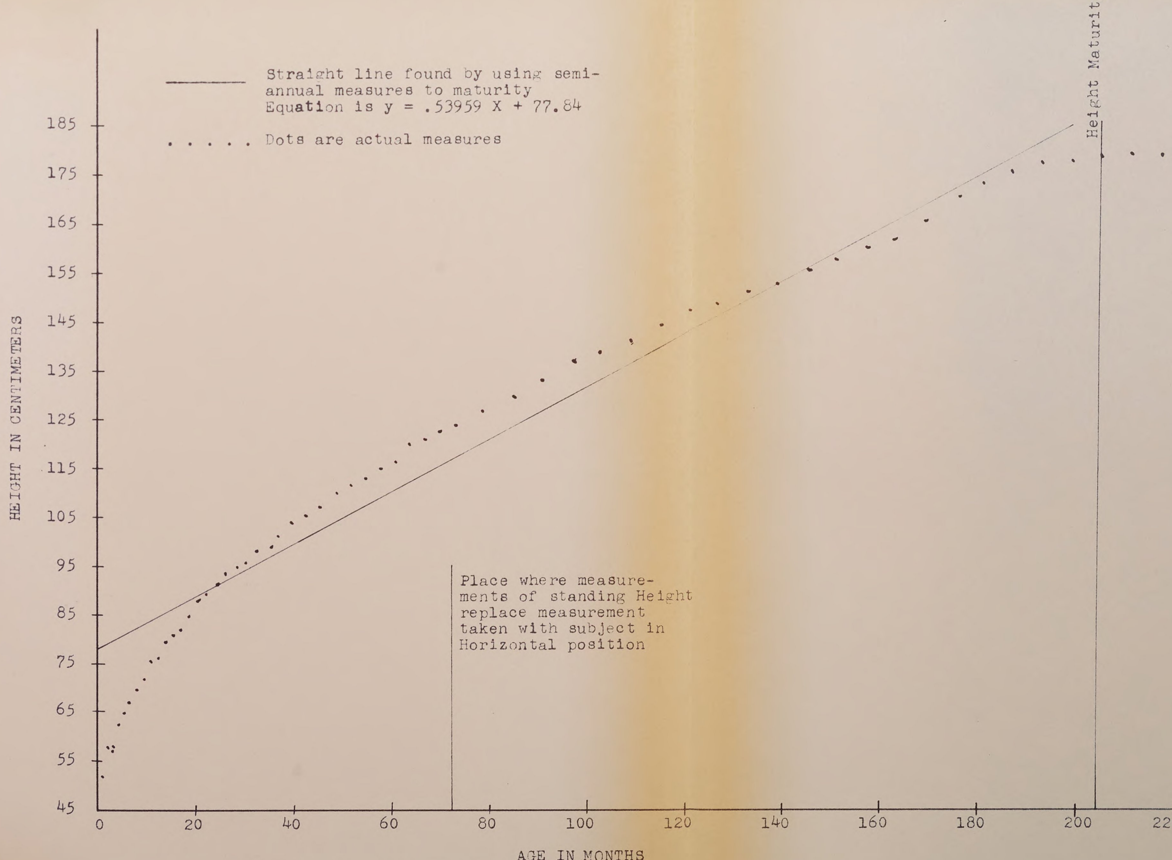


Figure 60. Case 81M. Height Measures and the Straight Line of Best Fit.

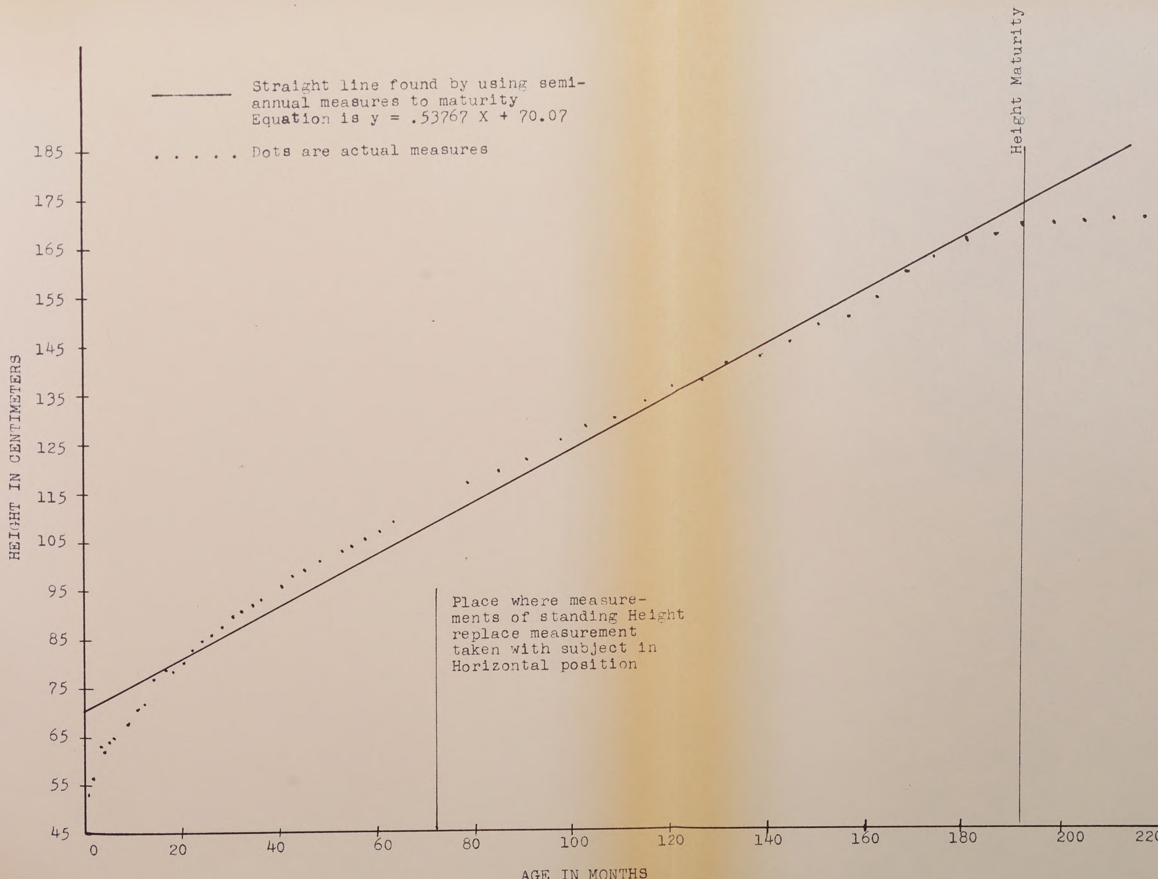


Figure 61. Case 84M*. Height Measures and the Straight Line of Best Fit.

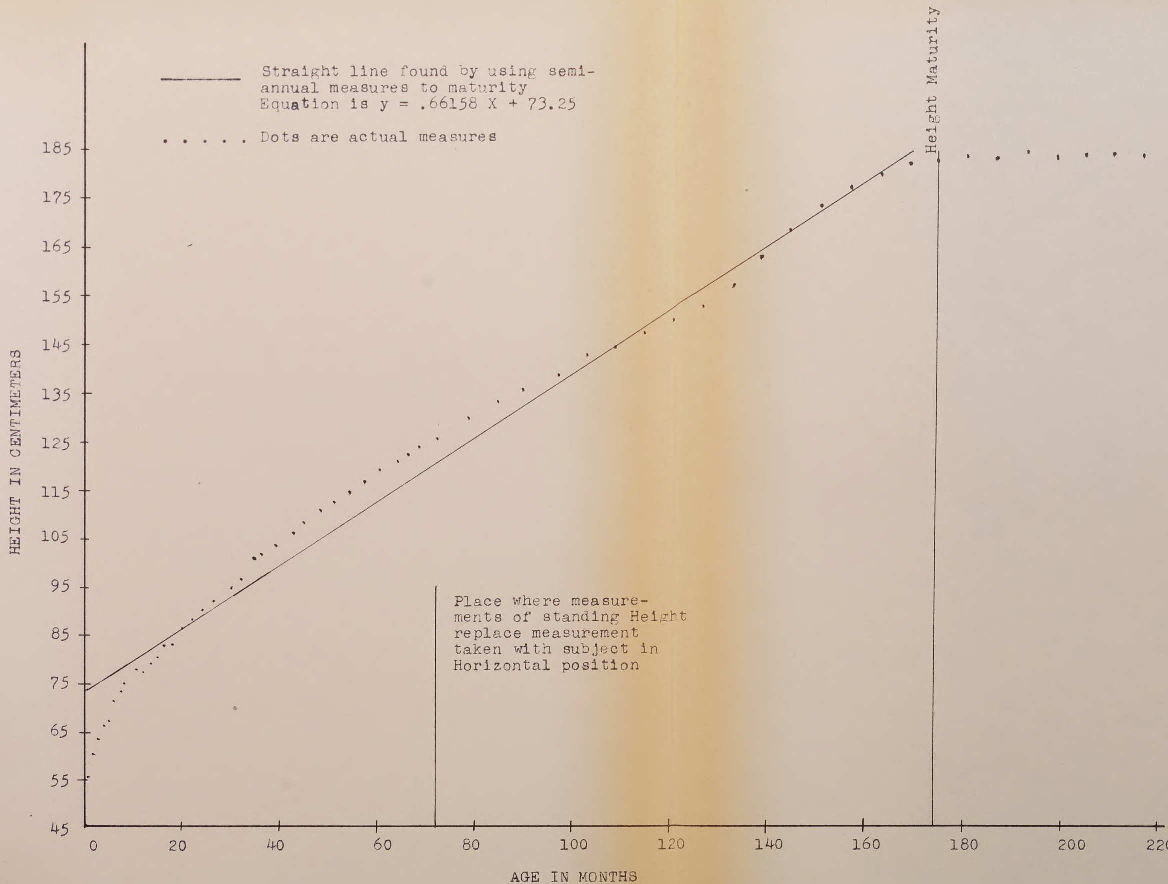


Figure 62. Case 92M. Height Measures and the Straight Line of Best Fit.

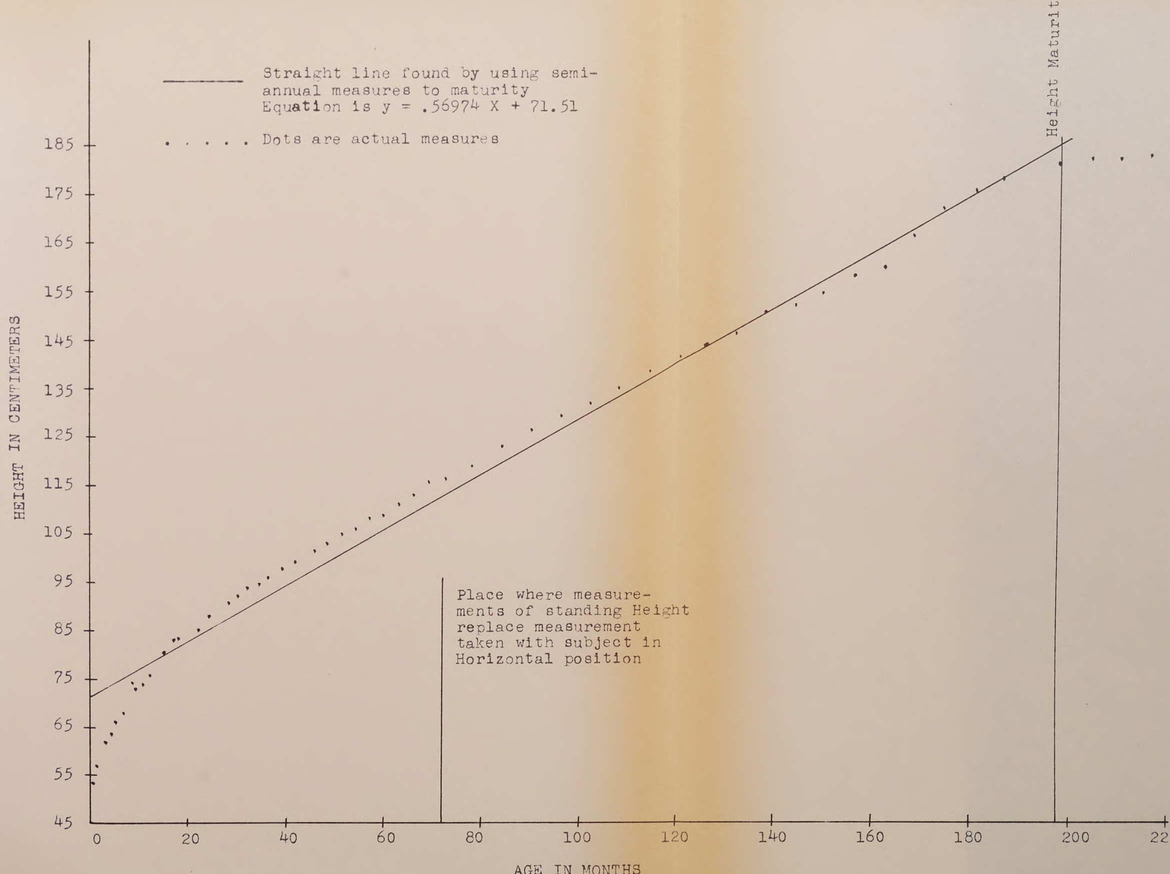


Figure 63. Case 98M*. Height Measures and the Straight Line of Best Fit.

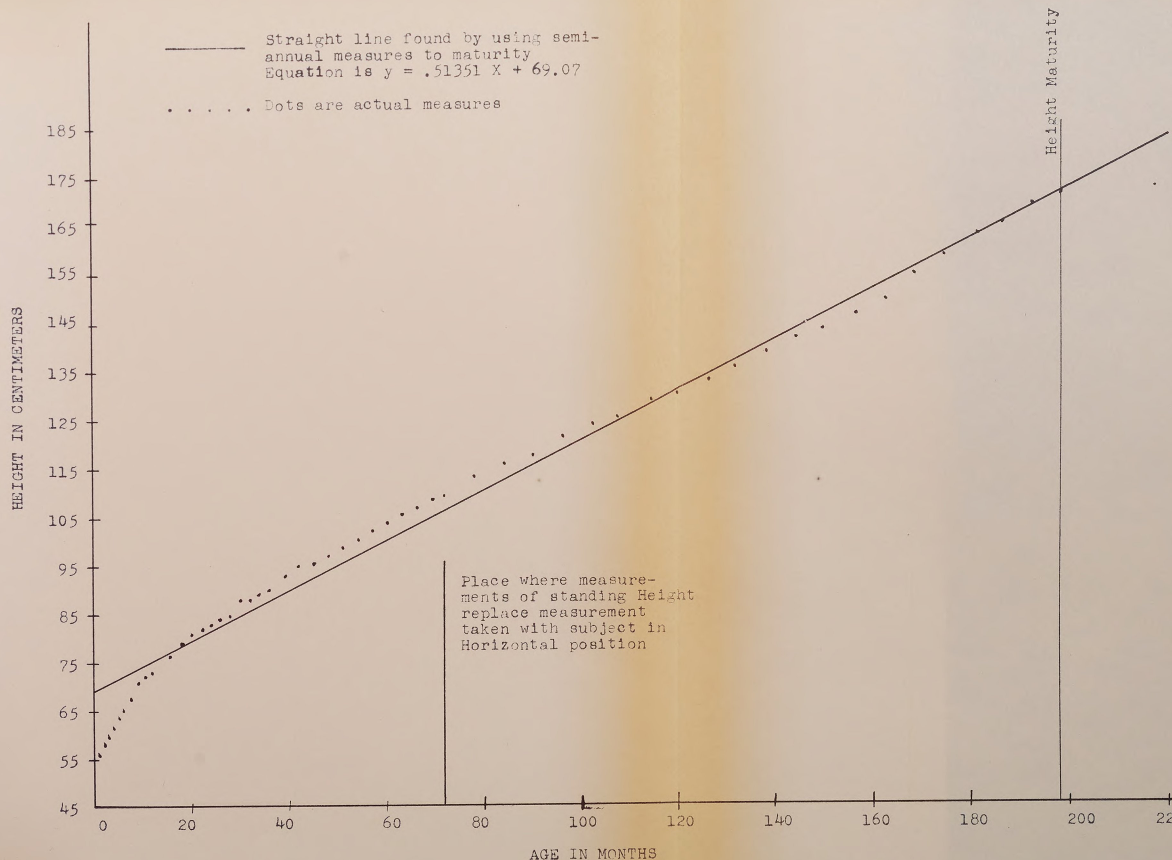


Figure 64. Case 102M*o. Height Measures and the Straight Line of Best Fit.

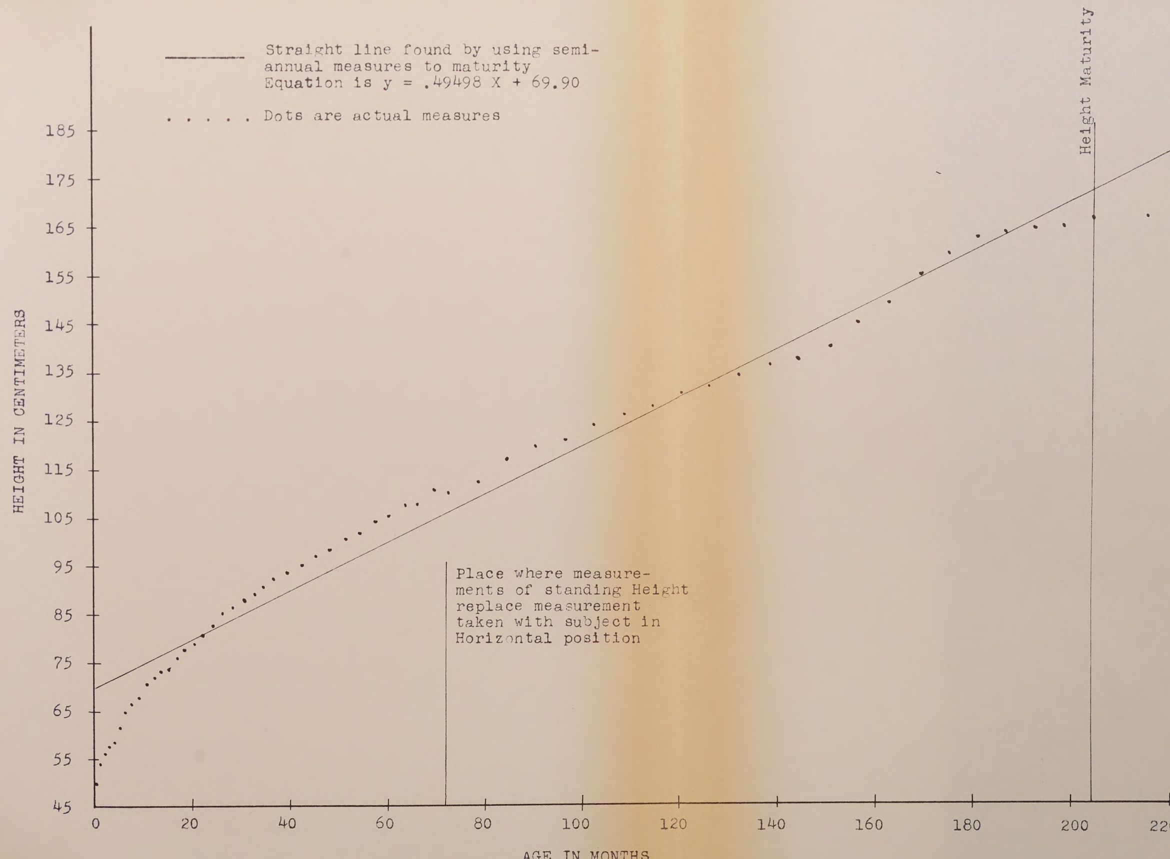


Figure 65. Case 112M. Height Measures and the Straight Line of Best Fit.

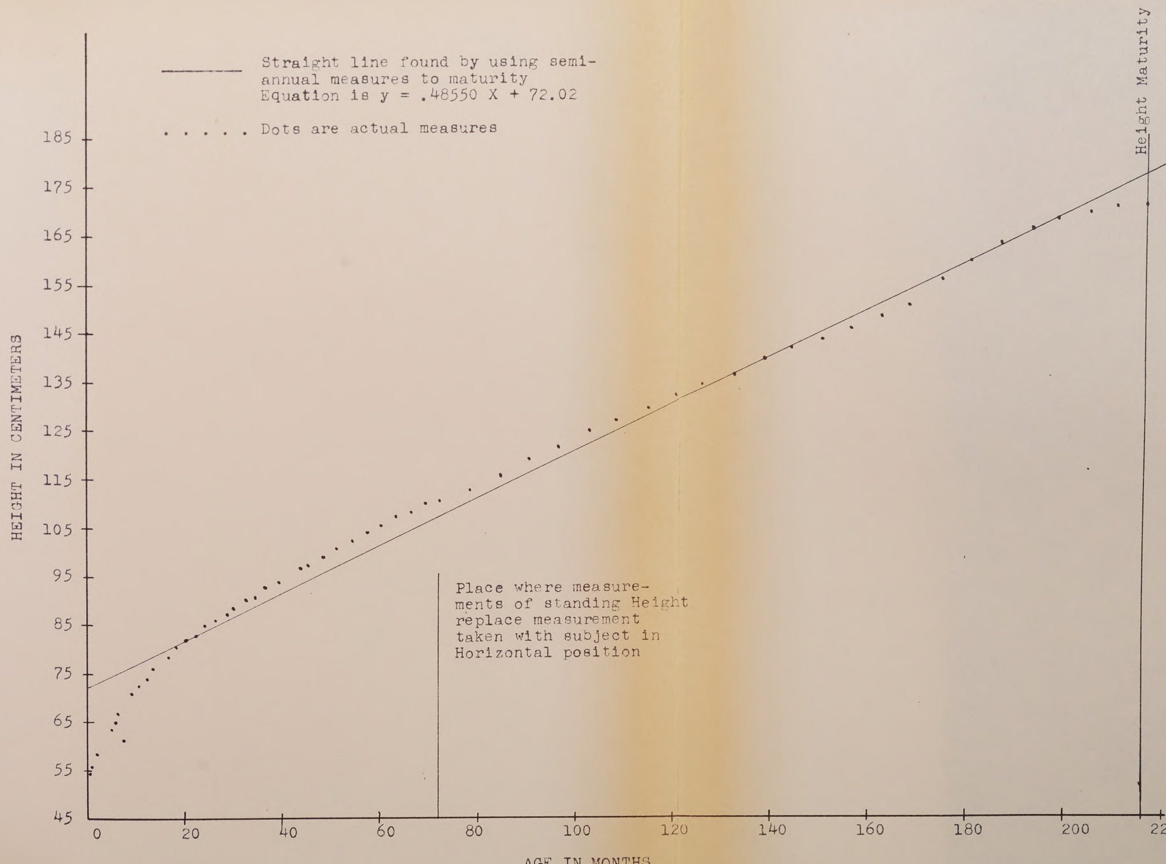


Figure 66. Case $114M^{O}$. Height Measures and the Straight Line of Best Fit.

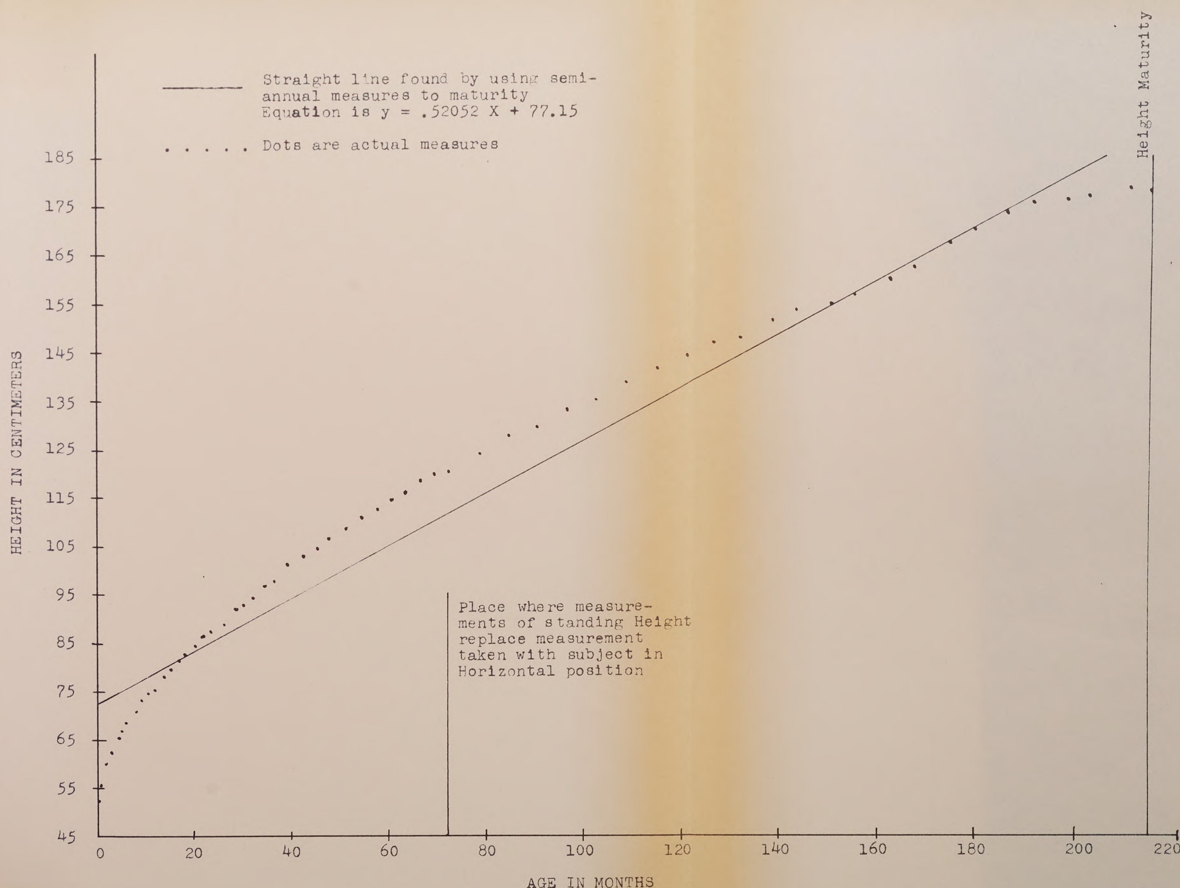


Figure 67. Case 135M°. Height Measures and the Straight Line of Best Fit.

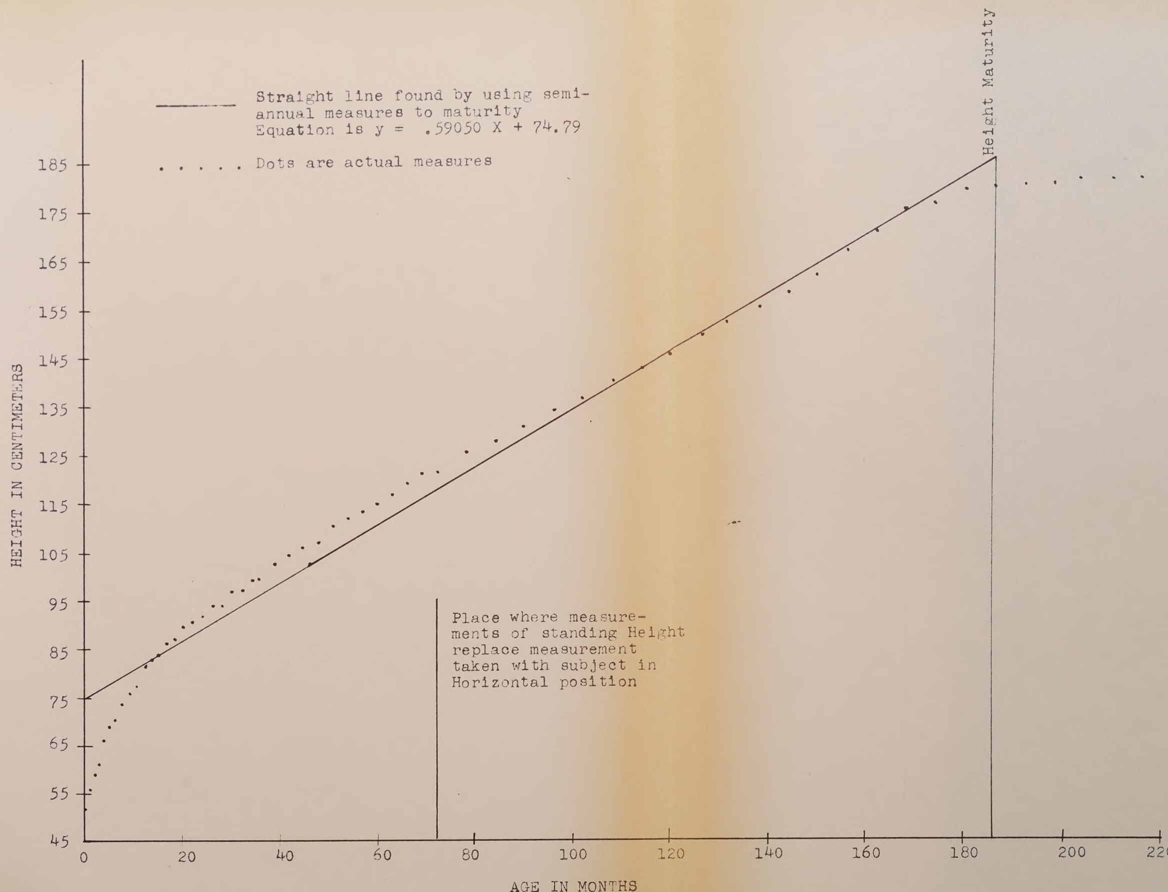


Figure 68. Case 138M. Height Measures and the Straight Line of Best Fit.

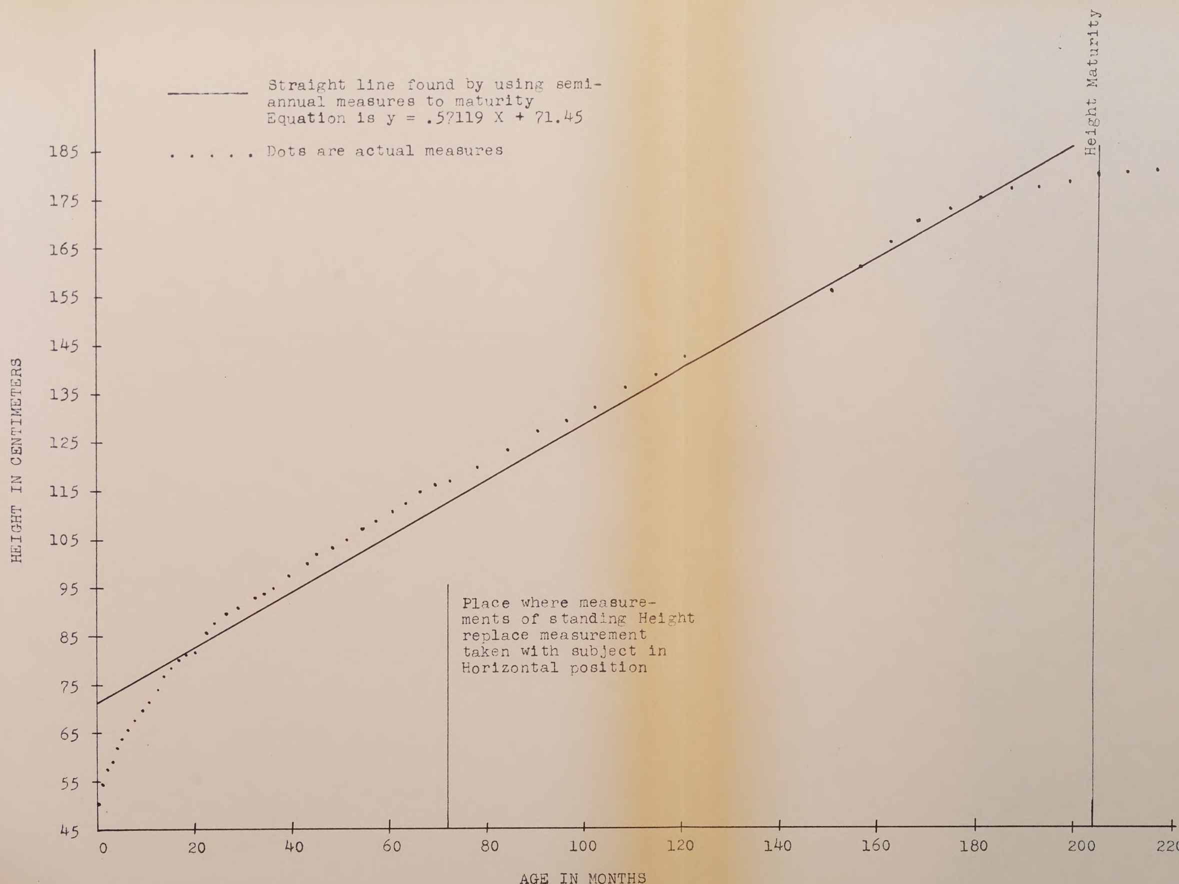


Figure 69. Case 141M*. Height Measures and the Straight Line of Best Fit.

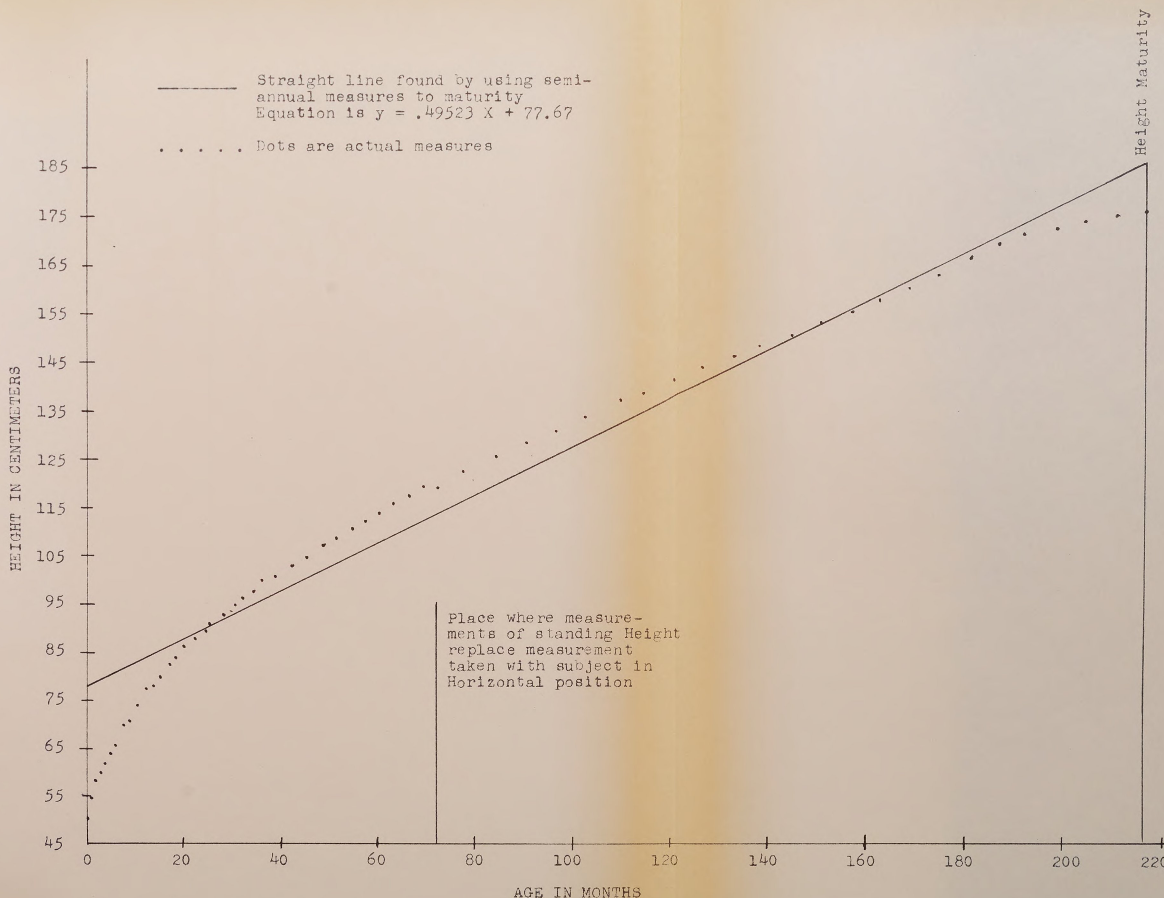


Figure 70. Case 153M^{o}. Height Measures and the Straight Line of Best Fit.

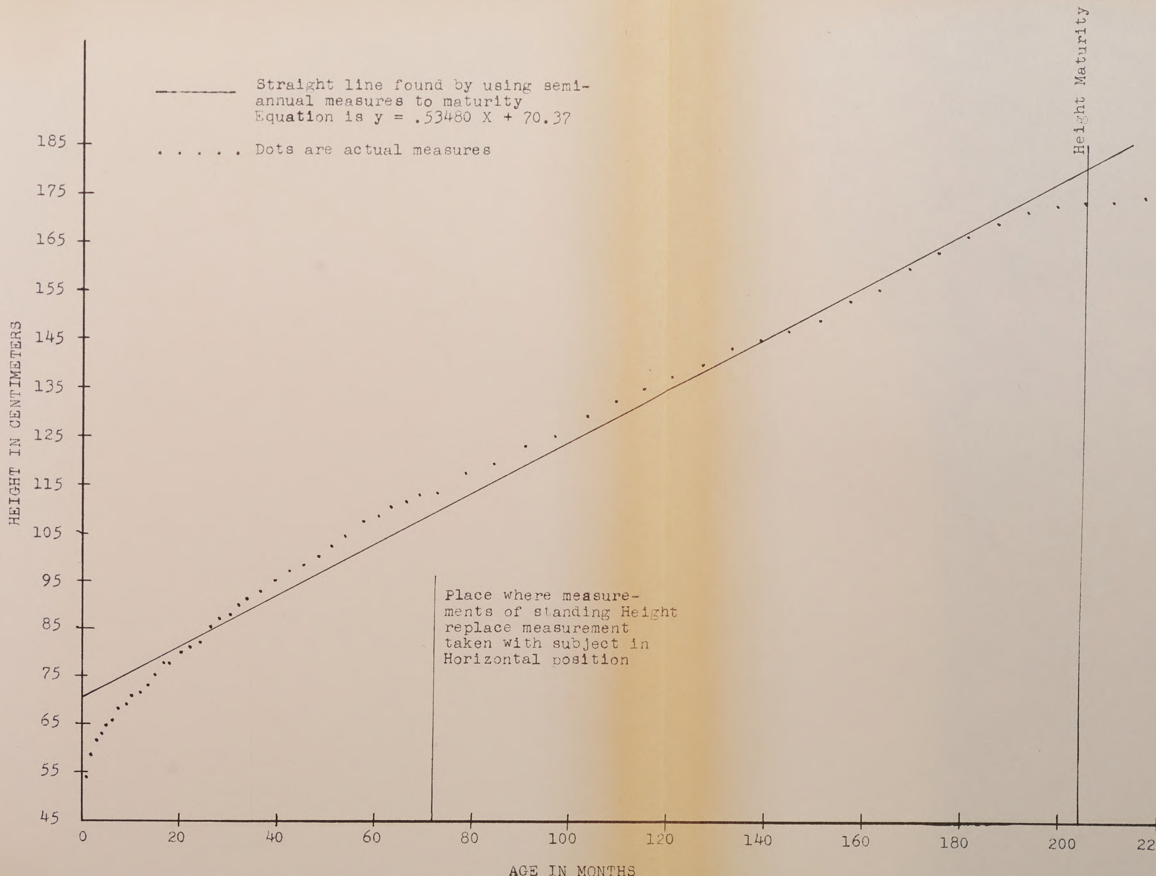


Figure 71. Case 154M. Height Measures and the Straight Line of Best Fit.

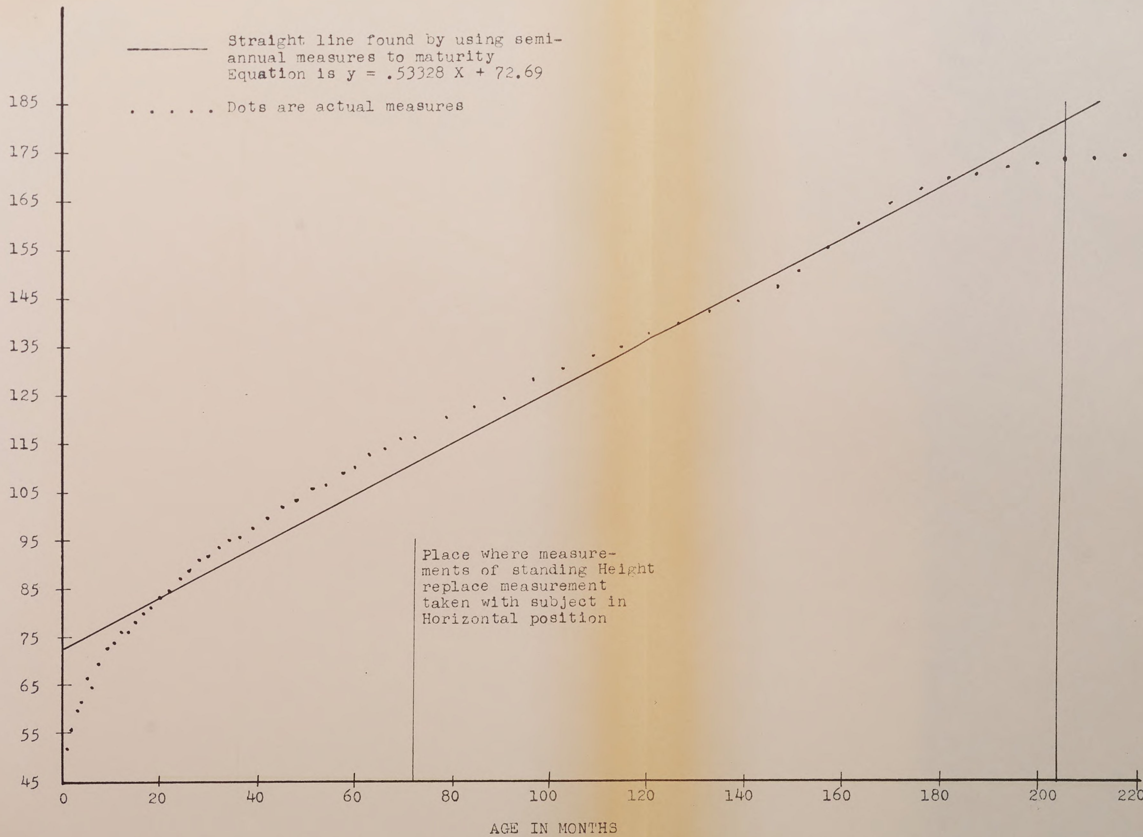


Figure 72. Case 156M. Height Measures and the Straight Line of Best Fit.

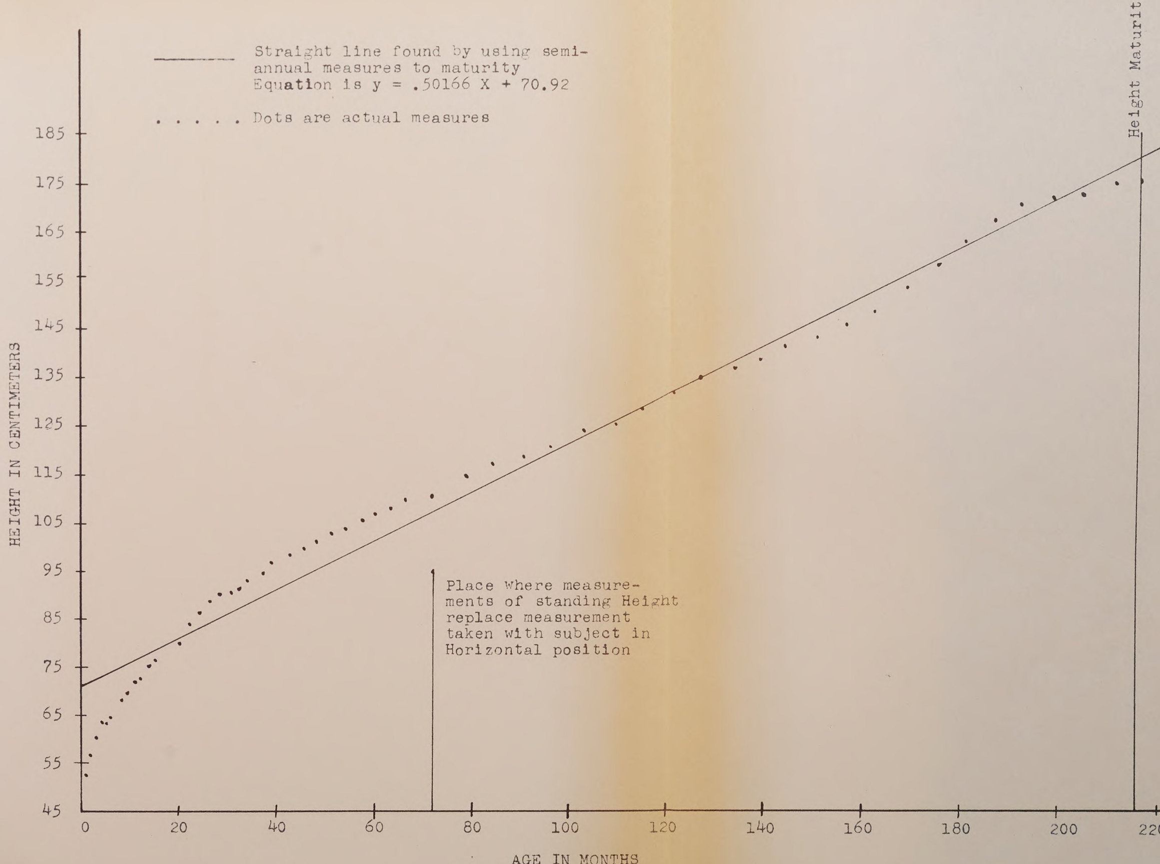


Figure 73. Case 157M°. Height Measures and the Straight Line of Best Fit.

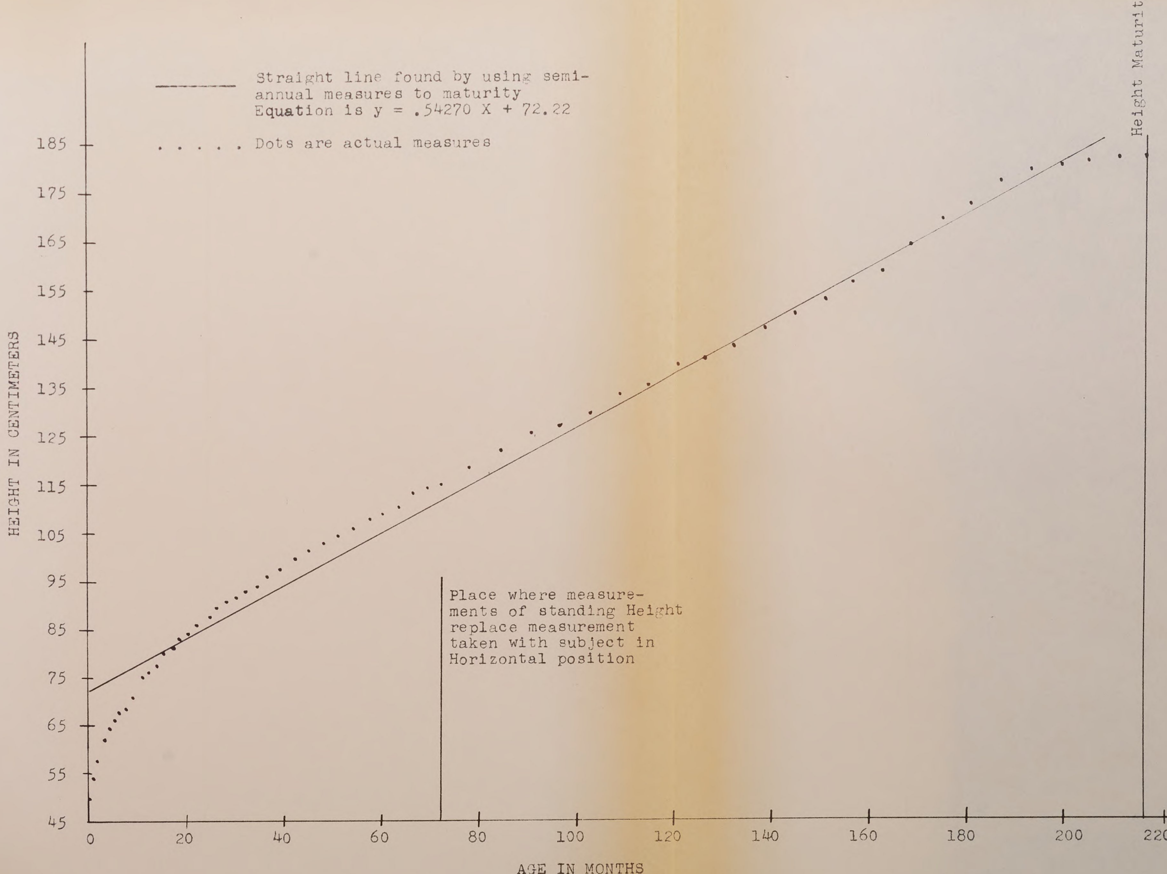


Figure 74. Case 160M°. Height Measures and the Straight Line of Best Fit.

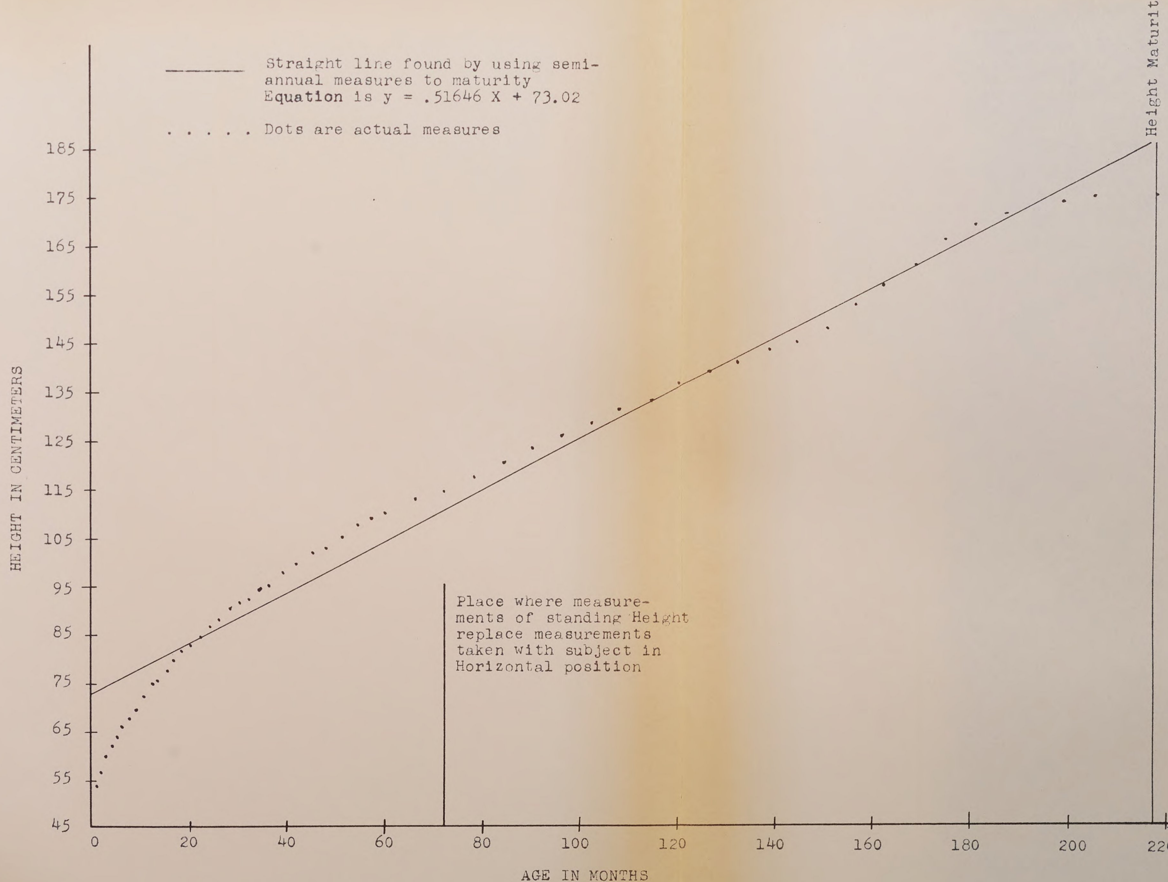


Figure 75. Case 167M°. Height Measures and the Straight Line of Best Fit.

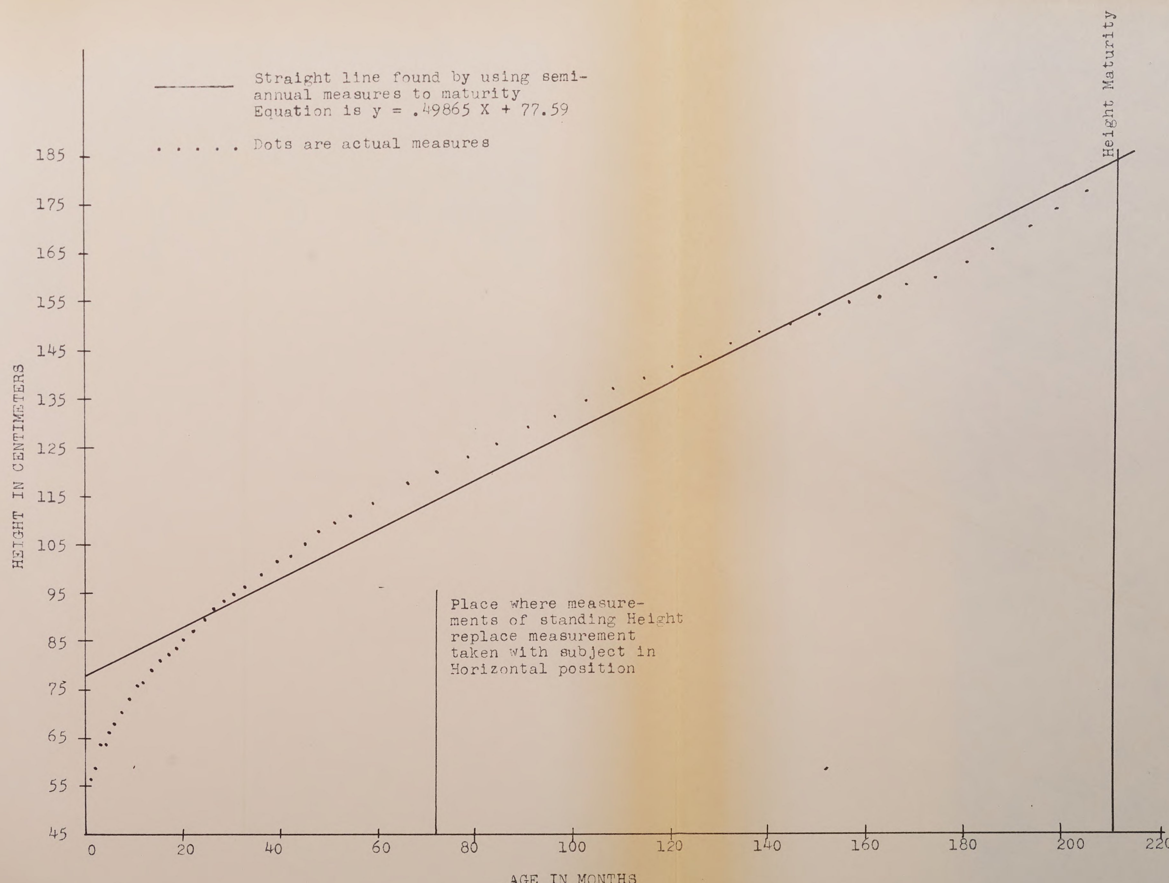


Figure 76. Case 174M°. Height Measures and the Straight Line of Best Fit.

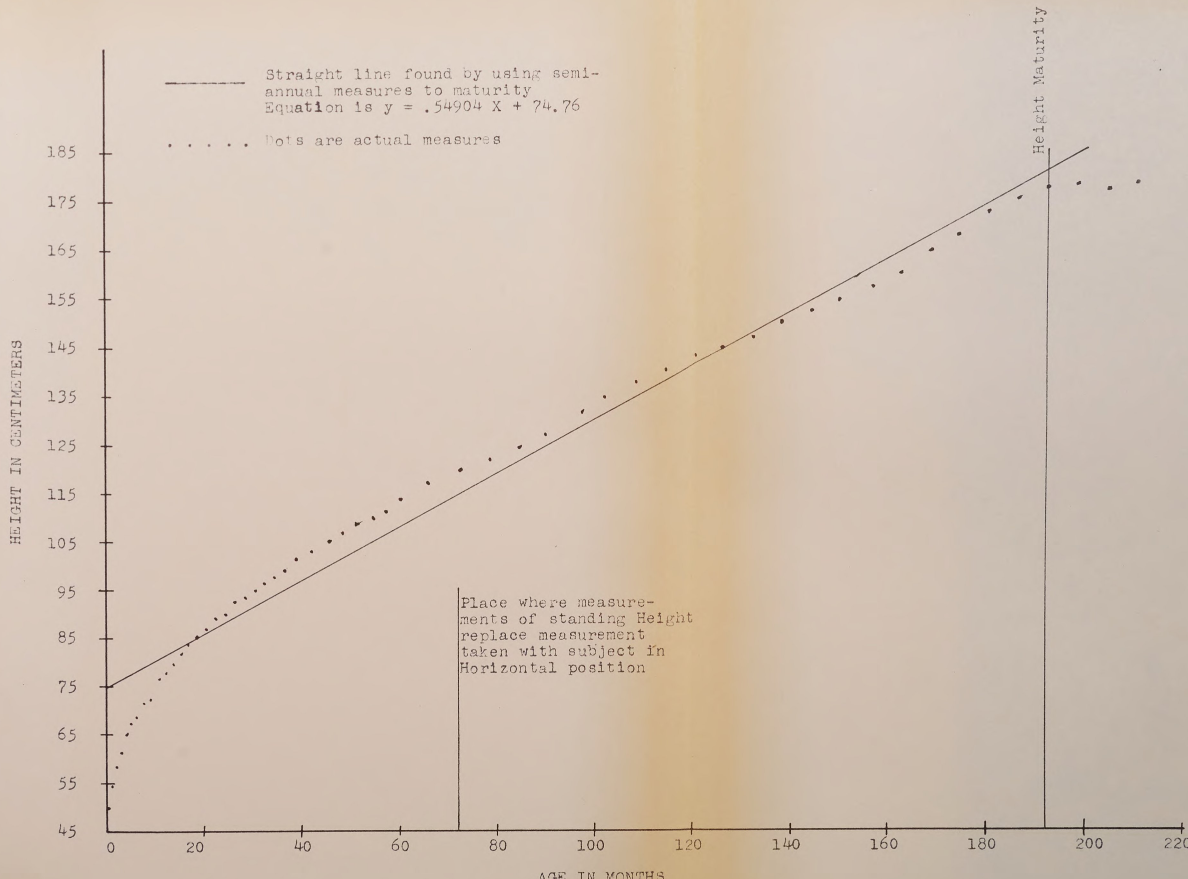


Figure 77. Case 177M. Height Measures and the Straight Line of Best Fit.

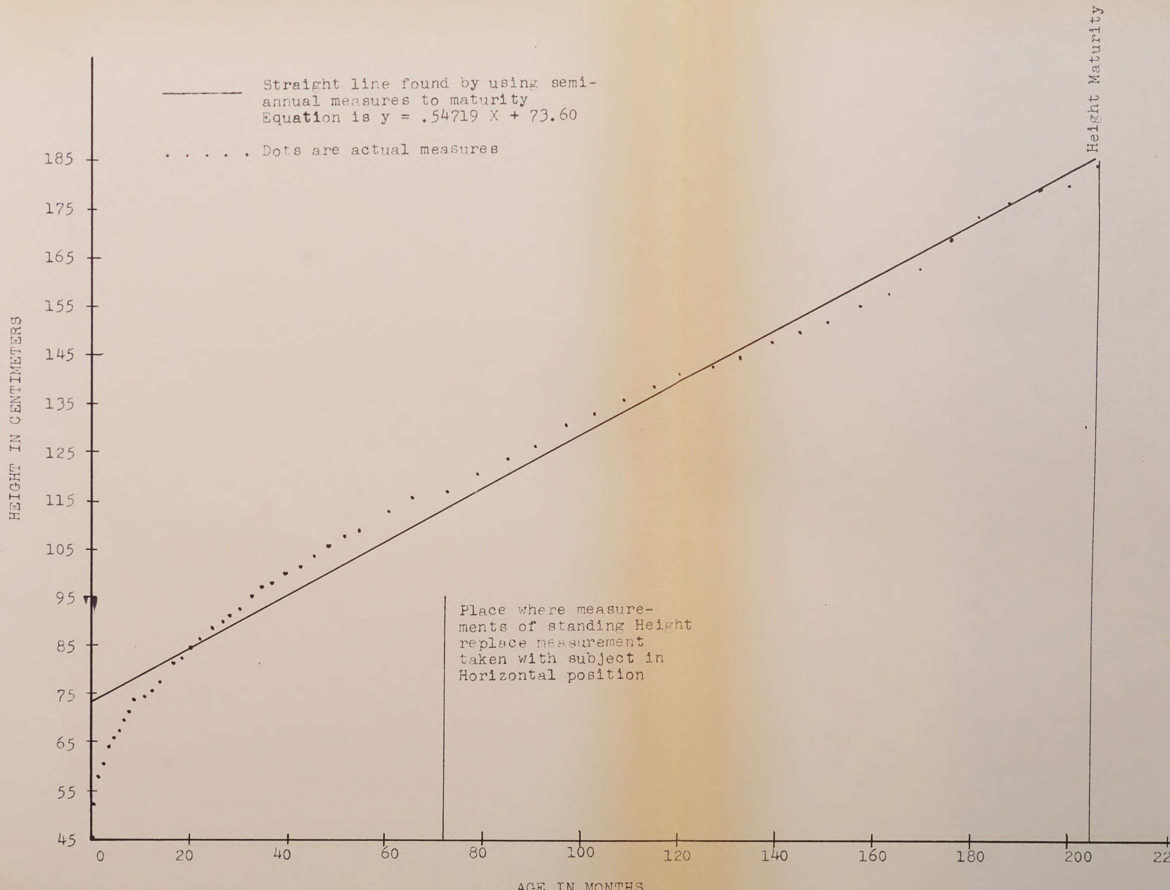


Figure 78. Case 180M°. Height Measures and the Straight Line of Best Fit.

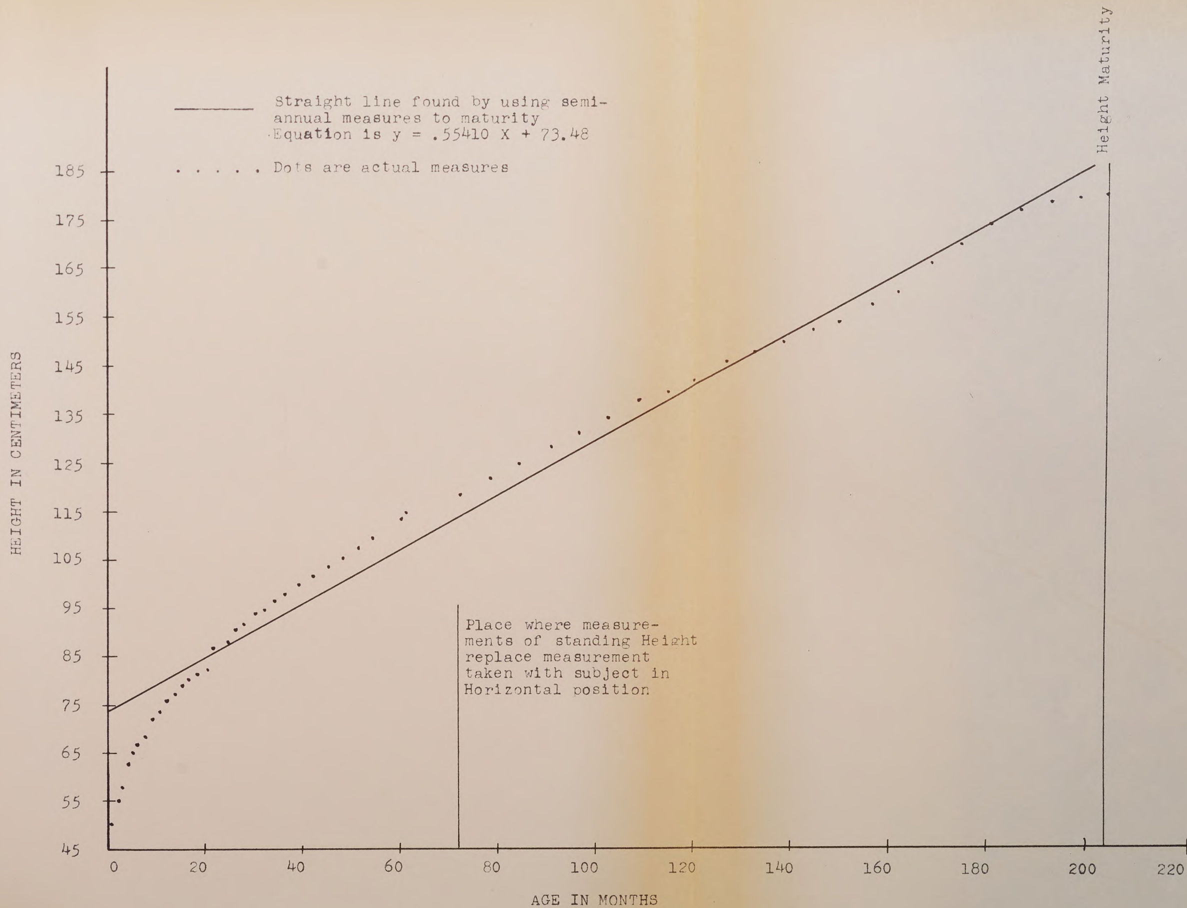


Figure 79. Case 183M.*o Height Measures and the Straight Line of Best Fit.

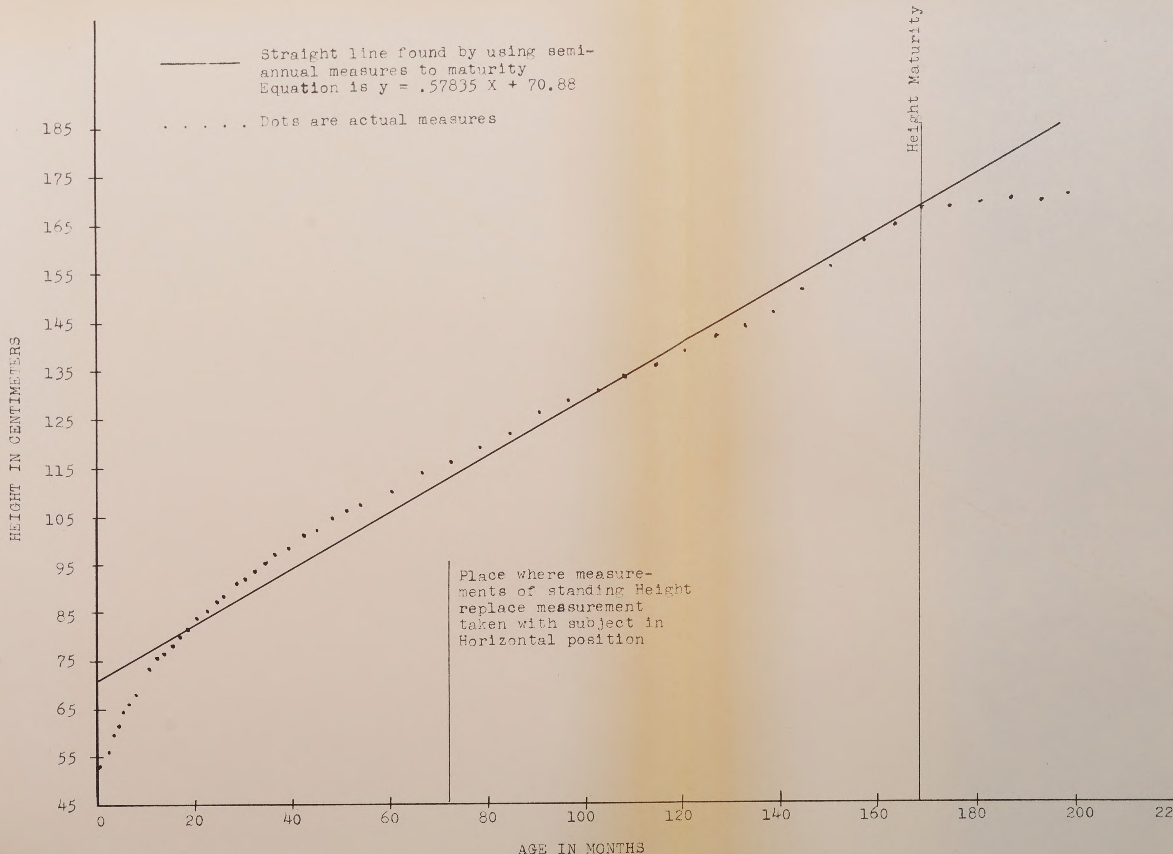


Figure 80. Case 186M. Height Measures and the Straight Line of Best Fit.

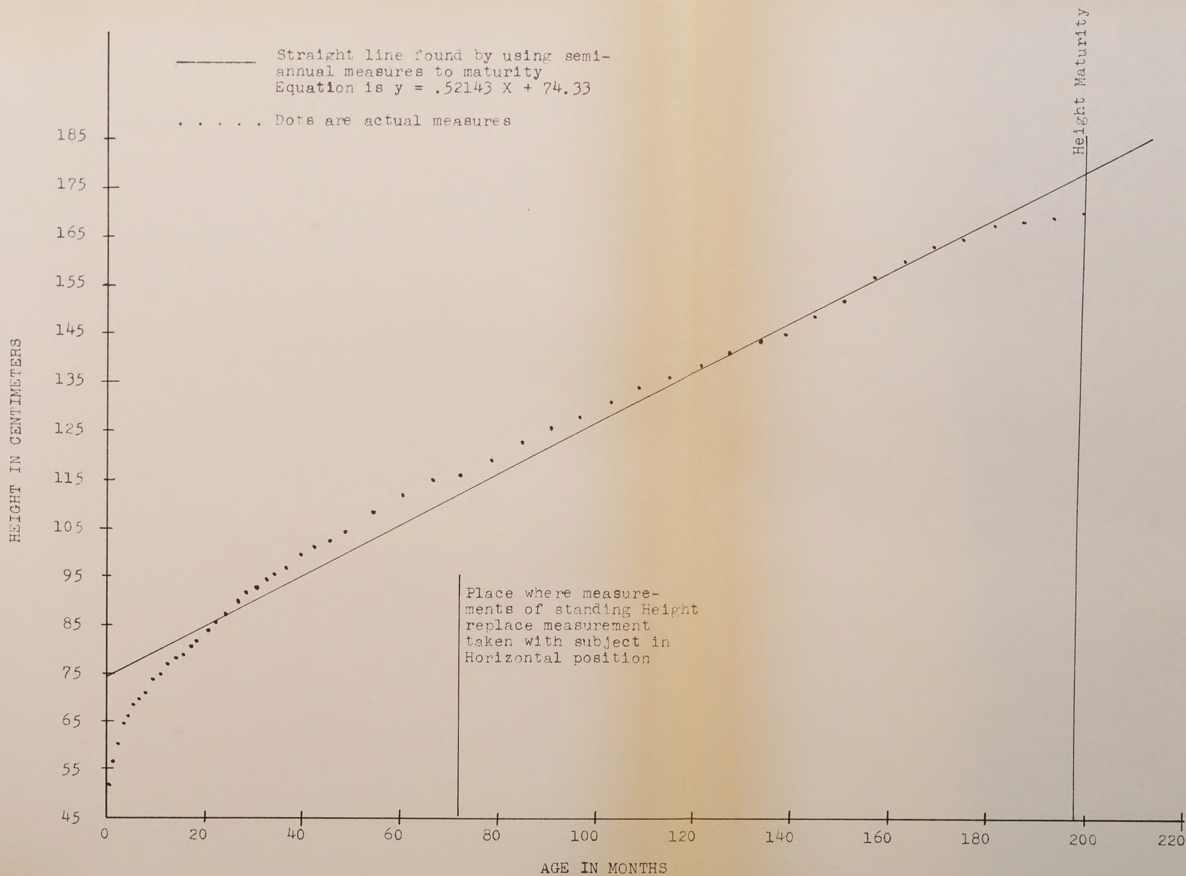


Figure 81. Case 189M°. Height Measures and the Straight Line of Best Fit.

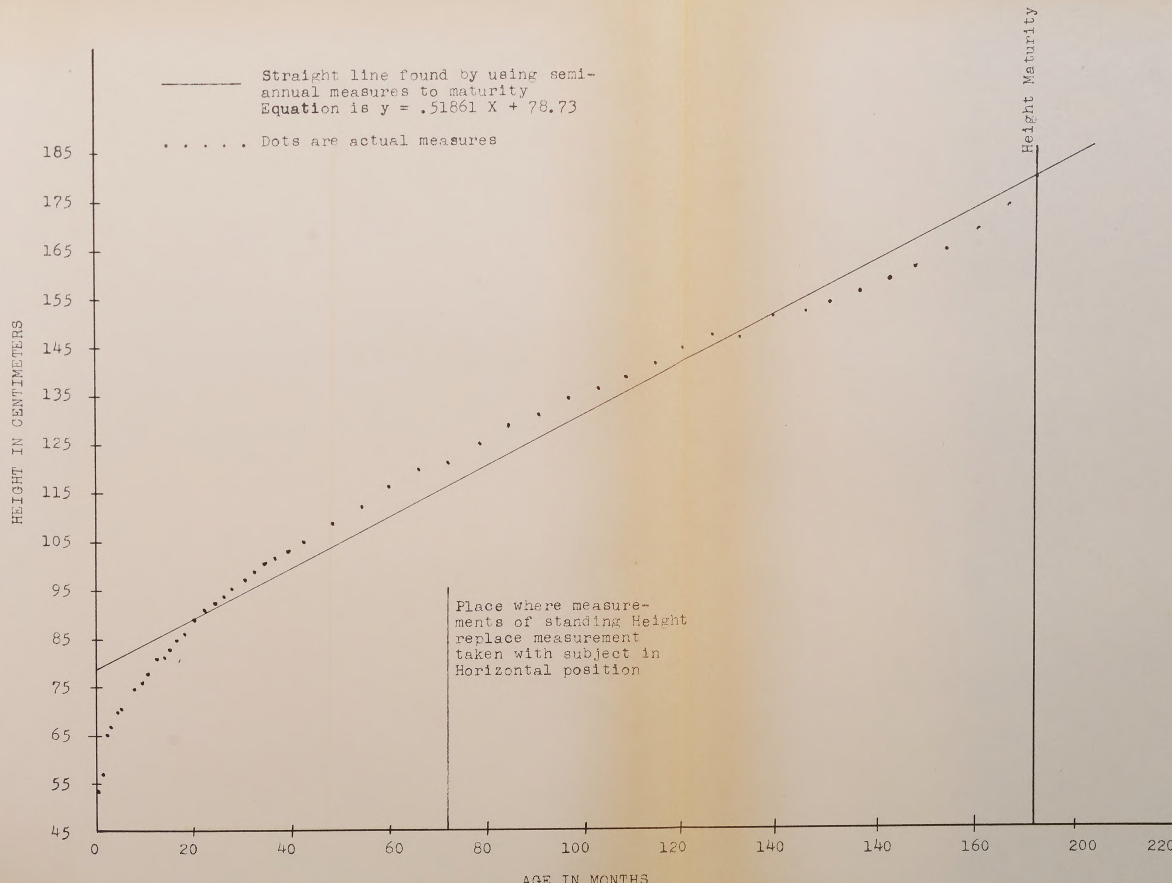


Figure 82. Case 197M°. Height Measures and the Straight Line of Best Fit.

years or 72 months was the time selected to change from one measure to another. Allowance for this change was made in the analysis of the cyclic pattern.

The longer vertical line on Figures 6 through 82, drawn at a later chronological age represents the time of height maturity of that boy or girl.

Figures 6 through 82 are drawn according to the same scale. Thus the figures can be superimposed on one another and apparent similarities and differences in the cyclic patterns can easily be discovered empirically and then substantiated or refuted by the mathematical magnitude and sign of the deviations (Appendices G and H).

The plotted pattern of each individual's height shows that growth is very rapid at birth and gradually decreases. This conclusion from the figures is substantiated by the change in magnitude of the deviations as shown in Appendices G and H.

The true growth pattern in all cases starts below the straight line representation of growth and crosses the line at approximately 18 months. In almost all cases the true growth pattern again falls below the straight line representation of growth. In some cases the true growth pattern again rises above the straight line representation and falls below this straight line (see Figure 6). In other cases the true pattern of growth rises toward the straight line, but does not rise above it (see Figure 10).

Thus in some cases there is a more distinguishable curve or cycle beginning at approximately 138 months than there is in other cases. Figure 53, Case 49M, is a good example of such a pronounced change in rate of growth at about the time when other adolescent changes could be expected to occur. Figure 41, Case 185F, is an example of little change in the height growth rate at about the time when adolescent change could be expected to occur. These cases were chosen as representative of two extremes on a continuum. Most of the cases fall somewhere in between these examples, but all of them have individual distinguishing characteristics that make no two curves exactly alike -- though they are sometimes similar.

The individual straight line equation constants for girls and boys respectively are found in Appendices C and D. The rates for girls range from .47317 to .66595 centimeters a month with the mean rate for the group being .56600. The rates for boys range from .48550 to .66158 centimeters a month with a mean rate of .54164 for the group.

The starting point of the straight line is in every individual case (see Figures 6. through 82) above the birth length of the child. Appendix C shows that the range of incipiencies for girls according to straight line growth is from 63.71 to 77.83 centimeters. Likewise the range of incipiencies of the hypothecated straight line growth for boys shown in Appendix D is from 69.7 to 78.73 centimeters. The group mean for girls is 70.53 centimeters and for boys 73.31 centimeters.

The amount of the deviations of actual growth from straight line growth at six month intervals for every individual case are shown in Appendices E and F. The algebraic sum of these deviations in addition to showing the pattern of growth with respect to straight line growth servesas a check on the accuracy of the straight line equation. The straight line of best fit was determined mathematically by the measurements taken at six month intervals from birth to height maturity. Therefore, by solving the equation for height at the time of the measure and subtracting this value from the measure algebraically, the sum of the differences should theoretically be zero if the equation is accurate. In rounding off the figures for purpose of multiplication in solving the equation, an error of up to .1 of a centimeter could theoretically occur for each measure. Thus if there were 25 measures at six month intervals used in finding the equation and if all of these happened to be rounded in the same direction the algebraic sum would be 2.5 centimeter, (either plus or minus depending upon the direction of rounding) and the equation would still be correct.

The cyclic pattern of height growth (as determined by the deviations of the measures from the straight line) from birth to maturity are shown in Appendices G and H. The straight line of best fit was determined mathematically by the measurements taken at six month intervals. To determine the cyclic pattern of growth the equation found was solved for

all times for which a height measure was recorded. This difference in centimeters between the actual measure and the straight line measure for every case is represented in Appendix G for the girls and in Appendix H for the boys. A plus sign indicates the measure was greater than the straight line and a minus sign means the measure was below the straight line.

In all cases the rate of the straight line was mathematically positive. The line was further from the base at the end of growth in height than at birth (see Figures 3 through 82). This is as would be expected from a straight line of best fit derived from growth data. Thus we have the growth plotted not only with respect to time, but also related to its own straight line of best fit -- a line that is slanted when compared to either the time or size axis.

In order to now determine objectively and mathematically the number of cycles of height growth it was necessary to have a working definition of a cycle. A cycle was considered to be characterized by increasing upward movement, followed by decreasing upward movement with respect to the straight line of best fit. This type of movement over time could readily be determined by the deviations. A cycle was considered to have ended only after an increased deviation showed that the next cycle began. The end of the cycle was then marked '.

The results of this analysis are summarized in Figures and 84. Twenty out of 46 girls as shown by Figure 83 have

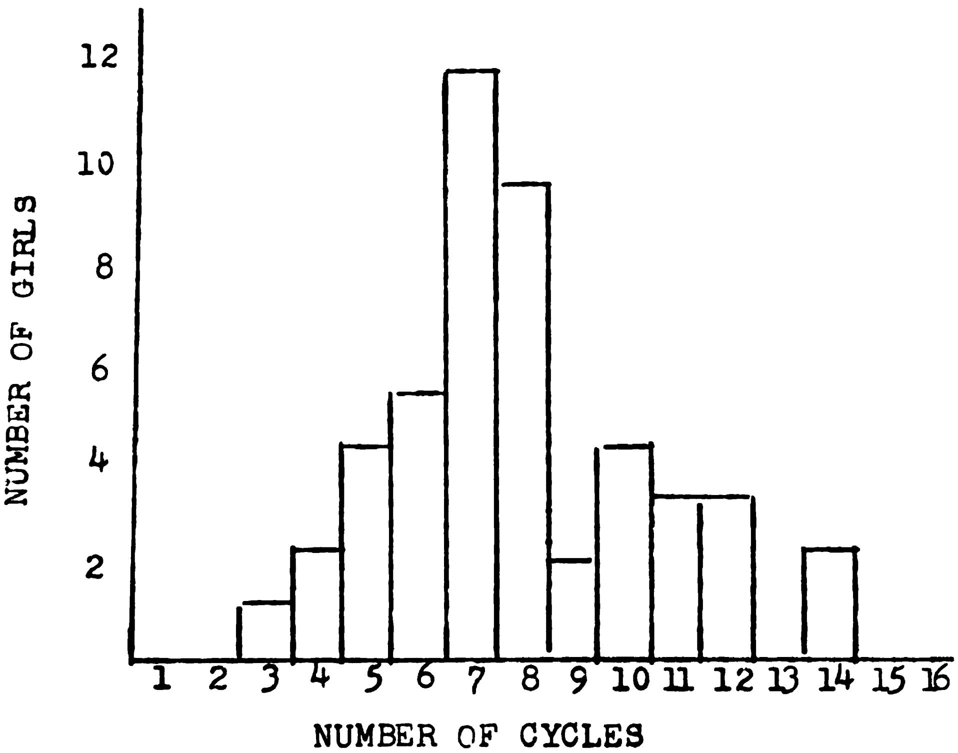


Fig. 83. Cycles of Height Growth, Girls

ther eight or nine cycles of height growth according to this finition of a cycle of height growth. Similarly Figure 84 ows that 13 of the 31 boys have seven or eight cycles of ight growth according to this definition of cycles.

It seems that according to most physical anthropologists he error of height measurement is at least .5 of a centimeter. herefore the individual deviations presented in Appendices G nd H were analyzed again to determine the cyclic pattern of height growth in which differences were considered only if they were greater than .5 of a centimeter. These individual cycles are marked " in Appendices G and H. Figures 85 and 86 summarize the results of this analysis. It can readily be seen that by using this added criteria in the definition of cycles we find that for both boys and girls there are fewer cycles of height growth.

From the age of 72 months to maturity the plotted data represent standing height measures rather than horizontal position measures. Since the horizontal measurement of body length is usually greater than standing height, the analysis of the number of cycles of height measures to this point could have included an extra cycle. Hence the data (Appendices G and H) were further analyzed according to the second definition (see page 131) of cycles. This time if the end of a cycle occurred at the time when standing height measures began, it was omitted from consideration as a cycle. Further, as seen by examination of Figures 6 through 82, there were a few times

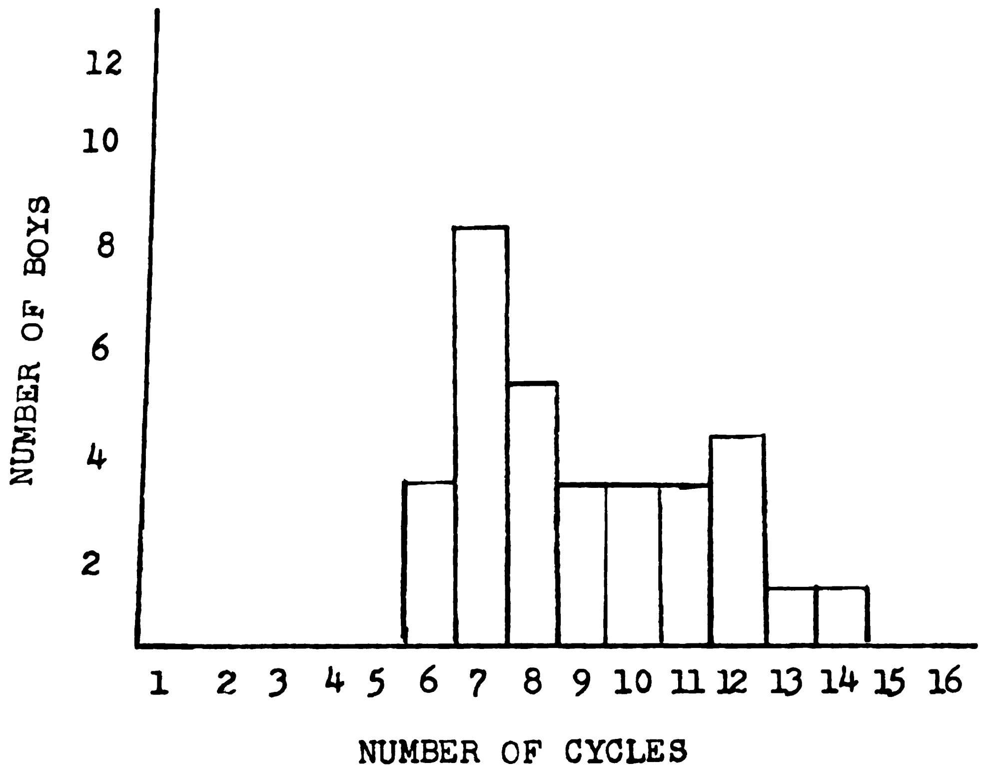


Fig. 84. Cycles of Height Growth, Boys

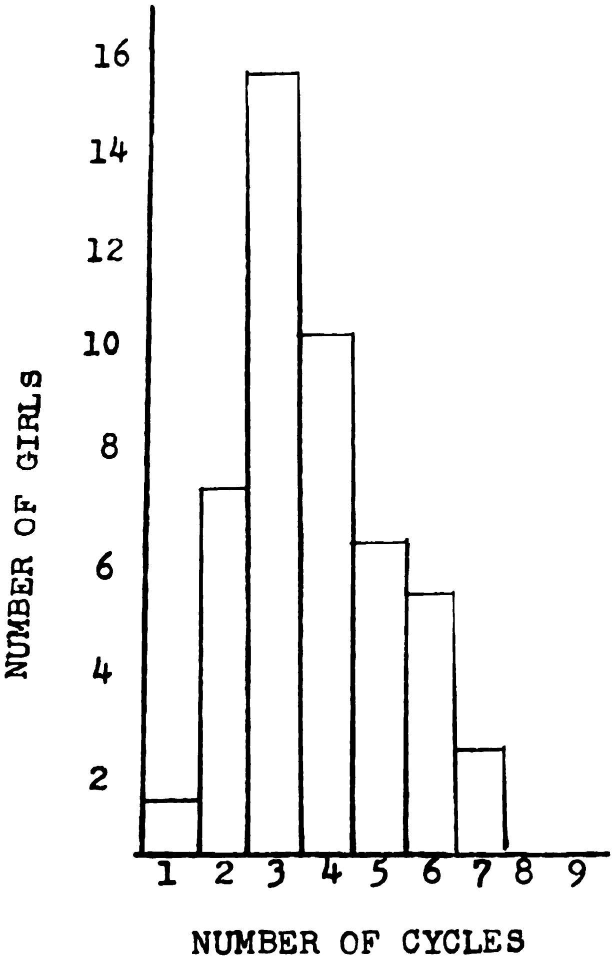


Fig. 85. Cycles of Height Growth, Girls

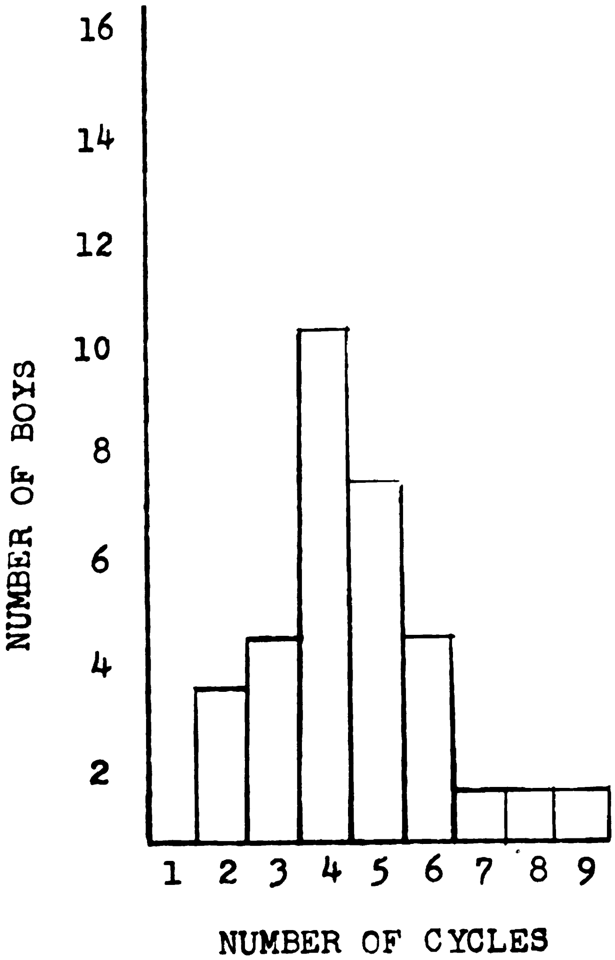


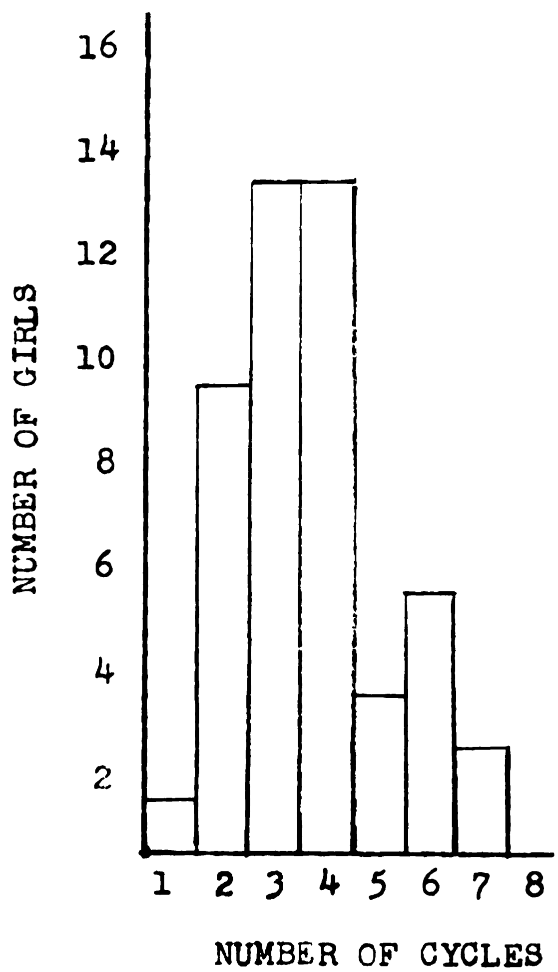
Fig. 86. Cycles of Height Growth, Boys

when a standing height measure was included among the horizontal position measures and there was one case where a horizontal position measure was included among the s tanding height measures. This was done on the Figures 6 through 82, and in the analysis because these were the only measures available at that date and it seemed better to include the measure. These type of measures could also appear to increase the number of cycles of height growth. Hence if one of those measures constituted the end of the cycle according to the second criteria for determining cycles -- it was not considered a cycle.

The number of cycles of height growth according to this third working definition of cycles are shown for each individual in the last column of Appendices G and H. The summary of these findings for girls and boys are found in Figures 87 and 88.

Fifty-six per cent of the girls are found to have either three or four cycles of height growth from birth to aturity. An equal number of these girls were in each of the wo cyclic categories. The next largest number of girls,) per cent, had two cycles of height growth from birth to turity. Thus 76 per cent of the girls experienced either o, three, or four cycles of height growth.

Forty-five per cent of the individual boys (as compared 26 per cent of the girls) measures showed four cycles of wth. The next largest number of boys, 19 per cent, showed e cycles of height growth. Thirteen per cent of the boys

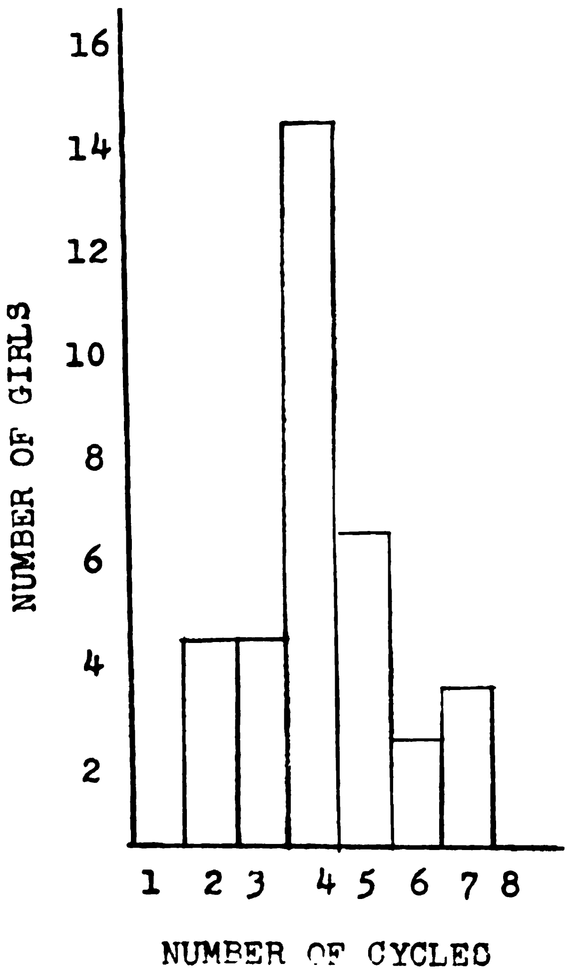


Mean 3.7

Standard Deviation 1.431

Range 1 - 7

Fig. 87. Cycles of Height Growth, Girls



Mean 4.2

Standard Deviation 1.385

Range 2 - 7

Fig. 88. Cycles of Height Growth, Boys

measures indicated three cycles of height growth. Thus 78 per cent of the boys measures showed either three, four, or five cycles of height growth.

The range in the number of cycles for the group of girls is one to seven cycles. The range for boys is similar -- two to seven cycles.

The mean number of cycles for the group of girls was 3.7 with a standard deviation of 1.431.

The mean number of cycles for the group of boys was 4.2 and the standard deviation was 1.385 cycles.

A test of significance showed that the means of the two uncorrelated groups was significant well above the .01 level of confidence.

For purposes of understanding the individual pattern of height growth, it is not only important to know the number of cycles from birth to maturity, but also the time when the cycles begin and end. Table II, which is a summary of the information found in Appendices G and H, shows where the cycles of height growth begin,* according to the second criteria for determining cycles.

From the table, it can be readily ascertained that the age where the greatest number of cycles began for the

---

*This point in time could just as correctly be thought of as the time when a cycle ended, since the mark was placed at the last deviation that exhibited decreasing upward movement rather than at the first deviation to exhibit increasing upward movement.

TABLE II

WHERE CYCLES OF HEIGHT GROWTH BEGIN

Age in Months	Number of Children Having the Beginning of a Cycle at this Time	
	Girls	Boys
0	0	0
1	0	0
2	0	0
3	0	0
4	0	1
5	0	0
6	1	1
7	0	0
8	0	1
9	1	0
10	0	0
11	0	1
12	1	1
13	2	2
14	0	1
15	0	1
16	2	0
17	0	0
18	0	5
19	0	0
20	2	1
21	0	0
22	1	0
23	0	0
24	2	2
26	2	1
28	0	3
30	4	1
32	4	4
34	0	2
36	1	3
39	1	2
42	2	0
45	6	1
48	3	4
51	3	1
54	5	3
57	4	1
60	1	3
63	6	3
66	1	2
69	0	0
72	5	9

TABLE II -- Continued

Age in Months	Number of Children Having the Beginning of a Cycle at this Time	
	Girls	Boys
78	6	4
84	2	4
90	3	3
96	3	1
102	1	3
108	4	0
114	3	4
120	8	1
126	5	0
132	8	3
138	14	2
144	4	4
150	3	5
156	2	2
162	2	8
168	0	5
174	0	0
180	0	0
186	0	1
192	0	0
198	0	0
TOTAL	128	110

girls was 138 months. Fourteen girls or 30 per cent of the group began a cycle at that age. Twenty-six girls or 57 per cent of the group began a cycle between 132 and 144 months.

The age at which the largest number of boys began a cycle of height growth was 72 months. However, this may appear to be a cycle only because 72 months was the age where most of the measures (for purposes of continuous analysis) were changed from crown-heel length to standing height and it is generally accepted that crown-heel measures are greater than standing height measures taken at the same time. At 162 months, the second largest number of boys, eight, or 26 per cent, began a cycle of height growth. Between 156 and 168 months 15 boys or 48 per cent of the group of boys began a height cycle.

Six of the boys experience a new cycle after 162 months, the age at which the last girl experienced a cyclic change. There are 25 changes in cycles among the boys after 138 months, the time when the largest number of girls began a new cycle, whereas there were only 11 changes in cycles for the group of girls after that time. If these last cycles are then labled the adolescent cycles, Table II shows that the adolescent cycle of height growth in many individual cases occurs at a later date for boys than it does for girls.

In an attempt to seek explanations for the variations among individuals in the numbers of cycles of height growth from birth to maturity, the health examination records were used. Four of what might be considered the more serious physical traumata were selected, these are: scarlet fever, whooping cough, appendicitis, and an appendectomy. The dates of these traumata for each individual were then compared to the date at which the cycles of height growth occurred (according to the second definition of a height cycle). If the trauma occurred six months previous to the beginning of a cycle, an x was placed to the left of the number representing the month of occurrence of the cycle (see Appendices I and J). If the

trauma occurred up to six months after the beginning of a cycle, an x was placed to the right of the figure that represented in months the date the cycle occurred. A summary of these findings is shown in Table III.

Seven of the girls and three of the boys had scarlet fever. Of the seven girls, in two instances the scarlet fever followed a cycle by six months or less. In five cases the scarlet fever did not occur within six months of a cycle. In one of the three cases of scarlet fever among the boys the disease followed a height cycle by six months or less. The other two cases of scarlet fever did not occur within six months of the beginning of a cycle.

Twenty-five of the girls and six of the boys had whooping cough. In six instances among the girls and in two instances among the boys this disease preceeded a cycle by six months or less. In three instances among the girls and in one instance among the boys the disease followed a height cycles by six months or less. In 16 cases among the twenty-five girls who had whooping cough and in three cases of the six boys who had whooping cough, the disease did not occur within six months of the beginning of a height cycle.

Two of the girls and none of the boys had appendicitis. one case the appendicitis attack followed a cycle by six nths or less.

Two of the girls and one of the boys underwent an endectomy. In one case, a girl, the appendectomy precceded eight cycle by six months or less.

PHYSICAL TRAUMA AND THEIR AFFECT ON HEIGHT CYCLES

Trauma	Girls			Boys		
	Number of Recorded Cases	Trauma Occurring Within 6 Mo. Previous to a Cycle	Trauma Occurring Up to 6 Mo. After a Cycle	Number of Recorded Cases	Trauma Occurring Within 6 Mo. Previous to a Cycle	Trauma Occurring Up to 6 Mo. After a Cycle
Scarlet Fever	7	0	2	3	0	1
Whooping Cough	25	6	3	6	2	1
Appendicitis	2	0	1	0	0	0
Appendectomy	2	1	0	1	0	0
TOTAL	36	7	6	10	2	2

Of the 36 traumata experienced by girls, seven of them occurred within the six month period previous to a height cycle and six of them occurred within a six month period following a cycle. Twenty-three of them, or 64 per cent, did not occur within six month of the beginning or the ending of a height cycle.

Of the ten traumata experienced by boys, two of them occurred within the six month period previous to a height cycle and two of them occurred within a six month period following a cycle. Six of them, or 60 per cent, did not occur within six months of the beginning or the ending of a height cycle.

In these examples of physical trauma among this group of boys and girls, there were many more instances where a cycle of height growth did not begin within six months of a trauma than there were instances where it did begin within that period of time. Therefore among this group according to this definition of height cycles, it would seem that in the majority of the cases the trauma and its related activities did not cause a cycle of height growth to occur.

Whether in some individual cases, cycles of height growth were caused by these traumata has not been determined by this analysis. Since there are several morphological components of height, a trauma might affect one component and not affect another. Age of occurrence, severity of the trauma, and constitution of the individual are a few of the many possible factors that would need to be investigated to determine the affect of traumata on growth.

CHAPTER V

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

This study was conducted to determine (from the height measures) the cyclic pattern of growth from birth to maturity.

All the cases from the Fels data that met the following criteria were selected for this study.

> 1. There had to be continuous height measurements from birth to maturity taken at semi-annual intervals from within the first three months of life to maturity. Cases were not chosen if more than two years of continuous measurements were missing in the total pattern of height growth from birth to maturity or a total of two and one-half years of measurements.
>
> 2. The epiphyses of the humerus had to be fused as an indication of maturity (long bone growth). The roentgenograms were used for this purpose.

Of the 300 cases, the measures of 46 girls and 31 boys met the above criteria.

The straight line that best fit the data was determined from the height measures that were taken at six month intervals from birth to maturity. All of the actual measures were then compared to this straight line. This was done mathematically by solving the straight line for its magnitude at the time of each measure. The difference between the actual measure and the result of solving the straight line equation was termed a deviation. If the observed measure was greater than the straight line, this deviation was considered positive. If it was smaller than or below the straight line, it was considered negative.

The deviations were then analyzed to determine the number of cycles of height growth. For purposes of analysis a cycle was considered to be characterized by increasing upward movement followed by decreasing upward movement.

Some of the more serious physical traumata were then considered with respect to this pattern of height growth.

Conclusions

A definite cyclic pattern of height growth from birth to maturity was exhibited to some degree in all cases.

The pattern of height growth of most boys and girls showed either three or four cycles. However, the range of cycles for the groups of boys and girls was from one to seven.

The general pattern of height growth for the various individuals showed many similarities, but when the pattern was scrutinized in an individual objective manner many unique characteristics were discovered.

In all cases the cycle occurring immediately after birth was the most pronounced. The rate of growth was most rapid after birth and gradually decreased for the next two or three years.

Almost all cases exhibited a distinguishable curve or cycle at what might be considered the time of adolescence.

During this period of time, however, some cases exhibited a less obvious curvilinear pattern than did other cases.

The individuality of the cyclic patterns of height growth are shown especially during the period between the beginning cycle and the adolescent cycle. During this period of the growth process the rate changed more frequently in some cases than in others and hence the patterns of some boys and girls consisted of a greater number of cycles than did the patterns of others.

Boys as a group exhibited more cycles than did girls as a group and the cycles occurred at a later chronological age. Similarly height maturity was reached at a later chronological age for boys than for girls.

Such physical traumata as scarlet fever, whooping cough, appendicitis, and appendectomy in most cases did not occur within six months previous to, or following the onset of a cycle.

Implications

Seasonal differences in growth rate and the diurnal variations in height could be readily ascertained if this same procedure were used with more frequent measures (when more frequent measures are available).

Individual cases should be analyzed more closely to determine the length of the cycles of height growth.

In those cases where a cycle of height growth does occur near the time of a trauma further analysis should be

made as to the severity of the trauma etc. There might be certain times during the growth process when these traumata may cause a cycle more readily than they would during other times. It is also possible that the occurrance of cycles within six months of a trauma was due to factors not related to the trauma.

Through following a standard criteria for determining cycles (as the third suggested criteria), a greater degree of similarity in the parameters of the Courtis equation should be possible among various writers of height equations.

Since both boys and girls exhibited some variation in the number of growth cycles and since the duration of these cycles and their time of occurrance varies, a further study of the interrelationship of aspects of growth and the cyclic pattern should provide clues to the following questions.

What causes growth cycles?

To what degree is the cause of growth cycles inherent within the individual and to what extent does environment affect the cyclic pattern of growth?

What is the relationship between the number of cycles and the rate of growth within the cycles?

What is the relationship among the cycles of height growth?

Do aspects of growth other than height follow a similar cyclic pattern?

What are the minimum criteria that are needed to match growing individuals for purposes of critical research?

The individual pattern of height growth from birth to maturity has been shown to occur at somewhat different times and in cycles of different magnitude. Therefore, when individuals are to be equated in experiments that purport to use the law of the single variable, such factors as the particular cycle of growth, rate of growth within the cycle and duration of the cycle, among other things, must be considered. That is, absolute magnitude of growth or change can not be used as a criterion of the effect of the experimental variable or the control, unless such factors or variables as rate, magnitude and duration of the growth within the cycle are first taken into account.

APPENDICES

APPENDIX A

HEIGHT DATA--SUMMARIES OF INDIVIDUALS, GIRLS

Case	Total No. of Measures	Age of 1st.Meas.	Age of Last Meas.	Age of Skipped Measurements	Age of Height Maturity	Age Permanent Standing Height Meas. Begin.
25F	48	1.0	216.5		186.0	63.0
28F	54	2.7	281.8	216.3-264.3	156.2	60.1
				264.3-281.8		
37F	49	2.9	288.6	216.2-250.2	162.0	51.0
				250.2-288.6		
59F	54	.9	263.9	217.2-242.4	186.4	48.0
				242.4-263.9		
66F	58	1.0	265.0	217.2-241.5	173.7	48.0
				241.5-265.0		
67F	60	1.2	261.1	215.9-240.6	197.9	39.0
				240.6-261.1		
72F	58	1.0	240.1	216.2-240.1	174.1	39.0
75F	60	1.0	240.3	216 -240.3	185.7	42.1
*76F	54	1.0	240.3	9.2-20.4	168.0	39.0
				192.5-204		
				215.9-240.3		
82F	50	1.0	216.2		174.9	40.3
83F	59	1.0	240.2	216 -240.2	167.9	57.0
*88F	52	1.0	217.8	5.9-15.1		
				206-217.8	174.3	36.6
*94F	39	1.6	185.8	51- 63.5	162.2	36.0
96F	38	3.0	241.4	216.5-241.4	191.6	36.0
97F	38	3.0	241.5	216.5-241.5	173.9	36.0
*°111F	44	1.1	178.7	101.8-112.8	178.7	28.0
				112.8-123.3		
				137.3-159.2		
				159.2-178.7		

*Indicates cases where one but not more than three measures are lacking at the time of the sixth month interval of measurement.

°Indicates cases in which the height maturity could not be determined by the method used in the study and hence a similar but alte nate method was used.

APPENDIX A --Continued

Case	Total No. of Measures	Age of 1st. Meas.	Age of Last Meas.	Age of Skipped Measurements	Age of Height Maturity	Age Permanent Height Meas.	Standing Begin.
111F	59	1.1	241.7	217.1-241.7	174.0	28.0	
120F	60	.2	239.8	216 -239.8	173.8	36.0	
126F	60	.1	217.4		179.7	26.0	
127F	59	1.3	239.9	216 -239.9	150.3	30.0	
137F	61	0	239.7	215.7-239.7	197.8	36.0	
140F	59	0	214.3		180.3	36.0	
142F	58	.1	210.2		168.3	36.0	
144F	60	0	215.5		191.9	44.9	
*145F	57	0	234.6	42-54 204.2-234	186.4	36.0	
*146F	52	0	217.3	69-89.8 119.7-132.3 132.3-143.1 143.1-156.4	162.0	36.1	
148F	60	0	216.1		180.1	36.0	
150F	58	0	216.0		175.3	36.0	
151F	59	0	216.0		174.0	36.0	
165F	58	0	215.4		161.9	35.9	
170F	56	0	210.8		174.2	35.9	
*171F	57	.1	216.1	156-168.3	168.3	35.9	
176F	56	0	210.4		168.4	36.0	
179F	54	0	204		174.0	41.8	
182F	50	0	204.3	179.9-198.7	162.1	36.1	
*185R	53	0	203.9	48-60	185.8	36.0	
188F	53	0	197.8		174.4	36.0	
191F	52	0	192		179.4	35.9	
193F	53	.1	197.9		186.0	36.0	
204F	48	0	186.1		156.2	35.8	
205F	48	0	186.2		161.8	34.1	
211F	45	0	180.1		162.0	36.0	
214F	46	0	179.9		149.8	78.0	
°217F	44	0	179.6		179.6	54.5	
220F	45	0	179.9		168.5	54.0	
221F	45	0	180.1		168.1	54.3	

APPENDIX B

HEIGHT DATA--SUMMARIES OF INDIVIDUALS, BOYS

Case	Total No. of Measures	Age of 1st.Meas.	Age of Last Meas.	Age of Skipped Measurements	Age of Height Maturity	Age Permanent Standing Height Meas. Begin.
74M	58	1.0	240.2	216-240.2	203.7	34.0
*10M	48	.8	288.1	.8-12 149.9-169.5 216-253.7 253.7-288.1	197.6	69.0
49M	50	2.5	268.6	216-238.3 238.3-268.6	186.0	54.4
*54M	48	1.0	215.8	72-84.5 161.2-180.3	192.0	43.8
o55M	56	1.0	263.0	216.3-263	216.3	48.0
*o71M	59	1.1	270.5	180-191.8 240.2-270.5 216.2-240.2	191.8	45.0
77M	60	.9	264.3	216.1-239.8 239.8-264.3	210.4	34.4
78M	60	1.0	249.0	216.1-249	185.9	42.2
81M	60	1.0	216.3		203.7	34.7
*84M	55	1.0	240.4	62 - 7-78 216-240.4	191.7	40.0
92M	59	1.0	241.0	215.2-241	173.9	32.0
*98M	56	.4	241.5	186-197.4 216-241.5	197.4	32.1
*o102M	56	1.0	242.5	197.8-217 217-242.5	197.8	36.0
112M	61	0	239.6	215.8-239.6	204.0	28.0
o114M	59	.4	239.9	216-239.9	216.0	30.0
o135M	60	0	215.0		215.0	36.0
138M	60	0	216.2		186.0	36.0
*141M	55	.1	216.1	120.2-149.9	204.0	36.0

* Indicates cases where one but not more than three measures are lacking at the time of the sixth month interval of measurement.

o Indicates cases in which the height maturity could not be determined by the method used in the study and hence a similar but alternate method was used.

APPENDIX B -- Continued

Case	Total No. of Measures	Age of 1st.Meas.	Age of Last Meas.	Age of Skipped Measurements	Age of Height Maturity	Age Permanent Standing Height Meas. Begin.
°153M	60	0	215.9		215.9	35.5
154M	60	.1	215.9		204.1	36.1
156M	60	0	216.0		203.9	39.0
°157M	57	0	215.8		215.8	38.9
°160M	60	0	216.0		216.0	39.3
°167M	57	0	217.4		198.1	36.0
°174M	56	0	210.3		210.3	41.7
177M	57	0	210.3		192.2	38.7
°180M	55	0	221.8	204-221.8	204.0	36.0
*°183M	55	.3	204.0	61.2-71.9	204.0	36.0
186M	52	0	197.7		168.2	36.0
°189M	53	.1	198.0		198.0	36.0
°197M	50	0	192.0		192.0	36.1

APPENDIX C

STRAIGHT LINE EQUATION CONSTANTS, GIRLS

Case	Rate	Incipiency
25F	.50150	70.76
28F	.64567	70.40
37F	.59364	68.24
59F	.53833	67.90
66F	.49195	72.41
67F	.49079	74.99
72F	.56014	71.70
75F	.49858	70.49
*76F	.60050	72.36
82F	.58342	67.15
83F	.55660	69.84
*88F	.58372	73.72
*94F	.57151	69.59
96F	.51357	69.05
97F	.52768	66.46
*°111F	.57231	71.34
117F	.56568	72.67
120F	.58760	72.14
126F	.57566	70.29
127F	.59930	62.74
137F	.47317	68.75
140F	.59681	77.83
142F	.57085	68.93
144F	.50027	69.95
*145F	.53661	72.62
*146F	.60522	68.82
148F	.53180	74.19
150F	.54356	69.23
151F	.57887	68.92
165F	.59293	71.25
170F	.53303	71.52
*171F	.60526	71.28
176F	.60847	73.39
179F	.55578	70.77
182F	.59317	68.15
*185F	.55377	68.99
188F	.57948	74.78
191F	.56630	71.11
193F	.55290	73.12
204F	.66595	71.20
205F	.64195	72.76
211F	.56663	68.88
214F	.53189	63.71
°217F	.57885	68.73
220F	.63223	72.78
221F	.58212	68.52
MEAN	.56600	70.53
RANGE	.47317-66595	62.74-77.83

APPENDIX D

STRAIGHT LINE EQUATION CONSTANTS, BOYS

Case	Rate	Incipiency
*10M	.55590	75.78
49M	.55224	75.60
*54M	.56160	71.77
°55M	.55139	71.90
*°71M	.56120	76.40
74M	.50627	74.05
77M	.50907	69.59
78M	.61704	70.30
81M	.53959	77.84
*84M	.53767	70.07
92M	.66158	73.25
*98M	.56974	71.51
*°102M	.51351	69.07
112M	.49498	69.90
°114M	.48550	72.02
°135M	.52052	77.15
138M	.59050	74.79
*141M	.57119	71.45
°153M	.49523	77.67
154M	.53480	70.37
156M	.53328	72.69
°157M	.50166	70.92
°160M	.54270	72.22
°167M	.51646	73.02
°174M	.49865	77.59
177M	.54904	74.76
°180M	.54719	73.60
*°183M	.55410	73.48
186M	.57835	70.88
°189M	.52143	74.33
°197M	.51861	78.73
MEAN	.54164	73.31
RANGE	.48550-.66158	69.07 - 78.73

APPENDIX E

DEVIATIONS OF ACTUAL GROWTH FROM THE STRAIGHT LINE AT 6 MONTH INTERVALS
GIRLS

Case	25F	28F	37F	59F	66F	67F	72F	75F
Time								
0	-14.8	-18.1	-11.3	-16.9	-16.8	-21.3	-16.8	-15.3
6	- 8.2	- 6.2	- 8.2	- 5.3	- 9.2	-11.3	- 9.2	- 7.7
12	- 2.7	- 2.9	- 2.4	- 2.4	- 3.3	- 6.4	- 5.0	- 3.4
18	- .6	0	+ 1.6	0	+ 1.3	- 1.1	- 2.4	- .1
24	+ 2.3	+ .4	+ 1.9	+ 2.4	+ 1.2	+ 2.0	+ .9	+ 1.6
30	+ 3.3	+ 4.0	+ 2.1	+ 2.1	+ 1.8	+ 2.1	+ 2.3	+ 3.0
36	+ 3.1	+ 5.6	+ 3.6	+ 2.7	+ 3.8	+ 3.6	+ 4.2	+ 2.8
42	+ 3.1	+ 5.6	+ 2.8	+ 2.4	+ 2.9	+ 4.0	+ 4.2	+ 3.6
48	+ 3.1	+ 5.3	+ 3.6	+ 2.4	+ 4.0	+ 5.4	+ 4.8	+ 3.7
54	+ 3.5	+ 5.4	+ 2.7	+ 2.5	+ 3.6	+ 4.6	+ 5.3	+ 4.1
60	+ 2.8	+ 3.9	+ 2.7	+ 3.4	+ 3.8	+ 5.0	+ 4.5	+ 3.4
66	+ 3.5	+ 3.5	+ 2.3	+ 3.5	+ 3.7	+ 4.4	+ 4.9	+ 4.1
72	+ 1.3	+ 2.4	+ .6	+ 3.0	+ 4.1	+ 4.0	+ 3.6	+ 2.4
78	+ 2.1	+ 1.7	+ .7	+ 2.4	+ 3.4	+ 3.1	+ 2.8	+ 2.9
84	+ 2.4	+ 1.9	+ .3	+ 3.0	+ 3.3	+ 4.4	+ 4.8	+ 2.1
90	+ 1.9	+ 1.4	+ .6	+ 2.8	+ 3.8	+ 4.8	+ 3.4	+ 2.9
96	+ 2.0	+ .6	- .2	+ 1.8	+ 3.3	+ 4.5	+ 3.3	+ 2.8
102	+ 2.3	- .3	+ .1	+ 1.5	+ 2.9	+ 2.9	+ 1.7	+ 2.0
108	+ 1.9	- 1.0	+ .6	+ 1.8	+ 2.0	+ 2.3	+ 1.9	+ 1.0
114	+ .7	- 1.4	+ 1.2	+ 1.8	+ 1.3	+ 1.9	+ .5	- .4
120	+ .4	- .9	+ 2.7	+ .1	+ .8	+ 1.9	+ .9	- 1.0
126	+ .5	+ 1.3	+ 4.0	+ .8	- .1	+ 1.8	+ .1	- 2.0
132	- .5	+ .2	+ 2.8	- .4	- 1.0	+ .5	- .3	- 2.4
138	- 1.0	+ .4	+ 1.8	- .3	- 2.8	- .1	+ .2	- 1.1
144	- .4	- 1.5	- .6	- 1.2	- 2.2	0	+ .3	- 1.1
150	+ .3	- 3.7	- 2.5	- 1.7	- 2.9	- .8	- .4	+ .5
156	+ .4	- 7.8	- 5.8	- 2.2	- 2.2	- .8	- 1.3	+ 1.0
162	+ .7	-10.4	- 8.3	+ .4	- 3.3	- .7	- 3.9	+ .9
168	- .6	-14.7	-10.9	- .2	- 2.9	+ .4	- 6.0	+ .4
174	- 2.1	-17.7	-15.1	- 1.2	- 4.1	- 1.3	- 8.4	- 1.7
180	- 4.4	-22.0	-19.1	- 3.3	- 5.6	- 1.4	-11.4	- 3.8
186	- 6.4	-24.6	-22.3	- 5.2	- 9.2	- 4.3	-15.1	- 5.5
192	- 9.0	-28.4	-26.1	- 8.4	-11.5	- 6.2	-17.7	- 8.8
198	-11.9	-31.7	-28.9	-11.1	-13.5	- 8.1	-21.4	-12.0
204	-14.0	-36.1	-32.3	-14.0	-16.6	-10.3	-24.2	-14.1
210	-18.0	-39.7	-35.6	-17.4	-19.1	-14.4	-27.6	-17.3
216	-20.3	-43.6	-39.6	-21.8	-22.6	-15.4	-30.9	-20.2
Algebraic Sum	- .1	- .2	- .6	+ .5	+ .2	- .2	+ .9	- .3

APPENDIX E -- Continued

Case	*76F	82F	83F	*88F	*94F	96F	97F	o*111F
Time								
0	-19.0	-18.2	-17.0	-22.2	-12.1	-15.3	-14.9	-16.7
6	-10.0	-11.3	- 9.5	- 8.0	- 3.8	- 9.4	-10.0	- 7.8
12	- 6.7	- 5.2	- 5.3	- 3.1	- 2.5	- 5.2	- 4.7	- 2.8
18	+ 1.0	+ 1.4	- 3.0	- .9	- 1.3	- 1.5	- .3	+ .6
24	+ 3.2	+ 2.2	+ 1.3	+ 2.4	- .9	- .2	+ 1.2	+ 1.7
30	+ 4.1	+ 2.3	+ 2.2	+ 3.1	+ 1.7	+ 1.5	+ 1.5	+ 2.7
36	+ 4.3	+ 3.5	+ 2.9	+ 4.2	+ 2.5	+ 3.5	+ 4.0	+ 2.9
42	+ 5.8	+ 4.5	+ 5.1	+ 4.4	+ 3.5	+ 4.5	+ 4.8	+ 3.1
48	+ 5.4	+ 4.3	+ 5.3	+ 4.5	+ 4.1	+ 5.3	+ 5.1	+ 3.0
54	+ 5.4	+ 5.6	+ 5.1	+ 3.8	+ 3.3	+ 3.0	+ 4.3	+ 3.1
60	+ 5.1	+ 5.4	+ 5.8	+ 3.7	+ 2.6	+ 4.1	+ 5.1	+ 3.0
66	+ 5.4	+ 5.9	+ 6.3	+ 4.4	+ 3.0	+ 4.9	+ 5.2	+ 3.8
72	+ 4.1	+ 3.7	+ 5.1	+ 4.1	+ 2.6	+ 4.1	+ 4.5	+ 2.6
78	+ 4.2	+ 3.4	+ 5.1	+ 4.1	+ 3.3	+ 4.1	+ 4.0	+ 2.6
84	+ 2.8	+ 2.8	+ 4.2	+ 4.2	+ 2.9	+ 4.0	+ 3.7	+ 2.5
90	+ 2.9	+ 2.4	+ 3.3	+ 4.2	+ 3.0	+ 3.2	+ 2.7	+ 1.9
96	+ 1.7	+ .4	+ 2.7	+ 2.9	+ 1.8	+ 2.9	+ 2.8	+ 2.6
102	+ .7	+ 2.1	+ 1.8	+ 2.2	+ 2.0	+ 2.0	+ 1.7	+ .7
108	- .1	+ .9	+ .1	+ 1.8	+ 1.0	+ 1.9	+ 1.0	
114	- .8	+ .9	- .3	+ .3	- .3	0	- .5	+ 1.3
120	- 1.3	+ .6	- .4	+ .5	- 1.4	- .2	- .7	
126	- 2.1	- .6	- .7	- .6	- 2.1	- 1.7	- 2.4	+ 2.5
132	- 2.7	- .1	- 1.6	- .3	- 3.8	- 1.8	- 5.6	+ 3.1
138	- 1.6	+ .8	+ .4	- .1	- 3.3	- .8	- 1.9	+ 1.9
144	- .8	+ .8	+ .1	+ .6	- 1.4	- 1.1	- 2.6	
150	- .4	+ .1	- .7	- .3	- 1.0	+ .3	- 1.4	
156	- 1.4	- .9	- 3.1	- 1.1	- .6	+ 1.4	- 1.1	
162	- 3.4	- 3.5	- 6.4	- 3.5	- 2.9	+ 2.4	- .4	- 4.1
168	- 5.0	- 6.2	- 8.5	- 6.0	- 5.7	+ 1.1	- 1.9	
174	- 9.0	- 8.7	-11.2	- 9.1	- 8.7	- .4	- 3.3	
180	-12.4	-11.8	-14.4	-12.1	-12.1	- 3.5	- 6.6	-14.5
186	-15.8	-14.9	-17.2	-15.6	-15.0	- 5.4	- 8.7	
192	-18.5	-18.4	-20.5	-18.6		- 7.9	-10.9	
198	-19.1	-21.8	-23.5	-23.2		-10.5	-13.9	
204	-25.7	-25.3	-27.5	-26.3		-13.9	-17.0	
210	-30.3	-28.2	-30.6			-16.6	-19.5	
216	-33.6	-32.5	-33.8	-32.9		-19.8	-22.8	
Algerbraic Sum	+ .8	- .7	+ .3	+ .2	- .1	- .2	- .1	- .3

APPENDIX E -- Continued

Case	117F	120F	126F	127F	137F	140F	142F	144F
Time								
0	-20.0	-19.1	-19.6	-16.5	-22.5	-24.2	-19.6	-21.5
6	-10.7	-10.0	- 5.5	- 6.3	- 9.3	-11.0	- 7.0	- 7.1
12	- 5.4	- 7.1	- 1.6	- 1.2	- 4.0	- 6.0	- 3.8	- 4.4
18	- 1.5	- 3.5	+ 3.2	+ 1.0	- .6	- 1.2	+ .8	- .2
24	+ 1.7	+ 1.3	+ 3.9	+ 3.2	+ 2.5	0	+ 3.3	+ 1.2
30	+ 2.4	+ 1.8	+ 4.3	+ 4.3	+ 3.2	+ 2.3	+ 3.0	+ 2.5
36	+ 3.5	+ 3.6	+ 4.2	+ 4.2	+ 3.9	+ 3.9	+ 3.7	+ 2.9
42	+ 4.5	+ 4.9	+ 3.2	+ 4.6	+ 4.1	+ 4.7	+ 4.6	+ 4.2
48	+ 5.5	+ 5.7	+ 3.8	+ 4.1	+ 4.0	+ 5.1	+ 5.1	+ 4.2
54	+ 5.7	+ 6.2	+ 3.0	+ 4.3	+ 5.0	+ 5.6	+ 4.9	+ 4.8
60	+ 6.6	+ 5.8	+ 3.4	+ 4.1	+ 5.5	+ 6.8	+ 4.6	+ 5.3
66	+ 6.6	+ 6.0	+ 2.7	+ 3.5	+ 5.7	+ 6.7	+ 4.5	+ 5.1
72	+ 4.6	+ 5.8	+ 2.5	+ 2.1	+ 4.3	+ 4.8	+ 2.9	+ 3.4
78	+ 4.6	+ 5.1	+ 2.2	+ .7	+ 4.6	+ 5.1	+ 2.1	+ 3.3
84	+ 3.3	+ 4.7	+ 1.8	+ .8	+ 4.1	+ 5.5	+ 2.9	+ 4.0
90	+ 3.1	+ 4.8	+ 1.5	- .8	+ 2.8	+ 5.1	+ 2.6	+ 3.1
96	+ 2.8	+ 4.1	+ .1	- 1.3	+ 2.8	+ 4.1	+ 1.8	+ 2.0
102	+ 2.8	+ 3.5	+ .3	- 1.5	+ 2.5	+ 3.6	+ .9	+ 2.7
108	+ 2.1	+ 2.6	- 1.4	- 2.5	+ 2.0	+ 3.2	- .4	+ 1.5
114	+ .9	+ 1.5	- 1.1	- 1.0	+ 1.2	+ 2.6	- 1.3	+ 1.7
120	+ .4	0	- 2.4	+ .4	+ .7	+ .7	- .9	+ .6
126	- .6	- .7	- 1.2	+ 2.7	+ .1	0	- 1.4	+ .6
132	- .5	- .9	- 2.2	+ 1.7	- 1.5	+ .8	- 1.2	- .1
138	- 1.6	- 1.5	- 2.1	- .7	- 1.9	- .6	- .8	- .9
144	- .5	- 2.6	- 1.1	- 3.2	- 2.6	+ .6	+ .2	- 1.6
150	- .5	- 3.4	+ 1.1	- 6.7	- 2.8	- .5	- .4	- 2.5
156	- 1.4	- 3.7	+ 2.1	-10.1	- 3.0	- .7	- 1.7	- 1.4
162	- 3.7	- 3.4	+ 2.2	-13.3	- 2.6	- 2.6	- 3.9	- 1.0
168	- 5.9	- 4.9	- .8	-15.9	- 1.0	- 4.7	- 5.8	0
174	- 8.6	- 6.9	- 1.5	-20.5	- .4	- 8.5	- 9.0	- 1.1
180	-11.5	- 9.7	- 4.2	-23.3	- .4	-11.2	-11.9	- 1.6
186	-15.1	-13.2	- 7.2	-26.9	- 1.1	-14.5	-14.7	- 4.2
192	-17.9	-16.4	-10.0	-29.8	- 2.3	-18.5	-17.9	- 6.0
198	-21.9	-19.7	-13.7	-33.5	- 3.3	-21.6	-21.1	- 8.9
204	-24.8	-22.4	-15.6	-36.2	- 5.5	-24.2	-23.9	-11.7
210	-28.4	-25.9	-18.5	-40.2	- 9.3	-27.2	-27.9	-13.4
216	-31.1	-29.6	-23.6	-43.4	-11.2	-30.1		-17.1
Algebraic Sum	+ .2	- .3	+ .8	0	- .3	0	- .3	- .5

APPENDIX E -- Continued

Case	*145F	*146F	148F	150F	151F	165F	170F	*171F
Time								
0	-22.2	-16.8	-23.4	-19.7	-19.2	-23.5	-21.6	-21.4
6	-10.0	- 5.2	- 9.6	- 6.8	- 7.5	- 8.5	- 6.2	- 9.1
12	- 3.5	- 2.1	- 1.8	- 2.2	- 1.4	- 2.9	- .9	- 2.7
18	+ .3	+ 1.4	0	- .6	+ 1.0	+ .4	+ .6	+ 2.3
24	+ 3.1	+ 3.4	+ 2.9	+ 1.5	+ 2.5	+ 2.7	+ 2.1	+ 3.1
30	+ 3.5	+ 3.4	+ 4.0	+ 3.4	+ 3.2	+ 3.7	+ 2.7	+ 4.3
36	+ 5.3	+ 4.6	+ 4.1	+ 5.0	+ 3.8	+ 5.4	+ 4.3	+ 4.5
42	+ 5.0	+ 4.5	+ 5.3	+ 4.9	+ 5.1	+ 4.9	+ 4.5	+ 4.8
48		+ 4.8	+ 5.8	+ 4.9	+ 4.9	+ 5.2	+ 5.0	+ 5.0
54	+ 6.2	+ 4.4	+ 5.4	+ 4.8	+ 4.4	+ 5.0	+ 5.4	+ 5.3
60	+ 5.9	+ 4.3	+ 6.5	+ 4.5	+ 4.4	+ 5.3	+ 4.8	+ 4.8
66	+ 5.9	+ 3.4	+ 5.8	+ 5.0	+ 4.7	+ 6.0	+ 4.9	+ 4.8
72	+ 4.4		+ 3.0	+ 3.1	+ 1.8	+ 4.2	+ 3.3	+ 3.0
78	+ 4.2		+ 3.4	+ 2.6	+ 2.9	+ 2.7	+ 2.0	+ 1.9
84	+ 3.8		+ 3.5	+ 1.9	+ 1.9	+ 3.1	+ 2.3	+ 1.9
90	+ 3.2	+ .4	+ 2.7	+ 1.6	+ 1.2	+ 2.6	+ 1.6	+ 1.5
96	+ 3.0	- .2	+ .9	+ .7	+ .5	+ 2.7	+ 1.4	+ .6
102	+ 2.0	- .3	+ 1.0	+ .5	- .6	+ 1.5	+ .5	+ .3
108	+ .5	- .7	+ .4	- .3	- .9	+ .7	- .7	- 1.1
114	+ .8	- 1.3	+ .7	- 1.0	- 1.2	+ .8	- .4	- 1.4
120	- 1.8	- 1.9	- 1.6	- 1.4	- 2.0	+ .3	- 1.0	- 1.8
126	- .7		- .3	- 2.3	- 1.7	- 1.4	- 1.1	0
132	- .3	- .7	- 1.3	- 1.5	- 1.2	- 2.2	- 1.9	+ 1.1
138	- 1.3		- 2.8	- .5	+ .5	- 2.1	- 2.3	+ 1.4
144	- .7	+ .8	- 2.1	+ .7	+ 1.8	- 3.4	- 1.1	+ .8
150	- 1.6		- 2.8	+ 1.8	+ 2.4	- 3.0	- .7	- 1.4
156	- 1.5	- 2.3	- 2.6	+ .5	+ .6	- 4.1	- .1	- 2.6
162	- 2.5	- 4.2	- 1.0	- 1.3	- 1.1	- 6.4	- .4	
168	- 2.8	- 8.2	- .9	- 3.3	- 3.7	- 9.4	- 2.4	- 9.5
174	- 2.6	-11.1	- 1.8	- 6.3	- 7.2	-13.5	- 4.5	-12.5
180	- 2.6	-14.4	- 3.4	- 9.1	- 9.9	-15.8	- 6.9	-15.9
186	- 3.1	-17.1	- 6.5	-11.9	-13.3	-19.6	-10.5	-18.5
192	- 5.9	-20.6	- 9.0	-14.4	-16.3	-22.4	-12.3	-21.8
198	- 8.9	-24.5	-11.5	-17.6	-18.8	-25.3	-15.6	-25.9
204	-10.9	-28.3	-14.4	-20.2	-22.5	-29.6	-18.5	-29.3
210		-31.5	-17.1	-24.6	-25.8	-32.9	-22.3	-33.3
216		-35.6	-20.8	-26.3	-30.0	-36.5		-36.4
Algebraic Sum	- .1	- .3	0	+ .2	- .1	- .3	+ .1	+ .4

APPENDIX E -- Continued

Case	176F	179F	182F	*185F	188F	191F	193F	204F
Time								
0	-21.8	-19.9	-15.4	-18.4	-22.9	-22.4	-20.9	-20.3
6	-10.1	- 7.1	- 5.7	- 7.2	-12.0	- 8.9	-11.3	- 6.5
12	- 4.6	- 1.2	- 1.2	- 3.2	- 3.2	- 4.6	- 6.1	- 2.5
18	- 1.0	+ 1.6	+ 2.4	- .6	+ .1	- .9	- 1.4	+ .8
24	+ 1.6	+ 3.2	+ 3.3	+ 1.0	+ 3.8	+ 1.4	+ 1.0	+ 3.2
30	+ 3.6	+ 3.2	+ 4.3	+ 3.2	+ 5.1	+ 2.7	+ 1.9	+ 4.2
36	+ 3.8	+ 3.4	+ 4.0	+ 4.1	+ 5.6	+ 4.1	+ 3.7	+ 4.3
42	+ 5.0	+ 3.8	+ 3.7	+ 4.9	+ 7.4	+ 5.0	+ 4.5	+ 4.5
48	+ 4.6	+ 3.8	+ 3.3	+ 4.0	+ 7.1	+ 5.5	+ 4.7	+ 5.1
54	+ 5.4	+ 3.8	+ 3.6		+ 5.3	+ 5.4	+ 5.4	+ 5.4
60	+ 4.8	+ 4.2	+ 3.3	+ 5.6	+ 5.4	+ 5.1	+ 5.6	+ 5.6
66	+ 5.3	+ 3.5	+ 2.5	+ 4.6	+ 5.8	+ 5.0	+ 5.9	+ 5.2
72	+ 2.9	+ 2.6	+ .8	+ 2.8	+ 3.5	+ 4.6	+ 5.2	+ 3.2
78	+ 3.7	+ 2.1	+ 1.4	+ 3.3	+ 3.2	+ 3.6	+ 5.0	+ 2.4
84	+ 3.3	+ 1.9	- .1	+ 2.5	+ 2.9	+ 4.1	+ 5.1	+ 1.4
90	+ 2.8	+ 1.9	+ .2	+ 1.7	+ 1.3	+ 3.8	+ 4.3	+ .3
96	+ 1.6	+ 1.4	- .4	+ 2.6	+ 1.1	+ 3.4	+ 4.0	+ .6
102	+ 1.0	+ 2.3	- .6	+ 1.3	+ .5	+ 2.5	+ 2.7	- .3
108	- .4	+ 1.4	- 1.0	+ 1.1	- .3	+ 2.1	+ 2.9	- .9
114	- .4	+ .4	- 1.2	+ .7	- 1.2	+ .5	+ 1.1	- 1.8
120	+ .4	- .3	- 1.7	+ .9	- 1.8	+ .2	+ 1.6	- 1.3
126	+ 1.8	- 1.3	- 1.6	0	- 1.1	- .7	+ .1	- 1.7
132	+ 2.4	- 1.9	- .7	+ .2	- 1.9	- .9	- .1	- 1.0
138	+ 1.7	- 1.7	+ .3	+ .3	- 1.4	- 1.3	- 1.0	- 1.6
144	+ 1.4	- 1.6	+ .1	+ .1	- 1.0	- .6	- .7	- .6
150	- .5	- .8	+ .1	+ .7	- 1.1	- .5	- .7	- 2.4
156	- 2.9	- .6	- 1.1	+ .7	+ .1	+ .6	0	- 5.2
162	- 6.6	- 1.3	- 3.0	- .5	- 1.5	- 1.4	- 1.0	- 9.9
168	- 8.8	- 2.4	- 5.6	- 1.5	- 3.2	- 3.9	- 2.5	-14.0
174	-12.0	- 4.9	- 9.6	- 2.6	- 5.4	- 5.7	- 4.3	-16.5
180	-15.5	- 7.1	-11.5	- 5.4	- 7.4	- 7.9	- 6.5	-15.8
186	-19.0	-11.0		- 6.7	-11.9	-11.2	- 8.2	-23.2
192	-22.1	-12.6		-10.8	-15.3	-13.9	-11.1	
198	-25.7	-15.1	-22.0	-14.0	-17.9	-13.4	-14.2	
204	-30.3	-19.0	-24.9	-16.6				
210	-32.3							
216								
Algebraic Sum	0	- .5	- .4	+ .2	+ .2	- .1	0	+ .7

APPENDIX E -- Continued

Case	205F	211F	214F	°217F	220F	221F
Time						
0	-21.4	-18.9	-17.6	-20.0	-21.2	-17.3
6	- 9.4	- 7.4	- 6.1	- 7.2	- 8.3	- 7.7
12	- 5.2	- 3.3	- 1.3	- 1.5	- 2.3	- 2.8
18	- 1.3	- .4	+ 1.1	+ 1.3	- .3	- .5
24	+ 2.0	+ 1.8	+ 2.3	+ 2.6	+ 2.0	+ .6
30	+ 3.9	+ 2.7	+ 4.3	+ 4.4	+ 4.4	+ 3.2
36	+ 4.5	+ 4.6	+ 4.2	+ 5.0	+ 4.2	+ 2.9
42	+ 4.9	+ 4.5	+ 4.1	+ 4.3	+ 4.2	+ 3.2
48	+ 5.8	+ 5.3	+ 4.8	+ 3.7	+ 5.1	+ 4.0
54	+ 5.6	+ 4.8	+ 4.9	+ 4.2	+ 5.0	+ 4.6
60	+ 5.6	+ 6.3	+ 4.5	+ 4.1	+ 4.6	+ 4.9
66	+ 5.4	+ 5.8	+ 3.7	+ 4.1	+ 4.5	+ 5.3
72	+ 5.1	+ 4.3	+ 1.4	+ 3.1	+ 2.0	+ 4.0
78	+ 4.7	+ 2.2	+ 1.4	+ 2.3	+ 2.3	+ 3.6
84	+ 4.5	+ 2.5	+ 1.0	+ .3	+ 1.9	+ 3.7
90	+ 4.0	+ .9	- .1	+ 1.0	+ 1.9	+ 3.3
96	+ 3.9	+ 1.9	- .5	+ .7	+ 1.1	+ 2.5
102	+ 2.4	+ .5	- .1	+ .1	+ .1	+ 1.5
108	+ 1.4	- .7	- .1	- .3	- .1	+ 1.2
114	+ .4	- 1.3	+ 3.6	- 1.1	+ .4	+ .5
120	- 1.4	- 1.6	- 2.8	- .5	+ 2.8	- .2
126	- 2.9	- 2.6	- 1.9	- .9	+ 3.1	- 1.5
132	- 3.1	- 1.2	- 1.8	- 2.3	+ 3.2	- 2.2
138	- 2.1	- 1.0	- 2.2	- .9	+ 3.3	- 1.9
144	- 1.9	- .4	- 2.3	+ .9	+ 1.4	- 3.4
150	- 3.8	- 2.2	- 3.9	+ 1.7	- .6	- 2.2
156	- 5.0	- 3.4	- 4.9	+ 1.7	- 5.0	- 1.6
162	- 7.0	- 4.7	- 8.8	+ .1	- 8.2	- 2.9
168	-10.4	- 7.4	-11.4	- 1.1	-10.6	- 4.7
174	-14.1	-11.0	-13.2	- 3.4	-14.1	- 6.7
180	-17.1	-14.0	-16.6	- 6.4	-18.4	-10.8
186	-21.5					
192						
198						
204						
210						
216						
Algebraic Sum	- .4	- 1.0	+ .6	- .1	+ .9	+ .1

APPENDIX F

DEVIATIONS OF ACTUAL GROWTH FROM THE STRAIGHT LINE AT 6 MONTH INTERVALS BOYS

Case	*10M	49M	*54M	°55M	°*71M	74M	77M	78M
Time								
0	-22.2	-19.8	-15.9	-18.4	-21.8	-19.6	-20.6	-16.7
6		-11.6	-8.2	-8.0	-11.1	-11.6	-5.6	-7.7
12	-5.3	-4.8	-3.8	-3.4	-7.1	-5.3	-3.3	-2.6
18	-.1	+.9	-.2	-.8	-2.5	-1.7	-1.4	-.4
24	+2.6	+2.5	+1.3	-3.1	-.8	+.8	-.8	+.7
30	+4.4	+3.9	+2.0	+1.7	-.9	+3.3	+.9	+1.9
36	+2.8	+4.5	+3.9	+2.7	+1.4	+3.4	+1.2	+1.8
42	+3.9	+5.4	+3.1	+2.9	+1.5	+3.7	+1.5	+2.5
48	+3.5	+5.5	+3.6	+3.3	+.2	+4.3	+2.3	+2.0
54	+4.4	+5.7	+4.3	+2.9	+4.3	+4.2	+2.6	+3.1
60	+4.6	+5.7	+4.8	+3.7	+4.6	+4.5	+3.3	+4.2
66	+4.6	+5.5	+4.8	+3.9	+5.0	+5.0	+4.4	+4.3
72	+1.7	+4.1	+4.5	+3.2	+4.5	+4.1	+3.5	+4.1
78	+3.2	+4.0		+2.6	+5.2	+3.8	+4.4	+3.9
84	+3.6	+3.7	+3.3	+2.7	+5.4	+4.9	+3.4	+4.2
90	+2.6	+2.9	+3.4	+3.5	+5.8	+4.0	+3.5	+4.4
96	+2.3	+2.1	+3.5	+3.7	+4.7	+3.3	+2.8	+4.7
102	+.7	+2.1	+3.2	+3.5	+4.9	+3.6	+3.0	+4.1
108	-.5	+.1	+2.1	+3.9	+4.7	+3.0	+3.0	+2.3
114	-1.4	-.4	+1.3	+1.9	+4.1	+2.6	+1.9	+1.9
120	-.7	-1.4	+.8	+2.7	+4.1	+1.7	+1.3	+.2
126	-2.3	-3.3	-1.6	+2.4	+3.2	+1.0	+1.5	-.9
132	-2.3	-3.3	-2.2	+1.6	+2.5	+.2	+.1	-3.0
138	-2.5	-4.2	-1.8	+.5	+.9	-.9	+.6	-2.7
144	-3.7	-4.8	-3.3	-.8	+1.7	-1.7	-.2	-3.5
150	-3.7	-1.0	-4.8	-1.2	+1.6	-2.5	-.2	-2.0
156		-.2	-3.3	-.6	+2.7	-2.3	-.2	-.5
162		+1.1	-2.0	-.1	+4.0	-2.6	-.6	+.5
168	+4.0	+.7		+.7	+4.7	-.5	-1.5	+.2
174	+3.2	-.3		+1.5	+3.1	+.5	-.9	-1.2
180	+2.0	-1.4	+.8	+2.6	+3.1	+.7	-.7	-3.4
186	-.8	-4.3	-1.1	+1.6		+.1	-.1	-6.3
192	-3.0	-7.0	-2.4	+.4	-2.4	-2.4	-.5	-8.9
198	-5.6	-10.7	-5.8	-2.4	-5.8	-5.1	-1.9	-13.4
204	-9.0	-13.1	-8.6	-4.2	-9.6	-7.0	-4.5	-16.6
210	-11.8	-16.8	-11.0	-7.3	-11.5	-10.0	-6.5	-20.3
216	-15.3	-20.2	-13.8	-9.8	-14.4	-12.8	-9.8	-24.2
Algebraic Sum	0	-.4	+.1	0	0	-.5	-.2	+.1

APPENDIX F -- Continued

Case	81M	*84M	92M	*98M	°*102M	112M	°114M	°135M
Time								
0	-27.0	-17.6	-18.8	-18.2	-13.6	-20.3	-18.0	-25.1
6	-14.6	- 9.0	- 5.0	- 7.6	- 7.2	- 8.4	- 8.6	-11.7
12	- 8.6	- 5.6	- 3.9	- 2.7	- 2.8	- 4.4	- 4.2	- 8.3
18	- 3.6	- 1.7	- 2.2	+ 1.2	+ .3	- 1.4	- .4	- 4.1
24	0	+ 1.6	+ 1.0	+ 2.5	+ 1.1	+ .6	+ 1.3	- 2.1
30	+ 1.3	+ 3.0	+ 1.4	+ 3.2	+ 2.9	+ 2.9	+ 2.1	- .1
36	+ 3.0	+ 3.6	+ 4.5	+ 3.3	+ 2.1	+ 4.1	+ 3.0	+ 1.7
42	+ 4.7	+ 5.1	+ 4.7	+ 3.4	+ 3.7	+ 3.7	+ 3.4	+ 3.4
48	+ 5.7	+ 5.0	+ 5.4	+ 3.4	+ 2.8	+ 4.2	+ 3.4	+ 4.6
54	+ 5.9	+ 4.6	+ 5.4	+ 3.4	+ 3.2	+ 4.5	+ 3.8	+ 5.5
60	+ 6.5	+ 4.5	+ 6.0	+ 2.7	+ 3.8	+ 5.2	+ 4.0	+ 5.8
66	+ 7.3	+ 5.0	+ 5.3	+ 3.4	+ 3.3	+ 4.7	+ 3.8	+ 6.6
72	+ 6.7		+ 4.7	+ 2.9	+ 2.9	+ 4.3	+ 3.3	+ 5.6
78	+ 6.8	+ 4.5	+ 4.7	+ 2.7	+ 3.9	+ 3.3	+ 2.6	+ 6.1
84	+ 6.3	+ 3.7	+ 4.2	+ 3.0	+ 3.1	+ 5.1	+ 2.5	+ 6.5
90	+ 6.4	+ 3.1	+ 2.5	+ 2.9	+ 1.9	+ 4.5	+ 3.2	+ 5.6
96	+ 6.9	+ 3.2	+ 1.3	+ 2.4	+ 2.6	+ 2.9	+ 2.5	+ 5.9
102	+ 5.8	+ 3.2	+ 1.5	+ 1.5	+ 2.1	+ 3.0	+ 2.8	+ 4.8
108	+ 4.9	+ 1.7	- .5	+ 1.8	+ .9	+ 2.2	+ 2.3	+ 5.5
114	+ 4.6	+ 1.9	- 1.5	+ 1.4	+ .8	+ .9	+ 1.6	+ 4.7
120	+ 4.4	+ 1.5	- 3.0	+ .7	- .7	+ .4	+ 1.5	+ 4.3
126	+ 2.8	0	- 4.0	+ .5	- 1.2	- .5	+ .9	+ 4.2
132	+ 2.0	- .2	- 3.9	- .9	- 1.5	- 1.6	+ .1	+ 2.4
138	+ .1	- 1.8	- 1.9	- .1	- 1.7	- 2.6	+ .2	+ 2.4
144	- .3	- 1.8	+ .3	- 2.2	- 1.9	- 3.6	- .3	+ 1.9
150	- 1.4	- 2.0	+ .9	- 3.1	- 3.5	- 4.7	- 1.1	- .3
156	- 2.3	- 3.9	+ .7	- 2.6	- 3.2	- 2.6	- 2.0	- 1.0
162	- 4.1	- 2.9	- .7	- 4.5	- 3.5	- 1.5	- 2.6	- 1.4
168	- 3.3	- .6	- 2.4	- 1.4	- 1.4	+ .8	- 2.6	- 1.7
174	- 2.1	- .6	- 6.0	+ .7	- .5	+ 2.5	- .7	- .3
180	- 2.1	- .5	- 9.0	+ .2	+ .2	+ 2.8	+ .7	- .3
186	- 2.8	- 3.1	-13.0	- .2	+ .9	+ .3	+ 1.5	- .6
192	- 4.2	- 3.8	-16.0		+ .8	- 1.5	+ .7	- .9
198	- 7.1	- 6.7	-20.7	- 3.8	- .5	- 4.1	+ .3	- 4.3
204	- 9.2	-10.0	-24.7	- 6.7		- 5.7	- 1.4	- 5.9
210	-12.2	-12.3	-28.7	-10.0		- 8.5	- 3.6	- 8.5
216	-15.8	-15.4	-32.2	-13.2	- 9.3	-11.2	- 5.9	-11.1
Algerbraic Sum	- .6	+ .1	+ .7	- .1	+ .1	- .6	+ .1	- .2

APPENDIX F -- Continued

Case	138M	*141M	°153M	154M	156M	°157M	°160M	°167M
Time								
0	-23.0	-21.2	-27.4	-19.1	-24.3	-22.6	-22.3	-22.9
6	- 8.5	- 9.7	-15.3	- 8.3	-11.6	- 9.2	- 8.3	-10.1
12	- .8	- 4.4	- 6.3	- 5.2	- 3.1	- 3.6	- 2.9	- 4.6
18	+ 1.1	- .7	- 3.4	- 2.7	- 1.3	- .6	+ .3	- 1.2
24	+ 2.6	+ 2.1	- .1	- 1.4	+ 1.4	+ 3.0	+ 1.7	+ 1.1
30	+ 4.0	+ 2.7	+ 2.0	+ .8	+ 2.9	+ 4.0	+ 2.6	+ 3.0
36	+ 3.1	+ 2.6	+ 3.1	+ 2.5	+ 3.4	+ 4.9	+ 3.5	+ 3.6
42	+ 4.5	+ 3.9	+ 4.1	+ 3.8	+ 4.5	+ 5.8	+ 4.1	+ 5.0
48	+ 3.7	+ 3.9	+ 5.3	+ 3.4	+ 4.8	+ 6.2	+ 4.2	+ 5.0
54	+ 4.8	+ 4.3	+ 5.7	+ 5.0	+ 4.8	+ 5.5	+ 4.1	+ 6.3
60	+ 4.2	+ 4.4	+ 6.0	+ 5.3	+ 5.5	+ 5.5	+ 3.5	+ 5.7
66	+ 5.1	+ 5.3	+ 6.7	+ 6.0	+ 6.1	+ 5.0	+ 4.5	+ 5.6
72	+ 3.5	+ 3.6	+ 4.9	+ 4.0	+ 5.0	+ 3.3	+ 3.3	+ 3.9
78	+ 4.1	+ 3.5	+ 5.8	+ 4.9	+ 5.6	+ 4.2	+ 3.6	+ 3.5
84	+ 2.9	+ 3.3	+ 5.7	+ 3.8	+ 4.6	+ 3.8	+ 3.4	+ 3.2
90	+ 2.4	+ 3.3	+ 5.6	+ 3.6	+ 3.5	+ 1.3	+ 3.9	+ 3.5
96	+ 2.1	+ 2.4	+ 4.8	+ 2.9	+ 3.7	+ 1.3	+ 2.0	+ 2.5
102	+ 1.1	+ 1.9	+ 5.0	+ 3.5	+ 3.1	+ 1.3	+ 1.4	+ 2.1
108	+ .8	+ 2.5	+ 4.9	+ 3.5	+ 2.2	- .3	+ 2.1	+ 1.8
114	+ .3	+ 1.4	+ 4.1	+ 2.8	+ 1.2	- .3	+ .4	+ .5
120	- .5	+ 1.7	+ 3.2	+ 2.3	+ .6	+ .1	+ 1.2	+ 1.1
126	- .6		+ 3.3	+ 1.9	- .7	- .1	- .1	- .1
132	- 1.2		+ 2.4	+ 1.7	- .8	- 1.4	- .8	- .8
138	- 1.6		+ 1.8	+ .3	- 1.7	- 2.0	- .9	- 1.5
144	- 2.3		+ 1.1	- .8	- 3.0	- 2.0	- 1.2	- 2.6
150	- 2.2	- 1.7	+ .7	- 2.3	- 2.2	- 3.3	- 1.8	- 2.9
156	- .8	+ .2	- .5	- 1.7	- .3	- 3.7	- 1.4	- 1.2
162	- .3	+ 1.9	- .4	- 2.5	+ 1.2	- 4.0	- 2.2	- .2
168	+ .7	+ 2.7	- 1.2	- .8	+ 1.9	- 2.6	0	+ .8
174	- 1.4	+ 1.5	- 1.4	- .7	+ 1.5	- .9	+ 1.4	+ 2.9
180	- 2.5	+ .3	- 1.0	- .8	+ .6	+ 1.2	+ 1.8	+ 2.9
186	- 5.6	- 1.7	- 1.3	- 1.4	- 1.5	+ 2.7	+ 2.9	+ 1.6
192	- 8.6	- 4.6	- 2.0	- 2.6	- 3.5	+ 3.4	+ 2.0	
198	-12.5	- 6.8	- 3.8	- 4.7	- 6.1	+ .9	- .6	- 2.5
204	-14.9	- 8.8	- 5.4	- 7.0	- 7.9	- .6	- 2.3	- 4.1
210	-18.3	-12.0	- 7.5	-10.1	-11.4	- 2.0	- 5.4	
216	-22.0	-14.9	- 9.6	-12.6	-13.9	- 4.2	- 7.8	-10.8
Algerbraic Sum	- .3	- .2	- .4	0	+ .1	0	- .4	+ .1

APPENDIX F -- Continued

Case	°174M	177M	°180M	°*183M	186M	°189M	°197M
Time							
0	-25.8	-25.3	-19.6	-26.6	-17.8	-22.5	-24.9
6	-12.7	- 9.6	- 7.8	-10.4	- 8.6	- 8.5	-10.8
12	- 7.4	- 3.5	- 4.5	- 4.7	- 2.4	- 3.6	- 4.3
18	- 3.3	+ .3	- 1.2	- 2.8	- .1	- 2.1	- 2.1
24	- .7	+ 1.9	+ 1.7	+ .8	+ 2.1	+ .3	+ .8
30	+ 1.7	+ 3.3	+ 2.7	+ 3.7	+ 3.5	+ 2.3	+ 2.7
36	+ 3.2	+ 4.1	+ 4.1	+ 4.2	+ 5.1	+ 3.4	+ 3.8
42	+ 4.4	+ 4.9	+ 4.6	+ 4.7	+ 5.4	+ 4.7	+ 4.2
48	+ 5.7	+ 5.3	+ 5.5	+ 4.9	+ 5.8	+ 4.5	+ 5.1
54	+ 5.8	+ 4.9	+ 5.2	+ 5.8	+ 5.0	+ 5.4	+ 5.1
60	+ 6.2	+ 5.8	+ 6.3	+ 6.5	+ 4.1	+ 5.4	+ 6.1
66	+ 6.7	+ 5.9	+ 5.4	+ 7.2	+ 4.2	+ 5.5	+ 6.2
72	+ 5.9	+ 4.8	+ 3.4	+ 4.5	+ 3.1	+ 3.7	+ 4.5
78	+ 5.6	+ 3.5	+ 3.5	+ 4.6	+ 2.9	+ 3.4	+ 5.0
84	+ 5.6	+ 2.6	+ 3.3	+ 4.2	+ 1.9	+ 3.9	+ 6.0
90	+ 5.6	+ 2.0	+ 2.6	+ 4.0	+ 2.8	+ 3.6	+ 4.9
96	+ 5.0	+ 3.5	+ 3.9	+ 3.8	+ 1.5	+ 2.9	+ 5.3
102	+ 5.2	+ 3.1	+ 3.1	+ 3.5	+ .6	+ 2.7	+ 4.4
108	+ 5.2	+ 3.0	+ 2.4	+ 3.6	- .1	+ 2.4	+ 3.5
114	+ 4.1	+ 2.3	+ 1.6	+ 2.0	- 1.1	+ 1.5	+ 3.0
120	+ 3.6	+ 1.8	+ 1.1	+ 1.3	- 2.0	+ .8	+ 3.0
126	+ 2.7	+ .4	- .3	+ 2.0	- 2.5	+ .4	+ 2.4
132	+ 2.2	- .7	- 1.0	+ .7	- 3.9	- .1	- .7
138	+ 1.5	- .6	- 1.8	- .6	- 4.4	- 1.7	- .3
144	+ .8	- 1.7	- 2.8	- 1.5	- 3.2	- 1.3	- 2.6
150	- 1.3	- 2.7	- 4.2	- 2.9	- 1.5	- .7	- 3.6
156	- 1.4	- 3.8	- 4.5	- 3.0	+ .2	+ .8	- 4.3
162	- 3.3	- 3.9	- 4.9	- 3.7	- .4	+ .7	- 4.6
168	- 3.3	- 2.9	- 3.5	- 1.3	- .4	+ 1.0	- 5.5
174	- 5.1	- 2.5	- .8	- .7	- 3.5	- .4	- 4.9
180	- 5.1	- 1.4	+ 1.3	+ .4	- 6.4	- 1.2	- 4.6
186	- 5.0	- 1.9	+ 1.0	- .1	- 9.2	- 3.6	- 3.0
192	- 4.1	- 3.3	+ .1	- 2.5	-13.0	- 5.9	+ .4
198	- 3.4	- 5.6	- 2.2	- 4.6	-14.9	- 8.1	
204	- 2.8	-10.1	- 4.0	- 7.2			
210	- 2.7	-12.2					
216							
Algerbraic Sum	- .7	- .4	- .3	- .2	- .2	- .4	+ .2

APPENDIX G

THE CYCLIC PATTERN OF HEIGHT GROWTH AS DETERMINED BY THE DEVIATIONS FROM THE STRAIGHT LINE, GIRLS

Age in Month	0	1	2	3	4	5	6
Case							
25F		-14.8					-8.2
28F			-18.1	-13.3		-9.2	-6.2
37F				-11.3	-8.2		-8.2
59F		-16.9		-12.3		-7.8	-5.3
66F		-16.8	-14.5	-11.7		-9.6	-9.2
67F		-21.3	-19.0	-16.6		-14.3	-11.3
72F		-16.8	-15.1	-12.2		-10.5	-9.2
75F		-15.3	-12.8	-10.9	-10.5	-7.9	-7.7
* 76F		-19.0	-15.5	-14.4	-13.2	-11.9	-10.0
82F		-18.2		-14.0		-11.3	-8.5
83F		-17.0	-16.2	-14.5	-12.4	-11.9	-9.5'
* 88F		-22.2	-16.7		-18.8	-10.3	-8.0
* 94F			-12.1				-3.8"'
96F				-15.3			-9.4
97F				-14.9			-10.0
°*111F		-16.7	-12.5	-12.3	-10.0	-8.9	-7.8
117F		-20.0	-16.7	-14.5	-14.2	-13.5	-10.7
120F	-19.1		-16.1	-13.9	-12.0	-10.4	-10.0
126F	-19.6	-14.9	-12.0	-9.4	-7.2	-5.4	-5.5'
127F		-16.5	-15.5	-13.5	-6.7	-6.3	
137F	-22.5	-18.9	-16.3	-14.2	-12.1	-10.7	-9.3
140F	-24.2	-19.9	-17.6	-16.2	-14.0	-12.4	-11.0
142F	-19.6		-14.9	-11.7	-10.0	-9.3	-7.0
144F	-21.5	-16.2	-14.5	-10.9	-10.1	-8.8	-7.1
*145F	-22.2	-18.2	-17.0	-15.4	-12.4	-10.1	-10.0
*146F	-16.8	-15.4	-11.8	-9.7	-7.3	-6.1	-5.2
148F	-23.4	-20.3	-19.5	-16.1	-13.8	-13.1	-9.6
150F	-19.7	-17.0	-14.5	-13.6	-12.2	-10.4	
151F	-19.2	-16.8	-13.8	-13.0	-9.0	-8.1	-7.5
165F	-23.5	-18.1	-16.0	-14.4	-12.5		-8.5
170F	-21.6	-17.5	-13.6	-12.6	-10.0	-7.9	-6.2
*171F	-21.4	-19.2	-18.4	-14.0	-11.8	-10.2	-9.1
176F	-21.8	-19.0	-17.1	-14.9	-13.0	-11.2	-10.1
179F	-19.9	-16.2	-13.5	-10.6	-8.4	-7.6	-7.1
182F	-15.4			-9.4	-7.5	-7.1	-5.7
*185F	-18.4	-14.7	-13.1	-10.7	-9.3	-7.7	-7.2
188F	-22.9	-18.8	-16.9	-14.6	-13.6	-12.4	-12.0
191F	-22.4	-18.4	-15.6	-14.3	-12.0	-11.1	-8.9
193F	-20.9	-18.7	-16.1	-13.6	-12.2	-11.3	
204F	-20.3	-15.9	-13.2	-10.5	-8.9	-7.1	-6.5
205F	-21.4	-17.3	-13.7		-10.7	-10.7	-9.4
211F	-18.9	-17.1	-13.6	-11.5	-10.3	-8.0	-7.4
214F	-17.6	-14.1	-12.5	-11.1	-8.6	-6.9	-6.1
°217F	-20.0	-16.8	-12.8	-12.0	-8.7	-7.7	-7.2
220F	-21.2	-17.5	-14.8	-12.7	-10.3	-9.5	-8.3
221F	-17.3	-14.4	-12.1	-10.4	-9.9	-8.5	-7.7
TOTAL CYCLES°							1

°According to second criteria for determining cycles.

'Where cycles occur according to first criteria.

"Where cycles occur according to second criteria.

APPENDIX G -- Continued

Age in Month	7	8	9	10	11	12	13
Case							
25F				- 4.8		- 2.7	
28F		- 5.0	- 3.4	- 3.6'		- 2.9	
37F			- 5.1			- 2.4	
59F	- 5.5'		- 3.8	- 2.9		- 2.4	
66F	- 8.0		- 6.3	- 5.0		- 3.3	
67F	-10.2		- 9.5	- 7.6		- 6.4	- 4.4
72F		- 8.0	- 7.0	- 6.4		- 5.0	
75F		- 3.8	- 3.6	- 3.3		- 3.4	
* 76F		- 7.5	- 6.7				
82F		- 6.5	- 5.1			- 5.2	
83F		- 9.7'	- 7.7	- 5.3		- 5.3	- 4.4
* 88F							
* 94F			- 4.5			- 2.5	
96F						- 5.2	
97F						- 4.7	
o*111F		- 5.7	- 5.4	- 4.3		- 2.8	- 2.1
117F	- 9.4		- 8.4	- 6.0			- 5.4
120F	- 7.0		- 8.4"'		- 7.0	- 7.1'	- 5.3
126F	- 3.2		- 3.6'	- 3.0		- 1.6	
127F	- 3.7		- 2.6	- 1.4		- 1.2	- .2
137F	- 6.8		- 5.9	- 4.6		- 4.0	
140F	-10.5		- 8.5	- 7.1		- 6.0	- 3.9
142F		- 5.3	- 5.8'	- 4.5		- 3.8	- 2.0
144F		- 6.9	- 7.0'	- 3.8		- 4.4"'	- 2.1
*145F	- 7.8		- 7.3	- 5.1		- 3.5	- 1.6
*146F	- 3.8		- 3.9	+ .1			- 2.1"'
148F	- 8.1		- 7.1	- 4.2		- 1.8	- 2.7"'
150F	- 6.8		- 6.8		- 4.1	- 2.2	- 2.5'
151F		- 6.6	- 5.8	- 3.6		- 1.4	- 1.0
165F	- 7.1		- 6.2	- 4.3		- 2.9	- 2.1
170F	- 4.6		- 2.9	- 1.9		- .9	- .5
*171F	- 6.2		- 4.8	- 3.3		- 2.7	- 1.5
176F			- 6.8	- 6.6		- 4.6	- 3.7
179F		- 5.5	- 4.3	- 2.2		- 1.2	- .5
182F	-10.3'	- 2.8		- 2.8		- 1.2	
*185F	- 5.5		- 5.7'	- 4.9		- 3.2	- 2.4
188F	- 8.7		- 6.0	- 4.1		- 3.2	- 2.7
191F	- 8.1		- 7.7	- 5.1		- 4.6	- 4.1
193F	- 8.5		- 7.3	- 6.5	- 6.1		
204F		- 4.1	- 3.0	- 2.2'		- 2.5	- .7
205F	- 8.3		- 6.7	- 6.0		- 5.2	
211F	- 6.0		- 5.8	- 4.3		- 3.3	- 1.6
214F	- 3.7		- 2.7	- 2.1		- 1.3	- .9
o217F	- 5.1		- 3.9	- 2.3		- 1.5	- .4
220F	- 6.1		- 5.7	- 3.9		- 2.3	
221F		- 6.0	- 4.3		- 4.0	- 2.8	- 2.2
TOTAL CYCLES			1			1	2

APPENDIX G -- Continued

Age in Month	14	15	16	17	18	19	20
Case							
25F		- .5			- .6'		
28F		- 3.0'				0	
37F		- .5			+ 1.6		
59F	- 2.0	- 1.4	- 2.0"'		0		+ 2.5
66F		- 2.3		+ .2		+ 1.3	
67F		- 3.1		- 1.6	- 1.1		- 2.0"'
72F	- 3.2	- 2.9	- 2.3		- 2.4'		+ .2
75F	- 1.3	+ .5	- .7"'		- .1		+ .6
* 76F							+ 1.0
82F					+ 1.4		
83F			- 4.0		- 3.0		- .3
* 88F		- 3.1	- 1.8			- .9	
* 94F		- 2.4			- 1.3		
96F					- 1.5		
97F					- .3		
o*111F		- .7	+ .3	+ .6			+ 1.1
117F		- 3.3	- 1.8		- 1.5		- 1.0
120F		- 4.5	- 4.1		- 3.5		- 1.7
126F	- .4	0		+ .1	+ 3.2		+ 1.8"'
127F		+ 1.3	+ 1.0		+ 1.6'		+ 3.7
137F	- 3.9	- 3.0		- .8	- .6		+ .7
140F		- 3.3	- 2.3		- 1.2		- 1.0
142F		- 1.2	+ .1		+ .8		+ 1.4
144F		- 2.2'	- 1.0		- .2		+ .3
*145F		- .7		- .3	+ .3		+ .9
*146F		- .8		+ 1.0	+ 1.4		
148F		- 1.0	+ .3		0'		+ 2.1
150F		- 1.7	- .6				+ .3
151F		+ ,k	+ .3		+ 1.0		+ 1.5
165F		- 1.4	+ .3		+ .4		+ 1.6
170F		+ .4	+ .4		+ .6		+ 1.3
*171F		+ .8	+ 1.2		+ 2.3		+ 1.8'
176F		- 3.1	- 2.4		- 1.0		+ .5
179F		+ .7	+ .9		+ 1.6		+ 2.5
182F	- .2		+ 1.2		+ 2.4		+ 3.3
*185F		- 2.1	- .7		- .6		+ .5
188F		- 1.8	- .5		+ .1		+ 1.0
191F		- 1.8	- 1.9'		- .9		0
193F	- 4.7	- 3.9	- 2.8		- 1.4		- .8
204F		- .5	- .4		+ .8		+ .8
205F	- 2.9	- 3.2'	- 1.9		- 1.3		- .4
211F		- 1.9'	- 1.5		- .4		- .1
214F		- .3		0	+ 1.1		+ 1.9
o 217F		+ .1	+ .5		+ 1.3		+ 2.5
220F	- 1.7	- 1.4	- .2			- .3'	+ 1.3
221F		- 2.0	- .6		- .5		+ .1
TOTAL CYCLES			2				2

APPENDIX G -- Continued

Age in Month	21	22	23	24	26	28	30
Case							
25F	+ 1.3			+ 2.3		+ 2.1'	+ 3.3
28F	+ 1.5			+ .4"'	+ 3.7	+ 3.8	+ 4.0
37F	+ 1.4'			+ 1.9	+ 2.9	+ 3.9	+ 2.1"'
59F		+ .8"'		+ 2.4	+ 2.9	+ 2.8	+ 2.1'
66F	+ 1.1'	+ 2.1		+ 1.2"'	+ 1.9	+ 1.8'	
67F		+ .1		+ 2.0	+ 1.8'	+ 2.2	+ 2.1'
72F		+ 1.1			+ .9'	+ 1.3	+ 2.3
75F		+ 1.4		+ 1.6	+ 1.9	+ 3.5	+ 3.0
* 76F		+ 1.9		+ 3.2	+ 3.3	+ 4.1	+ 4.1
82F	+ 1.6			+ 2.2		+ 3.2	+ 2.3"'
83F		+ .9		+ 1.3	+ 1.2'	+ 2.4	+ 2.2'
* 88F	+ .8	+ 1.5		+ 2.4	+ 4.3	+ 4.0	+ 3.1"'
* 94F				- .9		+ 1.2	+ 1.7
96F				- .2			+ 1.5
97F				+ 1.2			+ 1.5
o*111F		+ 1.0'		+ 1.7	+ 2.0	+ 2.5	+ 2.7
117F		+ .4		+ 1.7	+ 2.2	+ 2.4	+ 2.4
120F		- 1.3		+ 1.3	+ .6"'	+ 1.7	+ 1.8
126F		+ 2.6		+ 3.9	+ 3.8'	+ 4.0	+ 4.3
127F		+ 2.8'		+ 3.2	+ 3.1"'	+ 3.9	+ 4.3
137F		+ 2.1		+ 2.5	+ 2.0	+ 2.0'	+ 3.2
140F		+ .3		0'	+ 1.4	+ 1.7	+ 2.3
142F		+ 2.7		+ 3.3	+ 3.0	+ 2.5'	+ 3.0"
144F		+ .5		+ 1.2	+ 1.6	+ 1.5'	+ 2.5
*145F		+ 1.8		+ 3.1	+ 3.2	+ 4.3	+ 3.5'
*146F		+ 2.6		+ 3.4	+ 3.7	+ 4.0	+ 3.4'
148F		+ 2.5		+ 2.9	+ 3.5	+ 4.1	+ 4.0'
150F		+ 1.0		+ 1.5	+ 2.6	+ 2.7	+ 3.4
151F		+ 2.4		+ 2.5	+ 3.0	+ 3.1	+ 3.2
165F		+ 1.8		+ 2.7	+ 3.4	+ 3.9	+ 3.7'
170F		+ 1.7		+ 2.1	+ 2.7	+ 2.7	+ 2.7
*171F		+ 2.4		+ 3.1	+ 3.0'	+ 4.3	+ 4.3
176F		+ .6		+ 1.6	+ 2.3	+ 3.3	+ 3.6
179F		+ 3.2		+ 3.2	+ 3.3	+ 3.4	+ 3.2'
182F		+ 3.5		+ 3.3'	+ 4.0	+ 4.0	+ 4.3
*185F		+ 1.4		+ 1.0	+ 2.2	+ 3.4	+ 3.2'
188F		+ 2.2		+ 3.8	+ 3.6'	+ 4.6	+ 5.1
191F		+ .5		+ 1.4	+ 2.0	+ 2.6	+ 2.7
193F		- .7		+ 1.0	+ 1.4	+ 3.8	+ 1.9'
204F		+ 1.8		+ 3.2	+ 4.6	+ 4.2	+ 4.2
205F		+ .8		+ 2.0	+ 3.2	+ 3.8	+ 3.9
211F		+ .9		+ 1.8	+ 2.1		+ 2.7
214F				+ 2.3	+ 3.6	+ 3.5'	+ 4.3
o217F		+ 2.1'		+ 2.6			+ 4.4
220F		+ 1.9		+ 2.0	+ 3.9		+ 4.4
221F		+ .9'		+ .6	+ .9		+ 3.2
TOTAL CYCLES		1		2	2		4

APPENDIX G -- Continued

Age in Month	32	34	36	39	42	45	48
Case							
25F	+ 2.8'	+ 3.0	+ 3.1	+ 2.9'	+ 3.1	+ 2.8'	+ 3.1
28F	+ 5.1	+ 5.6	+ 5.6	+ 5.3'	+ 5.6	+ 4.9'	+ 5.3
37F	+ 3.3	+ 3.1'	+ 3.6	+ 3.8	+ 2.8"'	+ 3.6	
59F	+ 3.9		+ 2.7'	+ 2.8	+ 2.4	+ 2.4	+ 2.4'
66F	+ 2.2	+ 3.0	+ 3.8	+ 3.9	+ 2.9'	+ 3.4"	+ 4.0
67F	+ 4.3	+ 3.7	+ 3.6'	+ 4.1	+ 4.0"'	+ 4.4	+ 5.4
72F	+ 3.1	+ 4.3	+ 4.2	+ 3.9'	+ 4.2	+ 3.8'	+ 4.8
75F	+ 2.0"'	+ 3.2	+ 2.8'	+ 3.0	+ 3.6	+ 3.7	+ 3.7
* 76F	+ 4.3	+ 5.4	+ 4.3"'	+ 5.0	+ 5.8	+ 5.9	+ 5.4'
82F	+ 2.9		+ 3.5	+ 3.5	+ 4.5	+ 5.4	+ 4.3"'
83F	+ 3.3	+ 3.1	+ 2.9'	+ 3.8	+ 5.1	+ 5.6	+ 5.3'
* 88F	+ 3.8	+ 3.8	+ 4.2	+ 4.7	+ 4.4	+ 4.2'	+ 4.5
* 94F		+ 1.9	+ 2.5	+ 2.8	+ 3.5	+ 3.4'	+ 4.1
96F			+ 3.5		+ 4.5		+ 5.3
97F			+ 4.0		+ 4.8		+ 5.1
o*111F	+ 2.9	+ 2.6'	+ 2.9	+ 2.9	+ 3.1		+ 3.0
117F	+ 3.2	+ 3.6	+ 3.5'	+ 4.6	+ 4.5'	+ 5.6	+ 5.5
120F	+ 3.0	+ 3.0	+ 3.6	+ 4.9	+ 4.9	+ 5.6	+ 4.7
126F	+ 4.5	+ 4.2	+ 4.2	+ 3.9	+ 3.2'	+ 3.4"	+ 3.8
127F	+ 4.3	+ 4.5	+ 4.2'	+ 4.5	+ 4.6	+ 4.6	+ 4.1'
137F	+ 3.4	+ 3.0'	+ 3.9	+ 3.7'	+ 4.1	+ 5.0	+ 4.0"'
140F	+ 2.7	+ 2.7	+ 3.9	+ 3.6'	+ 4.7		+ 5.1
142F	+ 3.2	+ 3.4	+ 3.7	+ 4.5	+ 4.6	+ 4.6	+ 5.1
144F	+ 2.3'	+ 2.7	+ 2.9	+ 3.5	+ 4.2	+ 4.0'	+ 4.2
*145F	+ 3.7'	+ 4.2	+ 5.3	+ 5.2	+ 5.0'		
*146F	+ 3.8'	+ 4.8	+ 4.6	+ 4.6	+ 4.5	+ 4.0"'	+ 4.8
148F	+ 4.8	+ 4.7	+ 4.1'	+ 4.6"	+ 5.3	+ 5.2'	+ 5.8
150F	+ 4.0	+ 4.3	+ 5.0	+ 4.6'	+ 4.9	+ 3.1"'	+ 4.9
151F		+ 3.9	+ 3.8'	+ 4.3	+ 5.1	+ 4.6'	+ 4.9
165F	+ 4.4	+ 4.2'	+ 5.4	+ 5.2	+ 4.9'	+ 5.4	+ 5.2
170F	+ 3.5	+ 4.2	+ 4.3	+ 4.6	+ 4.5'	+ 4.8	+ 5.0
*171F	+ 4.7	+ 4.6	+ 4.5'	+ 5.9	+ 4.8	+ 4.1"'	+ 5.0
176F	+ 3.7	+ 4.1	+ 3.8'	+ 4.7	+ 5.0	+ 4.4'	+ 4.6
179F	+ 3.4	+ 3.1'	+ 3.4	+ 3.6	+ 3.8	+ 3.8	+ 3.8
182F	+ 5.3	+ 4.4	+ 4.0'	+ 4.5	+ 3.7'	+ 4.0	+ 3.3'
*185F	+ 3.3	+ 4.2	+ 4.1'	+ 4.8	+ 4.9	+ 4.8	+ 4.0"'
188F	+ 5.1	+ 5.3	+ 5.6	+ 6.3	+ 7.4	+ 6.4"'	+ 7.1
191F	+ 3.3	+ 3.1'	+ 4.1	+ 4.3	+ 5.0		+ 5.5
193F	+ 2.2"	+ 2.8	+ 3.7	+ 3.6'	+ 4.5	+ 5.2	+ 4.7'
204F	+ 4.1'		+ 4.3		+ 4.5		+ 5.1
205F		+ 3.9	+ 4.5		+ 4.9		+ 5.8
211F			+ 4.6		+ 4.5'		+ 5.3
214F			+ 4.2		+ 4.1'		+ 4.8
o217F		+ 5.0			+ 4.3		+ 3.7'
220F			+ 4.2		+ 4.2'		+ 5.1
221F		+ 2.9'			+ 3.2		+ 4.0
TOTAL CYCLES	4		1	1	2	6	3

APPENDIX G -- <u>Continued</u>

Age in Month	51	54	57	60	63	66	69
Case							
25F	+ 2.3"'	+ 3.5	+ 2.8	+ 2.8	+ 2.1"'		+ 3.5
28F	+ 5.2'	+ 5.4	+ 4.5	+ 3.9		+ 3.5	
37F	+ 2.8	+ 2.7		+ 2.7		+ 2.3	
59F		+ 2.5"		+ 3.4		+ 3.5	
66F	+ 4.4	+ 3.6	+ 3.1"'	+ 3.8	+ 2.9"'	+ 3.7	+ 4.0
67F	+ 5.1	+ 4.6"'	+ 5.2	+ 5.0	+ 4.8	+ 4.4	+ 4.4
72F	+ 4.9	+ 5.3	+ 5.3	+ 4.5'	+ 5.3	+ 4.9'	+ 5.6
75F	+ 3.7	+ 4.1	+ 3.8	+ 3.4	+ 3.4"'	+ 4.1"	+ 3.5
* 76F	+ 5.5	+ 5.4	+ 4.9'	+ 5.1	+ 5.4	+ 5.4	+ 5.3
82F	+ 5.1	+ 5.6	+ 6.0	+ 5.4	+ 5.3'	+ 5.9	+ 5.2
83F	+ 5.6	+ 5.1'	+ 5.3	+ 5.8	+ 6.7	+ 6.3	+ 6.2
* 88F	+ 4.9	+ 3.8'	+ 3.9	+ 3.7'	+ 4.3"	+ 4.4	+ 4.4
94F	+ 3.3				+ 2.6'	+ 3.8"	+ 3.5
96F		+ 3.0"'		+ 4.1			+ 4.9
97F		+ 4.3"'		+ 5.1			+ 5.2
o*111F	+ 2.3"'	+ 3.1		+ 3.0'	+ 3.2	+ 3.8	+ 3.5
117F	+ 5.4	+ 5.7	+ 6.4	+ 6.6	+ 5.6"'	+ 6.6	+ 6.0
120F	+ 5.7	+ 6.2	+ 6.0	+ 5.8'	+ 6.2	+ 6.0'	+ 6.3
126F	+ 3.2	+ 3.0'	+ 3.2	+ 3.4	+ 3.2	+ 2.7'	+ 2.9
127F	+ 4.8	+ 4.3	+ 4.2	+ 4.1	+ 3.5	+ 3.5'	+ 3.6
137F	+ 4.6	+ 5.0	+ 5.4	+ 5.5	+ 4.8"'	+ 5.7	+ 5.7
140F	+ 5.2	+ 5.6	+ 6.2	+ 6.8	+ 6.2'	+ 6.7	+ 6.7
142F	+ 5.2	+ 4.9	+ 4.9	+ 4.6	+ 4.5	+ 4.5	+ 4.2
144F	+ 5.7	+ 4.8"'	+ 5.4	+ 5.3'	+ 5.8	+ 5.1'	+ 5.6
*145F		+ 6.2	+ 5.2"'	+ 5.9	+ 6.3	+ 5.9'	+ 6.0
*146F	+ 4.0'	+ 4.4	+ 3.5"'	+ 4.3	+ 3.6	+ 3.4'	+ 3.5
148F	+ 5.5	+ 5.4'	+ 6.0	+ 6.5	+ 5.9	+ 5.8'	+ 6.3
150F	+ 4.6'	+ 4.8	+ 5.7	] 4.5'	+ 5.0	+ 4.7	+ 4.7
151F	+ 4.7	+ 4.4'	+ 4.9	+ 4.4'	+ 4.5	+ 4.7	+ 3.2
165F	+ 5.2	+ 5.0'	+ 5.4	+ 5.3	+ 5.2'	+ 6.0	
170F	+ 4.8'	+ 5.4		+ 4.8'		+ 4.9	
*171F	+ 5.3	+ 5.3	+ 4.8	+ 4.8		+ 4.8	
176F	+ 4.1"'	+ 5.4	+ 4.4'	+ 4.8"		+ 5.3	
179F		+ 3.8		+ 4.2		+ 3.5	
182F		+ 3.6		+ 3.3		+ 2.5	
*185F				+ 5.6		+ 4.6	
188F		+ 5.3'		+ 5.4		+ 5.8	
191F		+ 5.4		+ 5.1		+ 5.0	
193F	+ 4.8	+ 5.4		+ 5.6		+ 5.9	
204F		+ 5.4		+ 5.6		+ 5.2	
205F		+ 5.6		+ 5.6		+ 5.4	
211F		+ 4.8'		+ 6.3		+ 5.8	
214F		+ 4.9		+ 4.5		+ 3.7	
o217F		+ 4.2		+ 4.1		+ 4.1	
220F		+ 5.0		+ 4.6		+ 4.5	
221F		+ 4.6		+ 4.9		+ 5.3	
TOTAL CYCLES	3	5	4	1	6	1	

APPENDIX G -- Continued

Age in Month	72	78	84	90	96	102	108
Case							
25F	+ 1.3"'	+ 2.1	+ 2.4	+ 1.9'	+ 2.0	+ 2.3	+ 1.9
28F	+ 2.4	+ 1.7'	+ 1.9	+ 1.4	+ .6	- .3	- 1.0
37F	+ .6'	+ .7	+ .3'	+ .6	- .2'	+ .1	+ .6"
59F	+ 3.0	+ 2.4"'	+ 3.0	+ 2.8	+ 1.8	+ 1.5'	+ 1.8
66F	+ 4.1	+ 3.4	+ 3.3'	+ 3.8	+ 3.3	+ 2.9	+ 2.0
67F	+ 4.0	+ 3.1"'	+ 4.4	+ 4.8	+ 4.5	+ 2.9	+ 2.3
72F	+ 3.6	+ 2.8"'	+ 4.8	+ 3.4	+ 3.3	+ 1.7'	+ 1.9
75F	+ 2.4'	+ 2.9	+ 2.1"'	+ 2.9	+ 2.8	+ 2.0	+ 1.0
* 76F	+ 4.1'	+ 4.2	+ 2.8'	+ 2.9	+ 1.7	+ .7	- .1
82F	+ 3.7	+ 3.4	+ 2.8	+ 2.4	+ .4"'	+ 2.1	+ .9
83F	+ 5.1	+ 5.1	+ 4.2	+ 3.3	+ 2.7	+ 1.2	+ .1
* 88F	+ 4.1	+ 4.1'	+ 4.2	+ 4.2	+ 2.9	+ 2.2	+ 1.8
* 94F	+ 2.6"'	+ 3.3	+ 2.9'	+ 3.0	+ 1.8'	+ 2.0	+ 1.0
96F	+ 4.1	+ 4.1	+ 4.0	+ 3.2	+ 2.9	+ 2.0	+ 1.9
97F	+ 4.5	+ 4.0	+ 3.7	+ 2.7'	+ 2.8	+ 1.7	+ 1.0
o*111F	+ 2.6	+ 2.6	+ 2.5	+ 1.9"'	+ 2.6	+ .7"'	
117F	+ 4.6	+ 4.6	+ 3.3	+ 3.1	+ 2.8	+ 2.8	+ 2.1
120F	+ 5.8	+ 5.1	+ 4.7'	+ 4.8	+ 4.1	+ 3.5	+ 2.6
126F	+ 2.5	+ 2.2	+ 1.8	+ 1.5	+ .1'	+ .3	- 1.4'
127F	+ 2.1	+ .7'	+ .8	- .8	- 1.3	- 1.5	- 2.5"'
137F	+ 4.3'	+ 4.6	+ 4.1	+ 2.8	+ 2.8	+ 2.5	+ 2.0
140F	+ 4.8'	+ 5.1"	+ 5.5	+ 5.1	+ 4.1	+ 3.6	+ 3.2
142F	+ 2.9	+ 2.1"'	+ 2.9	+ 2.6	+ 1.8	+ .9	- .4
144F	+ 3.4	+ 3.3"'	+ 4.0	+ 3.1	+ 2.0"'	+ 2.7	+ 1.5"'
*145F	+ 4.4	+ 4.2	+ 3.8	+ 3.2	+ 3.0	+ 2.0	+ .5'
*146F				+ .4	- .2	- .3	- .7
148F	+ 3.0'	+ 3.4	+ 3.5	+ 2.7	+ .9'	+ 1.0	+ 1.4'
150F	+ 3.1	+ 2.6	+ 1.9	+ 1.6	+ .7	+ .5	- .3
151F	+ 1.8"'	+ 2.9	+ 1.9	+ 1.2	+ .5	- .6	- .9
165F	+ 4.2	+ 2.7'	+ 3.1	+ 2.6'	+ 2.7	+ 1.5	+ .7'
170F	+ 3.3	+ 2.0'	+ 2.3	+ 1.6	+ 1.4	+ 1.5	- .7'
*171F	+ 3.0	+ 1.9	+ 1.9	+ 1.5	+ .6	+ .3	- 1.1
176F	+ 2.9"'	+ 3.7	+ 3.3	+ 2.8	+ 1.6	+ 1.0	- .4
179F	+ 2.6	+ 2.1	+ 1.9	+ 1.9	+ 1.4"'	+ 2.3	+ 1.4
182F	+ .8"'	+ 1.4	- .1'	+ .2	- .4	- .6	- 1.0
*185F	+ 2.8'	+ 3.3	+ 2.5	+ 1.7"'	+ 2.6	+ 1.3	+ 1.1
188F	+ 3.5	+ 3.2	+ 2.9	+ 1.3	+ 1.1	+ .5	- .3
191F	+ 4.6	+ 3.6'	+ 4.1	+ 3.8	+ 3.4	+ 2.5	+ 2.1
193F	+ 5.2	+ 5.0'	+ 5.1	+ 4.3	+ 4.0	+ 2.7'	+ 2.9
204F	+ 3.2	+ 2.4	+ 1.4	+ .3'	+ .6	- .3	- .9
205F	+ 5.1	+ 4.7	+ 4.5	+ 4.0	+ 3.9	+ 2.4	+ 1.4
211F	+ 4.3	+ 2.2'	+ 2.5	+ .9"'	+ 1.9	+ .5	- .7
214F	+ 1.4	+ 1.4	+ 1.0	- .1	- .5'	- .1	- .1"
o217F	+ 3.1	+ 2.3	+ .3"'	+ 1.0	+ .7	+ .1	- .3
220F	+ 2.0'	+ 2.3	+ 1.9	+ 1.9	+ 1.1	+ .1	- .1'
221F	+ 4.0	+ 3.6'	+ 3.7	+ 3.3	+ 2.5	+ 1.5	+ 1.2
TOTAL CYCLES	5	6	2	3	3	1	4

APPENDIX G -- Continued

Age in Month / Case	114	120	126	132	138	144	150
25F	+ .7	+ .4'	+ .5	- .5	- 1.6"'	- .4	+ .3
28F	- 1.4'	- .9"	+ 1.3	+ .2'	+ .4	- 1.5	- 3.7
37F	+ 1.2	+ 2.7	+ 4.0	+ 2.8	+ 1.8	- .6	- 2.5
59F	+ 1.3	+ .1'	+ .8	- .4'	- .3	- 1.2	- 1.7
66F	+ 1.3	+ .8	- .1	- 1.0	- 2.8"'	- 2.2	- 2.9"'
67F	+ 1.9	+ 1.9	+ 1.8	+ .5	- .1'	0	- .8
72F	+ .5'	+ .9	+ .1	- .3'	+ .2"	+ .3	- .4
75F	- .4	- 1.0	- 2.0	- 2.4"'	- 1.1	- 1.1	+ .5
* 76F	- .8	- 1.3	- 2.1	- 2.7"'	- 1.6	- .8	- .4
82F	+ .9	+ .6	- .6'	- .1"	+ .8	+ .8	+ .1
83F	- .3	- .4	- .7	- 1.6"'	+ .4	+ .1	- .7
* 88F	+ .3'	+ .5	- .6'	- .3	- .1"	+ .6	- .3
* 94F	- .3	- 1.4	- 2.1	- 3.8'	- 3.3"	- 1.4'	- 1.0
96F	0	- .2	- 1.7	- 1.8"'	- .8	- 1.1'	+ .3
97F	- .5	- .7	- 2.4	- 5.6"'	- 1.9	- 2.6"'	- 1.4
o*111F	+ 1.3		+ 2.5	+ 3.1	+ 1.9		
117F	+ .9	+ .4	- .6'	- .5	- 1.6"'	- .5	- .5
120F	+ 1.5	0	- .7	- .9	- 1.5	- 2.6	- 3.4
126F	- 1.1	- 2.4"'	- 1.2	- 2.2'	- 2.1"	- 1.1	+ 1.1
127F	- 1.0	+ .4	+ 2.7	+ 1.7	- .7	- 3.2	- 6.7
137F	+ 1.2	+ .7	+ .1	- 1.5	- 1.9	- 2.6	- 2.8
140F	+ 2.6	+ .7	0"'	+ .8	- .6"'	+ .6	- .5
142F	- 1.3'	- .9	- 1.4'	- 1.2"	- .8	+ .2	- .4
144F	+ 1.7	+ .6	+ .6	- .1	- .9	- 1.6	- 2.5"'
*145F	+ .8	- 1.8"'	- .7	- .3	- 1.3"'	- .7	- 1.6'
*146F	- 1.3	- 1.9"'		- .7		+ .8	
148F	+ .7	- 1.6"'	- .3	- 1.3	- 2.8"'	- 2.1	- 2.8'
150F	- 1.0	- 1.4	- 2.3'	- 1.5	- .5	+ .7	+ 1.8
151F	- 1.2	- 2.0'	- 1.7"	- 1.2	+ .5	+ 1.8	+ 2.4
165F	+ .8	+ .3	- 1.4	- 2.2'	- 2.1	- 3.4'	- 3.0
170F	- .4	- 1.0	- 1.1	- 1.9	- 2.3"'	- 1.1	- .7
*171F	- 1.4	- 1.8"'	0	+ 1.1	+ 1.4	+ .8	- 1.4
176F	- .4"'	+ .4	+ 1.8	+ 2.4	+ 1.7	+ 1.4	- .5
179F	+ .4	- .3	- 1.3	- 1.9'	- 1.7	- 1.6"	- .8
182F	- 1.2	- 1.7'	- 1.6"	- .7	+ .3	+ .1	+ .1
*185F	+ .7'	+ .9	0'	+ .2	+ .3	+ .1"'	+ .7
188F	- 1.2	- 1.8"'	- 1.1	- 1.9'	- 1.4"	- 1.0	- 1.1'
191F	+ .5	+ .2	- .7	- .9	- 1.3"'	- .6	- .5
193F	+ 1.1'	+ 1.6	- 1.1	- .1	- 1.0'	- .7	- .7
204F	- 1.8'	- 1.3	- 1.7"'	- 1.0	- 1.6"'	- .6	- 2.4
205F	+ .4	- 1.4	- 2.9	- 3.1"'	- 2.1	- 1.9	- 3.8
211F	- 1.3	- 1.6	- 2.6"'	- 1.2	- 1.0	- .4	- 2.2
214F	+ 3.6	- 2.8"'	- 1.9	- 1.8	- 2.2	- 2.3	- 3.9
o217F	- 1.1"'	- .5	- .9	- 2.3"'	- .9	+ .9	+ 1.7
220F	+ .4"	+ 2.8	+ 3.1	+ 3.2	+ 3.3	+ 1.4	- .6
221F	+ .5	- .2	- 1.5	- 2.2'	- 1.9	- 3.4"'	- 2.2
TOTAL CYCLES	3	8	5	8	14	4	3

APPENDIX G -- Continued

Age in Month	156	162	168	174	180	186	192
Case							
25F	+ .4	+ .7	- .6	- 2.1	- 4.4	- 6.4	- 9.0
28F	- 7.8	-10.4	-14.7	-17.7	-22.0	-24.6	-28.4
37F	- 5.8	- 8.3	-10.9	-15.1	-19.1	-22.3	-26.1
59F	- 2.2"'	+ .4	- .2	- 1.2	- 3.3	- 5.2	- 8.4
66F	- 2.2	- 3.3'	- 2.9	- 4.1	- 5.6	- 9.2	-11.5
67F	- .8'	- .7"	+ .4	- 1.3	- 1.4	- 4.3	- 6.2
72F	- 1.3	- 3.9	- 6.0	- 8.4	-11.4	-15.1	-17.7
75F	+ 1.0	+ .9	+ .4	- 1.7	- 3.8	- 5.5	- 8.8
* 76F	- 1.4	- 3.4	- 5.0	- 9.0	-12.4	-15.8	-18.5
82F	- .9	- 3.5	- 6.2	- 8.7	-11.8	-14.9	-18.4
83F	- 3.1	- 6.4	- 8.5	-11.2	-14.4	-17.2	-20.5
* 88F	- 1.1	- 3.5	- 6.0	- 9.1	-12.1	-15.6	-18.6
* 94F	- .6	- 2.9	- 5.7	- 8.7	-12.1	-15.0	
96F	+ 1.4	+ 2.4	+ 1.1	- .4	- 3.5	- 5.4	- 7.9
97F	- 1.1	- .4	- 1.9	- 3.3	- 6.6	- 8.7	-10.9
o*111F		- 4.1			-14.5		
117F	- 1.4	- 3.7	- 5.9	- 8.6	-11.5	-15.1	-17.9
120F	- 3.7'	- 3.4	- 4.9	- 6.9	- 9.7	-13.2	-16.4
126F	+ 2.1	+ 2.2	- .8	- 1.5	- 4.2	- 7.2	-10.0
127F	-10.1	-13.3	-15.9	-20.5	-23.3	-26.9	-29.8
137F	- 3.0'	- 2.6"	- 1.0	- .4	- .4	- 1.1	- 2.3
140F	- .7	- 2.6	- 4.7	- 8.5	-11.2	-14.5	-18.5
142F	- 1.7	- 3.9	- 5.8	- 9.0	-11.9	-14.7	-17.9
144F	- 1.4	- 1.0	0	- 1.1	- 1.6	- 4.1	- 6.0
*145F	- 1.5	- 2.5	- 2.8'	- 2.6	- 2.6	- 3.1	- 5.9
*146F	- 2.3	- 4.2	- 8.2	-11.1	-14.4	-17.1	-20.6
148F	- 2.6"	- 1.0	- .9	- 1.8	- 3.4	- 6.5	- 9.0
150F	+ .5	- 1.3	- 3.3	- 6.3	- 9.1	-11.9	-14.4
151F	+ .6	- 1.1	- 3.7	- 7.2	- 9.9	-13.3	-16.3
165F	- 4.1	- 6.4	- 9.4	-13.5	-15.8	-19.6	-22.4
170F	- .1	- .4	- 2.4	- 4.5	- 6.9	-10.5	-12.3
*171F	- 2.6		- 9.5	-12.5	-15.9	-18.5	-21.8
176F	- 2.9	- 6.6	- 8.8	-12.0	-15.5	-19.0	-22.1
179F	- .6	- 1.3	- 2.4	- 4.9	- 7.1	-11.0	-12.6
182F	- 1.1	- 3.0	- 5.6	- 7.6	-11.5		
*185F	+ .7	- .5	- 1.5	- 2.6	- 5.4	- 6.7	-10.8
188F	- .1	- 1.5	- 3.2	- 5.4	- 7.4	-11.9	-15.3
191F	+ .6	- 1.4	- 3.9	- 5.7	- 7.9	-11.2	-13.4
193F	0	- 1.0	- 2.5	- 4.3	- 6.5	- 8.2	-11.1
204F	- 5.2	- 9.9	-14.0	-16.5	-15.8	-23.2	
205F	- 5.0	- 7.0	-10.4	-14.1	-17.1	-21.5	
211F	- 3.4	- 4.7	- 7.4	-11.0	-14.0		
214F	- 4.9	- 8.8	-11.4	-13.2	-16.6		
217F	+ 1.7	+ .1	- 1.1	- 3.4	- 6.4		
220F	- 5.0	- 8.2	-10.6	-14.1	-18.4		
221F	- 1.6	- 2.9	- 4.7	- 6.7	-10.8		
OTAL YCLES	2	2					

APPENDIX G -- Continued

Age in Month / Case	198	204	210	216	'	"	Number of Cycles
25F	-11.9	-14.0	-18.0	-20.3	12	5	4
28F	-31.7	-36.1	-39.7	-43.6	10	3	3
37F	-28.9	-32.3	-35.6	-39.6	8	4	4
59F	-11.1	-14.0	-17.4	-21.8	12	6	6
66F	-13.5	-16.6	-19.1	-22.6	11	7	7
67F	- 8.1	-10.3	-14.4	-15.4	10	6	6
72F	-21.4	-24.2	-27.6	-39.9	11	3	3
75F	-12.0	-14.1	-17.3	-20.2	8	6	6
* 76F	-19.1	-25.7	-30.3	-33.6	7	3	3
82F	-21.8	-25.3	-28.2	-32.5	6	5	5
83F	-23.5	-27.5	-30.6	-33.8	8	2	2
* 88F	-23.2	-26.3		-32.9	8	4	4
* 94F					9	5	4
96F	-10.5	-13.9	-16.6	-19.8	4	3	3
97F	-13.9	-17.0	-19.5	-22.8	4	4	4
o*111F					7	4	4
117F	-21.9	-24.8	-28.4	-31.7	7	3	3
120F	-19.7	-22.4	-25.9	-29.6	8	3	3
126F	-13.7	-15.6	-18.5	-23.6	12	5	5
127F	-33.5	-36.2	-40.2	-43.4	9	3	3
137F	- 3.3	- 5.5	- 9.3	-11.2	8	4	4
140F	-21.6	-24.2	-27.2	-30.1	7	4	4
142F	-21.1	-23.9	-27.9		6	4	4
144F	- 8.9	-11.7	-13.4	-17.1	14	7	7
*145F	- 8.9	-10.9			10	5	5
*146F	-24.5	-28.3	-31.5	-35.6	8	6	6
148F	-11.5	-14.4	-17.1	-20.8	14	6	6
150F	-17.6	-20.2	-24.6	-26.3	7	2	2
151F	-18.8	-22.5	-25.8	-30.0	7	3	2
165F	-25.3	-29.6	-32.9	-36.5	11	1	1
170F	-15.6	-18.5	-22.3		7	2	2
*171F	-25.9	-29.3	-33.3	-36.4	6	3	3
176F	-25.7	-30.3	-32.3		7	5	4
179F	-15.1	-19.0			5	3	3
182F	-22.0	-24.9			8	3	2
*185F	-14.0	-16.6			10	4	4
188F	-17.9				7	4	4
191F					4	2	2
193F	-14.2				8	3	3
04F					7	3	3
05F					3	2	2
11F					7	3	3
14F					5	3	3
17F					6	4	4
20F					5	2	2
21F					6	2	2

APPENDIX H

THE CYCLIC PATTERN OF HEIGHT GROWTH AS DETERMINED BY THE DEVIATIONS FROM THE STRAIGHT LINE, BOYS

Age in Month / Case	0	1	2	3	4	5	6	7	8
* 10M		-22.2							
49M			-19.8	-18.7	-15.6	-13.6	-11.6		
* 54M		-15.9				- 8.7	- 8.1		- 6.2
° 55M		-18.4	-14.9	-13.3			- 8.0	- 7.0	
°* 71M		-21.8	-18.3	-13.9	-11.9		-11.1	- 9.8	
74M		-19.6	-15.5	-14.4	-12.7	-11.6	-11.6		
77M		-16.5	-16.3	-14.2	-12.0	- 8.9	- 5.6	- 5.6	
78M		-16.7	-15.2	-12.1	-10.4	- 8.7	- 7.7	- 5.2	
81M		-27.0	-21.5	-22.1	-17.7	-16.1	-14.6		-12.7
* 84M		-17.6	-15.0	- 9.0	-10.5"'	- 9.0	- 9.0		
92M		-18.8	-14.4	-11.7	- 9.8	- 9.6	- 5.0	- 5.0	- 3.5
* 98M	-18.2	-15.5		-11.8	-10.4	- 8.4		- 7.6	- 2.4
°*102M		-13.6	-12.2	-11.1	- 9.6	- 8.1	- 7.2		- 5.8
112M	-20.3	-16.8	-14.7	-13.7	-13.6	-10.8	- 8.4	- 7.6	
°114M	-18.0	-16.9	-15.0		-11.0	- 9.7	- 8.6		-14.8"'
°135M	-25.1	-22.1	-18.6	-16.6	-14.3	-13.3	-11.7		-10.6
138M	-23.0	-20.0	-17.0	-15.6	-11.2	- 9.0	- 8.5	- 5.6	
*141M	-21.2	-18.0	-14.8	-14.5	-12.0	-11.0	- 9.7	- 8.4	
°153M	-27.4	-23.5	-20.5	-19.5	-18.0	-16.5	-15.3		-12.0
154M	-19.1	-17.0	-12.9	-10.7	-10.0	- 8.2	- 8.3'	- 6.3	
156M	-24.3	-22.3	-18.5	-15.0	-13.4	- 9.1	-11.6"'	- 7.2	
°157M	-22.6	-18.9	-15.6	-12.3	-10.0	-10.2'	- 9.2		- 7.3
°160M	-22.3	-19.2	-15.9	-12.2	-10.3	- 9.2	- 8.3	- 8.1	
°167M	-22.9	-19.1	-17.4	-14.7	-13.3	-12.2	-10.1		- 9.3
°174M	-25.8	-22.0	-20.0	-15.7	-16.2'	-14.0	-12.7		-11.5
177M	-25.3	-21.3	-17.7	-15.4	-12.2	-10.3	- 9.6	- 7.4	- 7.5'
°180M	-19.6	-16.2	-14.4	-11.4	-10.2	- 9.4	- 7.8	- 6.3	- 4.7
*°183M	-26.6	-24.1	-19.9	-17.2	-13.7	-11.5	-10.4	- 9.5	
186M	-17.8		-16.3	-13.1	-11.9	- 9.8	- 8.6	- 7.4	
°189M	-22.5	-18.3	-15.3	-11.7	-10.4	- 8.8	- 8.5	- 7.7	
°197M	-24.9	-22.8	-14.8	-13.7	-11.2	-10.8	- 8.3		
TOTAL CYCLES°					1		1		1

APPENDIX H -- Continued

Age in Month / Case	9	10	11	12	13	14	15	16	17
* 10M				- 5.3	- 2.7		- 2.4		
49M				- 4.8			- 6.4"'		
* 54M	- 5.7	- 5.4		- 3.8	- 3.2		- 2.1	- 1.6	
o 55M	- 6.9		- 3.7	- 3.4	- 2.9		- .1	- .8	
o* 71M	- 8.2	- 7.7		- 7.1		- 5.6	- 4.3	- 4.1	
74M	- 8.4	- 8.1	- 5.3		- 4.8		- 4.6	- 4.3	
77M	- 5.3	- 4.4		- 3.3	- 3.6		- 2.2	- 1.2	
78M	- 5.0		- 4.0	- 2.6		- 1.9	- 2.1'	- .1	
81M	-11.2	- 8.6		- 8.6	- 6.1		- 5.4	- 5.4	
* 84M	- 7.1		- 5.3	- 5.6'	- 1.0			- .5	
92M		- 2.5		- 3.9"'	- 3.2		- 2.6	- 1.4	
* 98M	- 4.0	- 4.2'		- 2.7			+ .1		+ 2.0
o*102M	- 3.3	- 2.7		- 2.8'			- .9		
112M	- 6.6	- 4.7		- 4.4	- 3.6		- 4.1	- 2.3	
o114M	- 5.6	- 4.7		- 4.2	- 2.6			- 1.8	
o135M	- 9.1	- 7.5	- 8.3"'	- 6.2			- 6.0	- 4.7	
138M	- 4.9	- 4.1		- .8	- .5		- .2	+ 1.7	
*141M	- 7.1	- 6.1		- 4.4		- 2.9	- 1.8	- .9	
o153M	-11.4	- 9.5		- 6.3	- 6.9"'		- 5.3		- 3.5
154M	- 6.4'	- 5.0		- 5.2'	- 4.5		- 3.3		- 1.8
156M	- 4.8	- 4.7		- 3.1	- 3.7"'		- 2.5	- 1.9	
o157M	- 6.2	- 4.6		- 3.6		- 2.4	- 2.1		
o160M	- 6.5		- 3.3	- 2.9	- 2.7		- .5		- .3
o167M	- 8.5	- 6.4		- 4.6'		- 4.7	- 3.7	- 1.8	
o174M	- 9.2	- 7.3		- 7.4'	- 5.7		- 4.6	- 3.9	- 3.3
177M		- 4.3		- 3.5	- 3.0		- 1.6	- .4	
o180M		- 5.1'		- 4.5	- 3.6			- 1.1	
*o183M	- 6.8	- 5.8		- 4.7		- 4.4	- 3.2	- 2.5	
186M			- 4.0	- 2.4	- 2.5'		- 2.1	- .6	
o189M	- 5.6	- 5.4		- 3.6	- 3.6		- 3.8'	- 2.8	
o197M	- 7.8	- 6.7		- 4.3		- 4.9"'	- 3.8	- 2.9	
TOTAL CYCLES			1	1	2	1	1		

APPENDIX H -- Continued

Age in Month / Case	18	19	20	21	22	23	24	26	28
* 10M	- .1			+ 1.5			+ 2.6		+ 4.8
49M	+ .9			+ 4.2			+ 2.5	+ 1.9"'	
* 54M	- .2		+ .9		+ 1.1		+ 1.3	+ .7'	+ 2.0
o 55M	- .8"'	+ .1		+ .3			- 3.1"'	+ 2.2	+ 1.7'
*o 71M	- 2.5		- 2.6'		- .7		- .8'	- .3	- .9
74M	- 1.7				+ .6		+ .8	+ 1.1	+ 1.8
77M	- 1.4		- 1.4'		- .7		- .8'	+ 1.6	
78M	- .4		- .6'		+ .4		+ .7	+ 1.2	+ 1.9
81M	- 3.6		- 1.2		- .4		0	+ 1.3	+ 1.4
* 84M	- 1.7"'		- 1.0		+ .6		+ 1.6	+ 2.0	+ 2.6
92M	- 2.2"'		0		+ .2		+ 1.0	+ 1.3	
* 98M	+ 1.2				+ .8'		+ 2.5		+ 2.8
o*102M	+ .3		+ 1.2		+ 1.0'		+ 1.1	+ 3.0	+ 1.0"'
112M	- 1.4		- 1.2		- .3		+ .6	+ 2.3	+ 2.2'
o114M	- .4		0		+ .2		+ 1.3	+ 1.4	+ 2.3
o135M	- 4.1		- 3.8		- 2.1		- 2.1	- 2.0	- .2
138M	+ 1.1"'		+ 2.7		+ 2.4'		+ 2.6	+ 3.8	+ 2.5"'
*141M	- .7		- 1.6"'		+ 1.2		+ 2.1	+ 3.0	+ 2.7'
o153M	- 3.4		- 1.8		- .9		- .1	+ .4	+ 1.1
154M	- 2.7"'		- 1.5		- 1.3'		- 1.4	+ .9	+ 1.4
156M	- 1.3		+ .2		+ .3		+ 1.4	+ 1.8	+ 3.4
o157M			- .6		+ 1.5		+ 3.0	+ 4.6	+ 4.8
o160M	+ .3		+ .3		+ 1.2		+ 1.7	+ 2.8	+ 2.7
o167M	- 1.2		- 1.1		- .1		+ 1.1	+ 1.7	+ 2.6
o174M			- 2.6		- 1.8		- .7	+ .6	+ .8
177M	+ .3		+ .8		+ 2.0		+ 1.9'	+ 3.3	+ 2.2"'
o180M	- 1.2'		0		+ 1.0		+ 1.7	+ 1.8	+ 1.9
*o183M	- 2.8		- 3.1'	+ 1.6			+ .8"'	+ 2.4	+ 2.6
186M	- .1		+ 1.4		+ 1.5		+ 2.1	+ 2.4	+ 3.5
o189M	- 2.1		- 1.1		- .5		+ .3	+ 2.0	+ 2.7
o197M	- 2.1		- .3		+ .4		+ .8	+ 1.3	+ 1.9
TOTAL CYCLES	5		1				2	1	3

APPENDIX H -- Continued

Age in Month / Case	30	32	34	36	39	43	45	48	51
* 10M	+ 4.4'	+ 5.2	+ 4.7	+ 2.8"'	+ 4.0	+ 3.9	+ 3.4'	+ 3.5	+ 5.8
49M	+ 3.9	+ 3.7'	+ 3.8"	+ 4.5	+ 5.0	+ 5.4	+ 4.5"'	+ 5.5	+ 5.4'
* 54M		+ 2.8	+ 2.3"'	+ 3.9	+ 3.9	+ 3.1'	+ 3.4	+ 3.6"	
o 55M			+ 2.4	+ 2.7	+ 3.4	+ 2.9'	+ 3.8	+ 3.3'	+ 3.6
o* 71M	- .9'	- .8	+ .9	+ 1.4	+ 2.1	+ 1.5	+ 1.4	+ .2"'	+ 3.7
74M	+ 3.3	+ 3.4	+ 3.2'	+ 3.4	+ 3.9	+ 3.7'	+ 4.0	+ 4.3	+ 4.6
77M	+ .9	+ .6"'	+ 1.1	+ 1.2	+ 1.3	+ 1.5	+ 3.2	+ 2.3	+ 1.8'
78M	+ 1.9	+ 2.0	+ 1.9	+ 1.8	+ .9"'	+ 2.5	+ 2.5	+ 2.0'	+ 2.9
81M	+ 1.3'	+ 2.7	+ 2.2'	+ 3.0	+ 4.6	+ 4.7	+ 4.9	+ 5.7	+ 5.8
* 84M	+ 3.0	+ 3.3	+ 3.1'	+ 3.6	+ 4.4	+ 5.1	+ 4.6'	+ 5.0	+ 4.6
92M	+ 1.4	+ 2.1	+ 4.5	+ 4.5	+ 4.3'	+ 4.7	+ 5.2	+ 5.4	+ 5.4
* 98M	+ 3.2	+ 3.5	+ 3.0'	+ 3.3	+ 3.6	+ 3.4'	+ 3.6	+ 3.4'	+ 3.8
o*102M	+ 2.9	+ 2.1'	+ 2.3	+ 2.1'	+ 3.5	+ 3.7	+ 2.6'	+ 2.8	+ 3.0"
112M	+ 2.9	+ 2.9	+ 3.3	+ 4.1	+ 3.9	+ 3.7'	+ 4.2	+ 4.2	+ 5.1
o114M	+ 2.1'	+ 2.4	+ 2.0'	+ 3.0	+ 2.7'	+ 3.4	+ 3.2'	+ 3.4	+ 3.7
o135M	- .1	+ .4	+ 1.5	+ 1.7	+ 2.6	+ 3.4	+ 3.6	+ 4.6	+ 5.0
138M	+ 4.0	+ 2.8"'	+ 3.5	+ 3.1'	+ 4.3	+ 4.5	+ 4.4	+ 3.7"'	+ 5.1
*141M		+ 2.9	+ 2.4'	+ 2.6"	+ 3.4	+ 3.9	+ 4.3	+ 3.9'	+ 4.1
o153M	+ 2.0	+ 2.5	+ 2.6	+ 3.1	+ 3.5	+ 4.1	+ 4.6	+ 5.3	+ 5.7
154M	+ .8"'	+ 1.8	+ 4.4	+ 2.5"'	+ 3.6	+ 3.8	+ 3.6	+ 3.4'	+ 5.0
156M	+ 2.9	+ 3.5'	+ 4.0	+ 3.4'	+ 4.2	+ 4.5	+ 4.9	+ 4.8'	+ 5.2
o157M	+ 4.0	+4.0"'	+ 5.1	+ 4.9'	+ 6.6	+ 5.8	+ 5.6'	+ 6.2	+ 5.7
o160M	+ 2.6'	+ 3.1	+ 3.0'	+ 3.5	+ 3.4'	+ 4.1	+ 4.7	+ 4.2	+ 4.1
o167M	+ 3.0	+ 2.8'	+ 3.6	+ 3.6	+ 4.1	+ 5.0	+ 5.5	+ 5.0"'	+ 5.5
o174M	+ 1.7	+ 2.2		+ 3.2	+ 3.2	+ 4.4	+ 5.0	+ 5.7	+ 6.2
177M	+ 3.3	+ 3.8	+ 3.9	+ 4.1	+ 5.1	+ 4.9'	+ 5.0	+ 5.3	+ 5.3
o180M	+ 2.7	+ 3.9	+ 4.2	+ 4.1	+ 4.0'	+ 4.6	+ 5.3	+ 5.5	+ 5.7
o*183M	+ 3.7	+ 3.0"'	+ 4.0	+ 4.2	+ 4.6	+ 4.7	+ 4.8	+ 4.9	+ 5.6
186M	+ 3.5	+ 4.1	+ 4.2	+ 5.1	+ 4.4"'	+ t.4	+ 5.0'	+ 5.8	+ 5.4
o189M	+ 2.3'	+ 3.0	+ 3.1	+ 3.4	+ 4.4	+ 4.7	+ 4.3'	+ 4.5	
o197M	+ 2.7	+ 3.0	+ 3.8	+ 3.8	+ 3.9	+ 4.2		+ 5.1	
TOTAL CYCLES	1	4	2	3	2	0	1	4	1

APPENDIX H -- Continued

Age in Month / Case	54	57	60	63	66	69	72	78	84
* 10M	+ 4.4'	+ 4.6	+ 4.6"	+ 5.4	+ 4.6	+ 4.3	+ 1.7"'	+ 3.2	+ 3.6
49M	+ 5.7		+ 5.7		+ 5.5		+ 4.1	+ 4.0	+ 3.7
* 54M	+ 4.3		+ 4.8		+ 4.8		+ 4.5		+ 3.3'
o 55M	+ 2.9"'	+ 4.2	+ 3.7	+ 3.6'	+ 3.9	+ 4.0	+ 3 2	+ 2.6'	+ 2.7"
o*71M	+ 4.3	+ 3.6"'	+ 4.6	+ 4.2'	+ 5.0	+ 5.3	+ 4.5"'	+ 5.2	+ 5.4
74M	+ 4.2'	+ 4.5	+ 4.5	+ 4.7	+ 5.0	+ 5.2	+ 4.1	+ 3.8"'	+ 4.9
77M	+ 2.6"	+ 3.2	+ 3.3	+ 2.2"'	+ 4.4	+ 4.2	+ 3.5"'	+ 4.4	+ 3.4'
78M	+ 3.1	+ 4.2	+ 4.2	+ 4.1'	+ 4.3	+ 5.3	+ 4.1	+ 3.9'	+ 4.2
81M	+ 5.9	+ 6.0	+ 6.5	+ 7.9	+ 7.3	+ 7.2	+ 6.7'	+ 6.8	+ 6.3'
* 84M	+ 4.6	+ 4.6	+ 4.5'	+ 5.0				+ 4.5	+ 3.7
92M	+ 5.4	+ 5.7	+ 6.0	+ 5.4	+ 5.3'	+ 5.4	+ 4.7	+ 4.7	+ 4.2
* 98M	+ 3.4'	+ 3.8	+ 2.7"'	+ 3.3	+ 3.4	+ 4.2	+ 2.9	+ 2.7'	+ 3.0
o*102M	+ 3.2	+ 3.4	+ 3.8	+ 3.8	+ 3.3'	+ 3.4	+ 2.9"'	+ 3.9	+ 3.1
112M	+ 4.5"'	+ 5.3	+ 5.2'	+ 5.8	+ 4.7"'	+ 6.1	+ 4.3	+ 3.3"'	+ 5.1
o114M	+ 3.8	+ 4.2	+ 4.0'	+ 4.5	+ 3.8"'	+ 4.4	+ 3.3	+ 2.6	+ 2.5"'
o135M	+ 5.5	+ 5.2'	+ 5.8	+ 6.1	+ 6.6	+ 6.5	+ 5.6'	+ 6.1"	+ 6.5
138M	+ 4.8	+ 4.6	+ 4.2'	+ 4.6"	+ 5.1	+ 4.9	+ 3.5"'	+ 4.1	+ 2.9
*141M	+ 4.3	+ 4.2'	+ 4.4	+ 4.3'	+ 5.3	+ 5.1	+ 3.6	+ 3.5	+ 3.3
o153M	+ 5.7	+ 5.9	+ 6.0	+ 6.8	+ 6.7'	+ 7.0	+ 4.9"'	+ 5.8	+ 5.7
154M	+ 5.0	+ 6.0	+ 5.3"'	+ 5.9	+ 6.0	+ 5.5	+ 4.0"'	+ 4.9	+ 3.8
156M	+ 4.8'	+ 5.7	+ 5.5'	+ 6.1	+ 6.1	+ 6.5	+ 5.0"'	+ 5.6	+ 4.6
o157M	+ 5.5	+ 5.5	+ 5.5	+ 5.2	+ 5.0		+ 3.3"'	+ 4.2	+ 3.8
o160M	+ 4.1	+ 3.9	+ 3.5	+ 3.3"'	+ 4.5	+ 3.9	+ 3.3'	+ 3.6	+ 3.4"'
o167M	+ 6.3	+ 5.8	+ 5.7		+ 5.6		+ 3.9	+ 3.5	+ 3.2'
o174M	+ 5.8'		+ 6.2		+ 6.7		+ 5.9	+ 5.6	+ 5.6
177M	+ 4.9'	+ 5.0	+ 5.8		+ 5.9		+ 4.8	+ 3.5	+ 2.6
o180M	+ 5.2'		+ 6.3		+ 5.4		+ 3.4'	+ 3.5	+ 3.3
* o183M	+ 5.8		+ 6.5	+ 7.2			+ 4.5'	+ 4.6	+ 4.2
186M	+ 5.0		+ 4.1'		+ 4.2		+ 3.1	+ 2.9	+ 1.9"'
o189M	+ 5.4		+ t.4		+ 5.5		+ 3.7	+ 3.4'	+ 3.9
o197M	+ 5.1		+ 6.1		+ 6.2		+ 4.5'	+ 5.0"	+ 6.0
TOTAL CYCLES	3	1	3	3	2		9	4	4

APPENDIX H -- Continued

Age in Month / Case	90	96	102	108	114	120	126	132	138
* 10M	+ 2.6	+ 2.3	+ .7	- .5	- 1.4"'	- .7	- 2.3	- 2.3	- 2.5
49M	+ 2.9	+ 2.1	+ 2.1	+ .1	- .4	- 1.4	- 3.3	- 3.3	- 4.2
* 54M	+ 3.4	+ 3.5	+ 3.2	+ 2.1	+ 1.3	+ .8	- 1.6	- 2.2"'	- 1.8
o 55M	+ 3.5	+ 3.7	+ 3.5'	+ 3.9	+ 1.9"'	+ 2.7	+ 2.4	+ 1.6	+ .5
o* 71M	+ 5.8	+ 4.7'	+ 4.9	+ 4.7	+ 4.1	+ 4.1	+ 3.2	+ 2.5	+ .9"'
74M	+ 4.0	+ 3.3'	+ 3.6	+ 3.0	+ 2.6	+ 1.7	+ 1.0	+ .2	- .9
77M	+ 3.5	+ 2.8'	+ 3.0	+ 3.0	+ 1.9	+ 1.3'	+ 1.5	+ .1'	+ .6
78M	+ 4.4	+ 4.7	+ 4.1	+ 2.3	+ 1.9	+ .2	- .9	- 3.0'	- 2.7
81M	+ 6.4	+ 6.9	+ 5.8	+ 4.9	+ 4.6	+ 4.4	+ 2.8	+ 2.0	+ .1
* 84M	+ 3.1'	+ 3.2	+ 3.2	+ 1.7'	+ 1.9	+ 1.5	0	- .2	- 1.8
92M	+ 2.5	+ 1.3'	+ 1.5	- .5	- 1.5	- 3.0	- 4.0'	- 3.9"	- 1.9
* 98M	+ 2.9	+ 2.4	+ 1.5'	+ 1.8	+ 1.4	+ .7	+ .5	- .9"'	- .1
o*102M	+ 1.9"'	+ 2.6	+ 2.1	+ .9	+ .8	- .7	- 1.2	- 1.5	- 1.7
112M	+ 4.5	+ 2.9'	+ 3.0	+ 2.2	+ .9	+ .4	- .5	- 1.6	- 2.6
o114M	+ 3.2	+ 2.5'	+ 2.8	+ 2.3	+ 1.6	+ 1.5	+ .9	+ .1'	+ .2
o135M	+ 5.6'	+ 5.9	+ 4.8"'	+ 5.5	+ 4.7	+ 4.3	+ 4.2	+ 2.4	+ 2.4
138M	+ 2.4	+ 2.1	+ 1.1	+ .8	+ .3	- .5	- .6	- 1.2	- 1.6
*141M	+ 3.3	+ 2.4	+ 1.9"'	+ 2.5	+ 1.4'	+ 1.7			
o153M	+ 5.6	+ 4.8'	+ 5.0	+ 4.9	+ 4.1	+ 3.2'	+ 3.3	+ 2.4	+ 1.8
154M	+ 3.6	+ 2.9"'	+ 3.5	+ 3.5	+ 2.8	+ 2.3	+ 1.9	+ 1.7	+ .3
156M	+ 3.5'	+ 3.7	+ 3.1	+ 2.2	+ 1.2	+ .6	- .7	- .8	- 1.7
o157M	+ 1.3	+ 1.3	+ 1.3	- .3	- .3'	+ .1	- .1	- 1.4	- 2.0
o160M	+ 3.9	+ 2.0	+ 1.4"'	+ 2.1	+ .4"'	+ 1.2	- .1	- .8	- .9
o167M	+ 3.5	+ 2.5	+ 2.1	+ 1.8	+ .5"'	+ 1.1	- .1	- .8	- 1.5
o174M	+ 5.6	+ 5.0'	+ 5.2	+ 5.2	+ 4.1	+ 3.6	+ 2.7	+ 2.2	+ 1.5
177M	+ 2.0"'	+ 3.5	+ 3.1	+ 3.0	+ 2.3	+ 1.8	+ .4	- .7'	- .6
o180M	+ 2.6"'	+ 3.9	+ 3.1	+ 2.4	+ 1.6	+ 1.1	- .3	- 1.0	- 1.8
o*183M	+ 4.0	+ 3.8	+ 3.5'	+ 3.6	+ 2.0	+ 1.3"'	+ 2.0	+ .7	- .6
186M	+ 2.8	+ 1.5	+ .6	- .1	- 1.1	- 2.0	- 2.5	- 3.9	- 4.4"'
o189M	+ 3.6	+ 2.9	+ 2.7	+ 2.4	+ 1.5	+ .8	+ .4	- .1	- 1.7'
o197M	+ 4.9'	+ 5.3	+ 4.4	+ 3.5	+ 3.0	+ 3.0	+ 2.4	- .7'	- .3
TOTAL CYCLES	3	1	3	0	4	1	0	3	2

APPENDIX H -- Continued

Age in Month	144	150	156	162	168	174	180	186	192
Case									
* 10M	- 3.7	- 3.7"'			+ 4.0	+ 3.2	+ 2.0	- .8	- 3.0
49M	- 4.8"'	- 1.0	- .2	+ 1.1	+ .7	- .3	- 1.4	- 4.3	- 7.0
* 54M	- 3.3	- 4.8	- 3.3"'	- 2.0			+ .8	- 1.1	- 2.4
o 55M	- .8	- 1.2"'	- .6	- .1	+ .7	+ 1.5	+ 2.6	+ 1.6	+ .4
*o 71M	+ 1.7	+ 1.6'	+ 2.7	+ 4.0	+ 4.7	+ 3.1	+ 3.1		- 2.4
74M	- 1.7	- 2.5	- 2.3	- 2.6'	- .5"	+ .5	+ .7	+ .1	- 2.4
77M	- .2	- .2	- .2	- .6	- 1.5"'	- .9	- .7	- .1	- .5
78M	- 3.5"'	- 2.0	- .5	+ .5	+ .2	- 1.2	- 3.4	- 6.3	- 8.9
81M	- .3	- 1.4	- 2.3	- 4.1"'	- 3.3	- 2.1	- 2.1	- 2.8	- 4.2
* 84M	- 1.8	- 2.0	- 3.9"'	- 2.9	- .6	- .6	- .5	- 3.1	- 3.8
92M	+ .3	* .9	+ .7	- .7	- 2.4	- 6.0	- 9.0	-13.0	-16.0
* 98M	- 2.2	- 3.1'	- 2.6	- 4.5"'	- 1.4	+ .7	+ .2	- .2	
o*102M	- 1.9	- 3.5'	- 3.2	- 3.5'	- 1.4	- .5	+ .2	+ .9	+ .8
112M	- 3.6	- 4.7'	- 2.6	- 1.5	+ .8	+ 2.5	+ 2.8	+ .3	- 1.5
o114M	- .3	- 1.1	- 2.0	- 2.6	- 2.6"'	- .7	+ .7	+ 1.5	+ .7
o135M	+ 1.9	- .3	- 1.0	- 1.4	- 1.7"'	- .3	- .3	- .6	- .9
138M	- 2.3'	- 2.2"	- .8	- .3	+ .7	- 1.4	- 2.5	- 5.6	- 8.6
*141M		- 1.7'	+ .2	+ 1.9	+ 2.7	+ 1.5	+ .3	- 1.7	- 4.6
o153M	+ 1.1	+ .7	- .5	- .4	- 1.2	- 1.4'	- 1.0	- 1.3	- 2.0
154M	- .8	- 2.3"'	- 1.7	- 2.5"'	- .8	- .7	- .8	- 1.4	- 2.6
156M	- 3.0"'	- 2.2	- .3	+ 1.2	+ 1.9	+ 1.5	+ .6	- 1.5	- 3.5
o157M	- 2.0	- 3.3	- 3.7	- 4.0"'	- 2.6	- .9	+ 1.2	+ 2.7	+ 3.4
o160M	- 1.2	- 1.8'	- 1.4	- 2.2"'	0	+ 1.4	+ 1.8	+ 2.9	+ 2.0
o167M	- 2.6	- 2.9"'	- 1.2	- .2	+ .8	+ 2.9	+ 2.9	+ 1.6	
o174M	+ .8	- 1.3	- 1.4	- 3.3	- 3.3	- 5.1	- 5.1'	- 5.0"	- 4.1
177M	- 1.7	- 2.7	- 3.8	- 3.9"'	- 2.9	- 2.5	- 1.4	- 1.9	- 3.3
o180M	- 2.8	- 4.2	- 4.5	- 4.9"'	- 3.5	- .8	+ .7	+ 1.0	+ .1
*o183M	- 1.5	- 2.9	- 3.0	- 3.7"'	- 1.3	- .7	+ .4	- .1	- 2.5
186M	- 3.2	- 1.5	+ .2	- .4	- .4	- 3.5	- 6.4	- 9.2	-13.0
o189M	- 1.3"	- .7	+ .8	+ .7'	+ 1.0	- .4	- 1.2	- 3.6	- 5.9
o197M	- 2.6	- 3.6	- 4.3	- 4.6	- 5.5"'	- 4.9	- 4.6	- 3.0	+ .4
TOTAL CYCLES	4	5	2	8	5	0	0	1	

APPENDIX H -- Continued

Age in Month Case	198	204	210	216	'	"	Number of Cycles
* 10M	- 5.6	- 9.0	-11.8	-15.3	8	6	5
49M	-10.7	-13.1	-16.8	-20.2	7	6	6
* 54M	- 5.8	- 8.6	-11.0	-13.8	7	5	5
o 55M	- 2.4	- 4.2	- 7.3	- 9.8	12	7	7
*o 71M	- 5.8	- 9.6	-11.5	-14.4	11	5	4
74M	- 5.1	- 7.0	- 7.0	-10.0	8	3	3
77M	- 1.9	- 4.5	- 6.5	- 9.8	12	6	5
78M	-13.4	-16.6	-20.3	-24.2	9	3	3
81M	- 7.1	- 9.2	-12.2	-15.8	6	2	2
* 84M	- 6.7	-10.0	-12.3	-15.4	10	4	4
92M	-20.7	-24.7	-28.7	-32.2	7	4	4
* 98M	- 3.8	- 6.7	-10.0	-13.2	13	4	4
o*102M	- .5			- 9.3	12	5	4
112M	- 4.1	- 5.7	- 8.5	-11.2	9	4	4
o114M	+ .3	- 1.4	- 3.6	- 5.9	12	5	5
o135M	- 4.3	- 5.9	- 8.5	-11.1	7	5	5
138M	-12.5	-14.9	-18.3	-22.0	10	8	7
*141M	- 6.8	- 8.8	-12.0	-14.9	10	4	4
o153M	- 3.8	- 5.4	- 7.5	- 9.6	7	3	2
154M	- 4.7	- 7.0	-10.1	-12.6	14	9	7
156M	- 6.1	- 7.9	-11.4	-13.9	11	5	4
o157M	+ .9	- .6	- 2.0	- 4.2	8	4	3
o160M	- .6	- 2.3	- 5.4	- 7.8	11	6	6
o167M	- 2.5	- 4.1		-10.8	7	4	4
o174M	- 3.8	- 2.8	- 2.7		6	2	2
177M	- 5.6	-10.1	-12.2		9	4	4
o180M	- 2.2	- 4.0			8	3	3
*o183M	- 4.6	- 7.2			8	5	5
186M	-14.9				7	4	4
o189M	- 8.1				7	2	2
o197M					6	4	4

°According to second criteria for determining cycles.
'Where cycles occur according to first criteria.
"Where cycles occur according to second criteria.

APPENDIX I

TRAUMA AND THE CYCLIC PATTERN, GIRLS

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle					
	25F		5	51	63	72	138		
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	28F		3	24	120				
Scarlet Fever									
Whooping Cough		x							
Appendicitis		x		x					
Appendectomy									
	37F		4	30	42	108			
Scarlet Fever									
Whooping Cough		x							
Appendicitis									
Appendectomy									
	59F		6	16	22	54	78	78	156
Scarlet Fever									
Whooping Cough		x					x		
Appendicitis									
Appendectomy									
	66F		7	24	45	57	63	138	150
Scarlet Fever									
Whooping Cough		x		x					
Appendicitis									
Appendectomy									
	67F		6	20	42	54	78	162	
Scarlet Fever									
Whooping Cough		x				x			
Appendicitis									
Appendectomy									

APPENDIX I -- Continued

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle					
	72F		3	78	138				
Scarlet Fever									
Whooping Cough		x							
Appendicitis		x			x				
Appendectomy									
	75F		6	16	32	63	84	132	
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	76F		3	36	132				
Scarlet Fever									
Whooping Cough		x		x					
Appendicitis									
Appendectomy									
	82F		5	30	48	96	132		
Scarlet Fever		x							
Whooping Cough		x		x					
Appendicitis									
Appendectomy									
	83F		2	132					
Scarlet Fever		x							
Whooping Cough		x							
Appendicitis									
Appendectomy									
	88F		4	30	63	138			
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	94F		5	6	66	72	138		
Scarlet Fever									
Whooping Cough		x							
Appendicitis									
Appendectomy									

APPENDIX I -- Continued

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle			
	96F		3	54	132		
Scarlet Fever		x					
Whooping Cough		x					
Appendicitis							
Appendectomy							
	97F		4	54	132	150	
Scarlet Fever		x					
Whooping Cough		x					
Appendicitis							
Appendectomy							
	111F		4	51	90	102	
Scarlet Fever							
Whooping Cough		x					
Appendicitis							
Appendectomy							
	117F		3	63	138		
Scarlet Fever							
Whooping Cough		x					
Appendicitis							
Appendectomy							
	120F		3	9	26		
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							
	126F		5	20	45	120	138
Scarlet Fever							
Whooping Cough		x			x		
Appendicitis							
Appendectomy		x				x	
	127F		3	26	108		
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							

APPENDIX I -- Continued

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle						
	137F		4	48	63	162				
Scarlet Fever										
Whooping Cough		x			x					
Appendicitis										
Appendectomy										
	140F		4	78	126	138				
Scarlet Fever										
Whooping Cough										
Appendicitis		x								
Appendectomy										
	142F		4	30	78	132				
Scarlet Fever										
Whooping Cough		x			x					
Appendicitis										
Appendectomy										
	144F		7	12	54	78	96	108	150	
Scarlet Fever										
Whooping Cough		x								
Appendicitis										
Appendectomy										
	145F		5	32	60	120	138			
Scarlet Fever										
Whooping Cough		x								
Appendicitis										
Appendectomy										
	146F		6	13	32	45	57	120		
Scarlet Fever										
Whooping Cough										
Appendicitis										
Appendectomy										
	148F		6	13	39	120	138	162		
Scarlet Fever										
Whooping Cough		x								
Appendicitis										
Appendectomy										

APPENDIX I -- <u>Continued</u>

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle				
	150F		2	45				
Scarlet Fever								
Whooping Cough								
Appendicitis								
Appendectomy								
	151F		3	72	126			
Scarlet Fever								
Whooping Cough		x						
Appendicitis								
Appendectomy								
	165F		1					
Scarlet Fever								
Whooping Cough								
Appendicitis								
Appendectomy								
	170F		2	138				
Scarlet Fever								
Whooping Cough		x						
Appendicitis								
Appendectomy								
	171F		3	45	120			
Scarlet Fever								
Whooping Cough								
Appendicitis								
Appendectomy								
	176F		5	51	60	72	114	
Scarlet Fever		x			x			
Whooping Cough								
Appendicitis								
Appendectomy		x						
	179F		3	96	144			
Scarlet Fever								
Whooping Cough								
Appendicitis								
Appendectomy								

APPENDIX I -- Continued

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle			
	182F		3	72	126		
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							
	185F		4	48	90	144	
Scarlet Fever							
Whooping Cough		x					
Appendicitis							
Appendectomy							
	188F		4	45	120	138	
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							
	191F		2	138			
Scarlet Fever		x		x			
Whooping Cough							
Appendicitis							
Appendectomy							
	193F		3	32	150		
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							
	204F		3	126	138		
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							
	205F		2	132			
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							

APPENDIX I -- Continued

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle			
	211F		3	90	126		
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							
	214F		3	108	120		
Scarlet Fever							
Whooping Cough		x					
Appendicitis							
Appendectomy							
	217F		4	84	114	132	
Scarlet Fever							
Whooping Cough		x					
Appendicitis							
Appendectomy							
	220F		2	114			
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							
	221F		2	144			
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							

APPENDIX J

TRAUMA AND THE CYCLIC PATTERN, BOYS

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle					
	10M		6	36	60	72	114	150	
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy		x							
	49M		6	15	26	34	45	144	
Scarlet Fever									
Whooping Cough		x							
Appendicitis									
Appendectomy									
	54M		5	34	48	132	156		
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	55M		7	18	24	54	84	114	150
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	71M		5	48	57	72	138		
Scarlet Fever		x			x				
Whooping Cough									
Appendicitis									
Appendectomy									
	74M		3	78	168				
Scarlet Fever									
Whooping Cough									
Appndicitis									
Appendectomy									

APPENDIX J -- Continued

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle					
	77M		6	32	54	63	72	168	
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	78M		3	39	144				
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	81M		2	162					
Scarlet Fever									
Whooping Cough		x							
Appendicitis									
Appendectomy									
	84M		4	4	18	156			
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	92M		4	12	18	132			
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	98M		4	60	132	162			
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	102M		5	28	51	72	90		
Scarlet Fever									
Whooping Cough		x			x				
Appendicitis									
Appendectomy									

APPENDIX J -- Continued

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle								
	112M		4	54	66	78						
Scarlet Fever												
Whooping Cough												
Appendicitis												
Appendectomy												
	114M		5	8	66	84	168					
Scarlet Fever												
Whooping Cough		x			x							
Appendicitis												
Appendectomy												
	135M		5	11	78	102	168					
Scarlet Fever												
Whooping Cough												
Appendicitis												
Appendectomy												
	138M		7	18	28	32	48	63	72	150		
Scarlet Fever												
Whooping Cough												
Appendicitis												
Appendectomy												
	141M		4	20	36	102						
Scarlet Fever												
Whooping Cough												
Appendicitis												
Appendectomy												
	153M		3	13	72							
Scarlet Fever		x										
Whooping Cough												
Appendicitis												
Appendectomy												
	154M		8	18	30	36	60	72	96	150	162	
Scarlet Fever												
Whooping Cough		x					x					
Appendicitis												
Appendectomy												

APPENDIX J -- <u>Continued</u>

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle					
	156M		5	6	13	72	144		
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	157M		4	32	72	162			
Scarlet Fever									
Whooping Cough		x							
Appendicitis									
Appendectomy									
	160M		6	63	84	102	114	162	
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	174M		2	186					
Scarlet Fever		x							
Whooping Cough									
Appendicitis									
Appendectomy									
	177M		4	28	96	168			
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	180M		3	90	162				
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									
	183M		5	24	32	120	162		
Scarlet Fever									
Whooping Cough									
Appendicitis									
Appendectomy									

APPENDIX J -- Continued

Factors Possibly Affecting Height Growth	Case	Indicates Occurrence of Trauma	Total of Cycles	Trauma and Age of Occurrence Within 6 Months Previous To or Following a Cycle			
	186M		4	39	84	138	
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							
	189M		2	144			
Scarlet Fever							
Whooping Cough		x					
Appendicitis							
Appendectomy							
	197M		4	78	168		
Scarlet Fever							
Whooping Cough							
Appendicitis							
Appendectomy							

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