RELATIONSHIP OF MENARCHE TO ACHIEVED GROWTH IN HEIGHT

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RELATIONSHIP OF MENARCHE TO ACHIEVED GROWTH IN HEIGHT

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ABSTRACT

The purpose of this study was to discover the relationship existing between the menarche and the achieved growth in height of adolescent girls. Much work has been done in the field of biology and human growth in an attempt to relate the menarche to other phases of development including the height; but the results have been narrative rather than specific and conclusive. It was believed that the desired relationship could be ascertained by using a developmental approach involved in the data of physical measurements collected periodically on a large number of the same individuals, from early life through pubescence.

The longitudinal height and menarcheal records of two hundred sixty-three cases of the original Harvard Growth Study were obtained from the Child Development Laboratory of the Bureau of Research and Service , College of Education, Michigan State University. Using the Courtis Technique, Gompertz equations were calculated from the individual data. The age at menarche was substituted for time in each equation, and the achieved growth in height at menarche was obtained for the preadolescent, adolescent, and total development. Thus the percentages of growth on each of these phases of development were obtained along with the constants--

maximum, rate, and incipiency, of these equations. These values were then analyzed and compared statistically.

The results showed that the mean age at which the menarche occurred was 13.06 years. Menarche was also found to occur when the adolescent girls have reached approximately 94.45 percent of their individual total development. The percentage of development at menarche in the preadolescent phase of growth was 96.56. It was found to be 75.95 percent on the adolescent phase of height development.

On the basis of the ranges of percentages, the total development phase was considered the most logical one on which to base the findings, whereas, that of the preadolescent cycle was considered of more predictive value. The adolescent cycle was found to have very little or no predictive value on the same basis.

A low but positive correlation of 0.384 was found between the ages and the percentage of total development. Therefore, the age at which menarche occurred was found to have no significant relation to the percentage of height development at menarche.

The maximum height to which the individuals grew, the incipiencies from, and the rates at which height development on each cycle began to grow were not found to vary with the varying ages at which the menarche occurred.

Menarche was found to occur most frequently in the fall and least frequently in the winter among the cases.

A tendency for measures taken about a year before and after menarche to show a spurt and a drop about the growth curve before and after menarche, respectively, was generally evident among the group.

Whenever this tendency was very marked in a case, it was found to be related to a low percentage of adolescent development in height.

ACKNOWLEDGMENTS

The circumstances and creditable events which led to the successful execution of this study cannot be enumerated at length without creating undue attraction from and disproportionment to certain parts of the volume. In sum therefore, the writer wishes to express his gratitude to his colleagues in the Child Development Laboratory and teachers of the University who supplied many helpful suggestions as well as encouragement. The helpful hints of Dr. C. V. Millard are also highly esteemed here. Special indebtedness is felt to Dr. A. R. DeLong for his friendly and considerate guidance. Much appreciation is also due to friends and other sources of support.

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CHAPTER I

INTRODUCTION

From antiquity man has always sought to use a variety of methods in his attempt to understand nature. Yet how true does nature often reassert itself that "my thoughts are not your thoughts, neither are your ways my ways" (1). But man's inability to predict nature with perfect accuracy has not deterred him from his continuous search for reality. On the contrary, every succeeding generation has been progressively ploughing into the secrets of nature and increasing its ability to predict and control specific natural phenomena. Man's experiences, discoveries, and history comprise the context of his science and education.

Science begins where there is a system of classification in which different facts are associated and regarded as being due to relatively the same cause. To the scientist as such, "nature is only the summation of observed facts fitted into patterns which resume and classify them" (2). Absolute reality therefore, has no meaning to him. Moreover, because of the complex nature of some natural phenomena, scientific observations are not always carried out directly; hence, man has invented and standardized many media of scaling nature (3).

Sometimes many incorrect ideas resulting from erroneous association of facts persist as superstitions among men who hold them for many years, thus impeding advancement towards objectivity. This often happens because "from both the scientific and philosophic point of view all that man can study is disturbance of consciousness. For man is himself a part of what he seeks to understand, and there is no known way by which man can get outside himself to study himself . . ."; he thus is the creator of what he studies. Time, space through all other constructs which he calls laws, are different aspects of his observing nature (4).

Despite these inventions and the standardization of instruments, man's first attempts towards accurate scaling of nature were directed on objects farthest away from him, the stars (5). The attitude of looking farther away from "self" in search of the understanding of nature has caused man to know relatively very little about himself. Consequently, such knowledge of things related to him were picked up as superstitions. For instance, mental diseases were for ages attributed to demons (6); crops were believed to be defiled and destroyed by the influence of women merely passing through farm lands during the period of their menstrual flow (7); and I.Q. is still believed by many to be

constant, hereditary, and conclusive proof of an individual's natural endowment (8, 9, 10).

With the "basic conviction that nature is constant; that under identical conditions, a given cause will always produce identical effects, and vice versa," its inconstancies as revealed in the apparent differences between individuals (11), either did not appeal to man at first as having constant basis or were accepted and explained away as being of no significance.

Eventually coming home to himself, man's attention was turned to observations made on the so-called "lower animals" and a great deal of what is known about humans is inferred from such studies (12, 13, 14).

It is therefore very obvious that though man has been interested in many aspects of nature which concern him (15), some things such as those related to his birth, growth, and development have been held for ages as sacred and therefore unquestionable. Only with reluctance have certain aspects of growth been added to modern school curriculum (16).

Differential psychology has contributed a great deal to our present understanding of the variable nature with respect to individuals (17). Modern man is therefore no longer satisfied with such simple notions as, that except for childbirth, males and

females are alike. Rather with more scientific constructs and tools, such as the masculinity-femininity scales, he further investigates into other elemental irregularities of nature as manifested in the human organisms. The most obvious ones, such as the differences in height, weight, pigmentation, behaviour, and ability to resist diseases (18, 19), have been discovered as existing between sisters or even in individuals of the same sex born at the same time--twins (20). Moreover, there are many peculiarities in development and growth of observable secondary sex characteristics existing among boys and girls, or individuals of the same sex (21).

The scientific man, with all that has been invented to aid his search into objective nature, often stoops to wonder as to whether his tools are comparable to nature's. Are his instruments identical with nature's? Have they any correlations? If they are correlated, he further wants to know how high or low the correlations are (23, 24, 25). Sometimes he strives further to improve his instruments and methods of observations. This latter state of the scientist's desires and endeavours can safely be implied with the Courtis adaptation of the Gompertz function to educational measurement.

CHAPTER II

STATEMENT OF THE PROBLEM

Many observable differences exist between individuals. Some of these are the differences in height, weight, strength of grip, dexterity, and musculature.

There are also psychological as well as behavioural differences which go to make the study of individual differences as interesting as it is complex.

Some of the characteristic differences do not appear at birth, but rather emerge after individual organs have gone through the processes of myelination and maturation. The age at which these processes manifest themselves varies chronologically with individuals.

Apparently nature therefore does not seem to be consistent with human beings. But if every individual goes through similar processes of maturation in his progress from an immature state, there must be an ultimum point on each phase toward which the development progresses.

If complete or total maturity depends on the subsequent maturation of the individual phases of development (26, 27), there must be a relationship between a stage in one phase of development and

another, and this relationship should be similar in all individuals irrespective of chronological age, size, and height (28).

This study therefore purports to determine through the use of the Courtis (29) adaptation of the Gompertz function, the relationship between the achieved growth in height and the advent of menarche in an adolescent girl.

Therefore, if menarche is a physical sign of sexual maturity (30), and if an individual also grows progressively towards a mature point in height, there should be a relationship between the status of development in height and the menarche at the time it occurs in an adolescent girl. That the results of our observations have not found such relationships similar for all individuals indicates that we have not used the right scales (31).

CHAPTER III

IMPORTANCE OF THE STUDY

Modern educators have encountered difficulties in bringing the "Organismic Concept" (32) to bear upon the minds of teachers and parents alike. Ancestrial customs and traditions have sought conformity through laws almost universally enacted to have children of the same age enter school, go through the same grades and classes and graduate at the same time, despite apparent disparities in their responses and emotional states (33, 34, 35, 36). Ultimately children of the same age level of maturation at any level in the school process are expected to perform in school activities with equal intellectual and artistic ability, read, write, and solve arithmetic and scientific problems with equal fluency. Inability of some pupils to perform at par with other pupils has created great concern in teachers and parents, and has resulted in unwarranted emotional problems in their charges (37).

The success of this research in discovering the relationship between menarche and the achieved growth in height shall provide a basis for organizing school admission and classification according to the natural law of organismic growth and development.

Parents are even worried when their children fail at a certain age to measure up to a certain height or weight depicted as average for their age (38, 39). Therefore, it is exigent to gather as much scientific evidence to demonstrate convincingly that every individual child operates as "its own whole" and nature has obviously its own units of reckoning according to individual rhythm.

The works of Nally (40), Kowitz (41), Lee (42), and Rusch (43) have testified effectively to the relative accuracy of the Gompertz function in illustrating the natural pattern of growth and development of human organisms.

The organismic concept and all that it implies in education shall at least have gone a step forward when this study successfully augments such proofs by showing, that there is a close relationship between the height of an adolescent girl and the advent of menarche. It will demonstrate that chronological age and height in the traditional measures are not nature's units. This study shall further affirm the accuracy of the Courtis adaptation of the Compertz function in tracing the natural course of organismic growth.

Lee (44), in discussing the findings on his study of 60 menarche cases, using the Gompertz function, concluded by emphasizing the need for studying larger and more representative groups

to verify more clearly the correlative trends between menarche and the achieved percentage of height development which he discovered.

Nally (45) specifically suggested the use of the Gompertz function to study these cases which were previously studied by Shuttleworth (46), who acknowledged the needs for a better method amenable to the study of longitudinal data.

I. DEFINITION OF TERMS

The following terms will be used to connote the following concepts:

1. "Menarche" (47): The first menstration.
2. "Development" (48): The progress towards maturity brought about in an immature organism by the action of appropriate environmental forces under constant conditions.
3. "Growth" (49): An observed sequential difference or change in one phase of development.
4. "Growth Cycle" (50): The course traced in the progress towards a specific state of condition made by an immature organism, other things being equal.
5. "The Gompertz Function" (51): $y = ke^{ce^{at}}$ or $y = ki^{rt}$ (52).

Where:

y = achieved growth at time "t";

k = maximum towards which growth is progressing;

e^c = incipiency (i), or the degree of development at the beginning of the period of growth; and

e^a = rate (r) of growth expressed in isochrons.

6. "Isochron": One percent of the time necessary for the generation of the Gompertz function from 0.000000189 percent to 99.90917 percent.
7. "Maturity" (53): The maximum of development related to a specific growth and situation; e.g., physical maturity is factor "k" of the Gompertz function. Social, psychological, or other maturity is related to the immediate situation.
8. "Organismic": This modifies the concept that an organism naturally grows as a whole.

II. REVIEW OF LITERATURE

A considerable amount of writing dealing with the physical manifestations of pubertal maturity has been done in the field of human growth, but this review is limited to topics directly related to the menarche and the method employed in this study.

Writers in the fields of biology and medical science often use the term "maturation" (54) to imply "sexual development" regarding the menarche as its peak point. This conception is not too different from that of preliterate or less advanced societies who treated that period of development with ceremonial rites and dignity (55, 56, 57). Modern man has, however, not failed to suspect the social impact of the adolescent phase of development (58); hence, Hall (59) studied and wrote extensively on the relationship of the psychology of the adolescent to adolescent physiology, anthropology, sociology, sex, crime, religion, and education. Thus social scientists recognize and attribute the upheavals in adolescent emotional behavior to pubertal development and maturation. Campbell (60) found high positive correlations between adolescent-social-sex-development and both skeletal and mental age.

Biological scientists rather seek to understand the adolescent phase of development on strictly biological bases. Obviously menarche, therefore, is conceived of as a homeostatic consequence of bodily functioning at pubescence. Hence Richey (61) studied the physiologic maturation and associated growth and development to changes in blood pressure in boys and girls before and after puberty. He concluded that blood pressure increases with age, that of the females decreasing after the sixteenth year of age. He also found

significant differences between the blood pressures of the two sexes. Pressures of children of the same age were found to vary within wide limits. While the differences in precocity of sex maturation were reflected in the behavior of the blood pressures, the first menstration (a general criterion for discerning puberty), he averred, resulted from long years of biological preparation. The pressures of different maturing groups were found to reach peaks at different chronological ages. In the same vein, somatic and glandular effects on maturation have also been investigated extensively (62, 63, 64). The activities of the endocrine glands are found to excite sexual maturation and other phases of growth (65). Greulich found that the immature pituitary body maintains certain positive relations with the gonads, but at puberty the pituitary gonadomophin and steroid hormones show increases until adult equilibrium is established.

Basal metabolism (66) rates were also discovered to vary with the stage of development. The rate for girls at about the age of 12 rises to 15 percent above normal and returns to normal at about the age of 14 years. A similar effect was found to occur in boys in about two years later (67, 68). This increase coincides with the physiologic age rather than with the chronological age, and

occurs earlier in girls than in boys, coincident with their earlier and late pubescence respectively.

Thus the functioning of the pituitary glands, the blood pressure, and the basal metabolism rate rise at around an average age of about 13 years, which coincides with the average for menarche. Studies have also been carried out to relate the menarche to climatic conditions (69, 70). The results of such studies have been conflicting and therefore inconclusive (71, 72). However, many investigations seem to indicate that the incidence of menarche is lowest in the summer months, highest in the winter, with spring as the next in order of frequency of occurrence (73).

III. PATTERN OF INDIVIDUAL GROWTH

Examination of the accumulated data from studies of various phases of human growth, gradually revealed a unique pattern to individual courses of development.

Boas found that the growth curve was intimately related to the moment of maximum rate of growth, less so to the date of menarche (74). Other writers in the field signified various "physical symptoms" of puberty (75, 76, 77). Mass statistical methods as applied to cross-sectional studies were found to be inadequate in describing individual course of growth observed longitudinally (78, 78, 80).

Thus the idea of individual pattern of growth further led to the recognition of the organismic concept. Olson (81) averred that there is a difference in growth pattern correspondent with differences in behaviour. Coghill (82) asserted that there is a common element among differences implied in the biologists' discovery that the individual acts as a whole. The underlying unity in growth (83) was found to apply to intellectual and other growths as well. Hence, the "Organismic Age Concept" (84).

Henceforth, ossification, fat distribution, sexual maturation, and other aspects of growth were found to be accurate in the prediction of any phase of development (85, 86, 87).

Studies soon ensued to relate one phase of development to the other (88, 89, 90). Garrison defined "maturity" as "attained level of psychological functioning" (91). Murphy (92) found that individual abilities and patterns of responses were more significant than age trends in predicting development. Jones (93) found that children taught individually showed more growth than those taught by any other methods.

IV. THE GROWTH CURVE

The concept of organismic development was further confronted with the lack of media by which growth data collected longitudinally could be analyzed.

Obviously, it was not enough to conceptualize organismic development without a satisfactory technique for the processing of growth

data. Consequently, many attempts have been made to formulate and utilize different methods.

Merrell (94), through impirical and mathematical processes, demonstrated that mass statisfical methods of calculating averages, standard deviations, and correlations were inadequate when attempting a description of the pattern of growth of living organisms.

However, Gesell and Armatuda (95) dared to suggest the use of correlative treatment in pediatric diagnostics. Nevertheless, the general opinion continues to insist that only longitudinal study and methods of analysis other than familiar routine statistical procedure will serve to portray growth patterns (96, 97).

In Brody's concept, a curve that would serve to illustrate the course of human growth would be skewed with inflection point at about one-third of mature development (98).

The experiment of Loeb and Carrel (99, 100) provided Robertson and Pearl with assumptions which were employed in their analysis of growth data. Huxley (101), utilizing his law of constant differential growth, found definite correspondence between the growth of components and the totality.

With the assumption that the pattern of organismic growth is very highly complex, Shoch (102) implied that the Gompertz curve, which has its inflection point at 34 percent of development, would be

better able to illustrate the complex pattern of biological growth than any other curves (103).

Olson conceived of organismic age (104), arrived at by computing averages for achieved growth at each stage of development. Shuttleworth (105) plotted increment curves utilizing the annual increments on height of individual cases. With this method he studied sexual maturation and physical growth of girls from six to nineteen years of age. The present study is using the same data as Shuttleworth used.

Shuttleworth (106) concluded that endocrine factors, or factors associated with the menarche, were largely responsible for the late or early appearance of changes in the pattern of growth of the adolescents. Such factors, he asserted, were negligibly associated with mature stature.

Cases of individuals whose maturity occurred early according to chronological age, he found, had their accelerated physical growth when comparatively young, short, and far below their mature stature, while the late maturing ones had theirs when they were older, taller, and nearer their mature stature. "These patterns [he assumed] were not rigidly uniform but strikingly similar and progressively different between groups."

Shuttleworth applied the same method in studying sitting heights and weight of the same group of cases (107).

V. THE GOMPERTZ FUNCTION

Otis and Courtis (108) utilized the Boas-Becking concept of the normal Gaussian or Bessel curve as a rational for the development of the Gompertz curve, whereby growth is represented as a Gaussian distribution moving through time. Nonbiological data such as population growth, as well as autocatalytic reactions of inorganic materials, when put to analysis with the same function, produce curves similar to that of biological growth.

This complex mathematical function $y = ke^{ce^{at}}$ has been reduced by Courtis to the simple usable form $y = k(rt+i)$ through the use of isochrons (f) which are Naperian Lologarithms adjusted to eliminate their negative value.

Many research workers have been successful in describing and predicting the phenomena of growth by utilizing the Gompertz function (109). Several other reviews of formulae used in predicting growth where maturation is a factor appear in the literature. In accord with Courtis that the Gompertz (110, 111, 112) function is the "Law of Growth" and the only one up to the present which works in describing and predicting maturational growth (113, 114),

all these reviews give special attention to this function. Dearborn and Rothney recognized it as possessing greater merits than other functions that they reviewed.

Millard utilized this function in a study of spelling (115) and also in research on preadolescent reading maturation (116). Long and Dearborn employed it in discerning growth trends in mental development (117). Kunkle used it to study reading maturation (118). Nally applied it to establish the relationship between the growth in height and beginning of reading (119).

Meredith failed to test this function successfully in predicting the growth of six boys selected from the Iowa studies (120). DeLong and Nally (121) have pointed out the gross errors which led to Meredith's failure to apply the technique successfully. Kowitz (122) utilized this function to explore into the relationship of physical growth to classroom behaviour of elementary school pupils. Rusch (123) employed it to relate the growth in height to that of weight. The Child Development Laboratory of Michigan State University has been successfully using this function in analyzing many phases of growth and development.

The only study in which the Courtis-Gompertz function was utilized to discern the relation of the heights of girls to the advent of first menstration was undertaken by Lee (124). He analyzed the

menarche and the height data of sixty girls previously studied by VanDyke (125). Only five annual measurements (two before and two after the menarche) were available. Consequently, he was confronted with three major handicaps as follows:

1. Too few cases from which to generalize (126). Obviously Lee was restricted to the five measures to determine the possible path of growth curve, and that for the adolescent cycle only.
2. Too few or insufficient number of measurements (127).
3. Too narrow an age range (12 to 15 years) (128, 129).

Computing with this adolescent cycle thus obtained, he arrived at the following conclusions:

1. On the average, the onset of menstration occurs in a girl when she attains 70 percent of her adolescent growth.
2. The younger maturing girls have greater maximum of adolescent growth and a larger incipiency than do later maturing girls.
3. There are definite correlational trends between the constants of the isochronic equation and the percentage of adolescent development at which menstration occurs.

That in spite of the limitations Lee's results were relatively accurate is creditable to the accuracy of the Gompertz function in illustrating the course of organismic growth.

CHAPTER IV

THE DATA

The nature of this study requires data on a considerable number of girls whose dates of birth and of the menarche have been accurately recorded along with periodic measurements of height from an early age up through adolescence. Consequently, the Harvard Growth Study which has been recognized as providing a set of the most accurately and systematically collected data in the field of longitudinal study was chosen.

I. THE HARVARD STUDY

The Harvard Research Project which began in 1922 and continued through 1934 studied 3,342 pupils from the age of 6 years when they first entered school to 19 years of age when they completed their secondary school education. Measurements of many dimensions, including height and weight, were taken periodically and recorded along with accurate dates of birth and of the advent of the first menstration for girls (130). However, this menarcheal record was not available for every one of the girls (131).

Three different individuals were responsible for taking each of the measures three times. They were so located that one person could not see or know the results of another's measurements at the time of measure. Every measurement had to approach within 1.1 units of the other two. Failing this, the child was remeasured. The final results of each person's three measures were averaged out as follows:

1. Measurements which were within 1.1 units of the others, or the average of two of the three measures which approached within 1.1 units, were to be used.
2. Where more than three measurements were within 1.1 of each other, each single measurement in all cases was doubled and their sum divided by 6.
3. If there were only three measurements which were within 1.1 of the other, they were averaged out if two were found within 0.6. Measurements which varied by more than 2.2 were circled and all the others were weighted and averaged out as in Item 2 above.

Anthropometres calibrated in millimetres were used to measure the heights (132).

II. THE DATA USED

The two hundred sixty-three cases used in this study were those girls whose accurate dates of menarche and of birth were available along with records of their annual height measurements.

The original Harvard Growth Study data from which these cases were extracted are available in the Child Development Laboratory of The Bureau of Research and Service, College of Education, Michigan State University, East Lansing, Michigan. The summary on the data written by Walter F. Dearborn, John W. M. Rothney, and Frank K. Shuttleworth under the title, "Data on the Growth of Public School Children," published in the Monographs of the Society for Research in Child Development was also used for comparative purposes (133). Wherever there were some discrepancies in the records of the two sources, the record of the original data was preferred. Moreover, there were some cases having menarcheal records in the original data, but were not included in the "Data" publication.

CHAPTER V

PROCEDURE

An organism progressing from a state of immaturity towards maturity goes through several processes. Some of these processes result or terminate in certain specific physical characteristics visible to the human eyes: increase or decrease in height, weight, size, strength of grip, and appearance of secondary sexual characteristics. These apparent changes on every phase of development do not go on forever, but rather, tend to proceed towards relatively definite maxima or minima consonant with individual pattern. However, with the basic assumption that nature is constant, there are difficulties in accepting these human variabilities as natural without impirical evidence and proof.

Therefore, it is assumed that if the most natural method or means of scaling organismic growth is utilized to process longitudinal data, in the final analysis, a relationship should be found to exist between every phase of development and the point in time at which a sign of maturity is manifested

Consequently, it becomes pertinent to hypothesize that if the Gompertz function is in reality a more refined and accurate method

of illustrating the natural pattern of organismic growth, the result of its use to treat height data collected longitudinally on girls whose dates of menarche are available should discover a natural point of individual growth in height about which the menarche occurs irrespective of age. This point or amount of growth should be the percentage of development.

Similarly, because every organism has its own individual pattern of growth, results of processing data with the Gompertz function should disclose that neither the rate at which the individual grows, the maximum or maxima towards which the individual grows, nor the point from which the individual begins to grow singly would make any marked difference to this achieved percentage of development.

The Courtis adaptation of the Gompertz Growth Curve is based upon the isochronic system which assumes that the growths made in equal units of time are equal (134). This system does not only enable one to express a growth curve in a mathematical formula, but also facilitates the establishment of individual rates of growth. Thus while the former satisfies a scientific need, the latter is in accord with our knowledge of the variability of individuals.

The following procedure was therefore followed closely in fitting individual height growth data to the Courtis-Gompertz growth curves:

1. The data were plotted on logarithmic paper.
2. Points which were obviously out of the pattern were discarded in order to obtain a trial maximum. These points were regarded as probably being errors of measurement. They were, however, included when computing the error of the equation (135).
3. The percentage of development of each measure was calculated by dividing by the maximum. The results were plotted on isochronic paper. The trial maximum was varied until it more closely approximated a straight line graph. This was considered to be the true maximum. A positively accelerated line indicated that the assumed maximum was too low, whereas a negatively accelerated line meant that it was too high. The accuracy of the maximum was checked in an attempt to achieve a curve between two curves which were positively and negatively accelerated, respectively.
4. The equation was written with the trial maximum which resulted in the nearest approximation to a straight line (on isochronic paper). This maximum was again varied to approximate more closely the true maximum. That maximum which gave the least isochronic error was

selected as the best. Thus the equation with zero errors would be regarded as superior to another which balanced the error among several points.

5. The residuals of the first cycle were used with the same method to write equations for the second cycle, in order to compare the amount of the total growth achieved in each phase of development by individuals at the time of menarche.

6. The date of menarche was substituted in the individual equations, respectively, and the achieved growth at menarche was thus obtained. These were each divided by their determined maxima, respectively, and the percentage of development at menarche was thus obtained for the pre-adolescent cycle, the adolescent cycle, and for the total development (both cycles together).

7. The equations for all the cases were grouped in age ranges with intervals of 6 months between them, as was set up by Shuttleworth. Eight groups were thus obtained as follows:

    1. Cases with menarche before 11 years 6 months;
    2. Cases with menarche from 11 years 6 months to 11 years 11 months;

3. Cases with menarche from 12 years 0 months to 12 years 5 months;
4. Cases with menarche from 12 years 6 months to 12 years 11 months;
5. Cases with menarche from 13 years 0 months to 13 years 5 months;
6. Cases with menarche from 13 years 6 months to 13 years 11 months;
7. Cases with menarche from 14 years 0 months to 14 years 5 months; and
8. Cases with menarche after 14 years 5 months (136).

For the purposes of confirming or refuting the hypothesized assumption that the percentage of total development in height is an index to the time at which the menarche occurs in an adolescent girl, the parameters of the equations, maxima, rate, incipiencies, and the achieved percentage of development were analyzed statistically for each cycle and each group.

CHAPTER VI

ANALYSIS OF THE DATA

The mathematical formula of the Gompertz function as adapted by Courtis was used to write height equations for the 263 cases of girls of the Harvard Research Study whose dates of menarche were also available.

Seventeen of these cases had data sufficient to fit only the adolescent cycle. Therefore, the preadolescent cycle is not reported for them.

For ease of comparison, the 263 cases were arranged into eight groups according to the age at which menarche occurred. There was a six-month interval between each group. This grouping was also used by Shuttleworth.

There were twenty-three cases in which the menarche occurred before 11 years and 6 months of age. These are identified in Group I and are presented in Table XV.

Twenty cases had menarche occurring between 11 years and 6 months and 11 years and 11 months. These were identified as Group II and are presented as Table XVI.

The thirty-four cases which had their menarche occur between 12 years and 12 years and 5 months are given in Table XVII as Group III.

Group IV contained fifty-six cases. These had their menarche occur between 12 years and 6 months and 12 years and 11 months. These are presented in Table XVIII.

There were sixty-four cases in which the menarche occurred between 13 years and 13 years and 5 months. These were classified in Group V, as shown in Table XIX.

The thirty-four cases in which the menarche occurred between 13 years and 6 months and 13 years and 11 months are assigned to Group VI and presented in Table XX.

Those cases with the menarche occurring between 14 years and 14 years and 5 months were the twenty-three cases identified in Group VII, as shown in Table XXI.

The last set consisting of nine cases with menarche occurring after 14 years and 6 months are in Group VIII, as presented in Table XXII.

Each case had the height equation written showing the maxima, the rates, and the incipiencies for the preadolescent and the adolescent cycles of development. Moreover, the dates of birth and of the menarche, the percentage of development of each cycle as well as the

percentage of total development in height achieved at the time of menarche, are also included with each case. Along with these a number of height measurements and their average deviation from the curve of best fit are also given with each case, respectively.

Those cases which had only the adolescent cycle equation are given last in the tables wherever they occur in each group. These tables are contained in the Appendix.

In order to ascertain whether the age at which the menarche occurred affected the maxima to which an adolescent grows, this parameter was examined as follows:

The preadolescent cycle maximum ranges from 1,300 to 1,600 millimetres for Tables I, II, and IV; 1,310 to 1,550 millimetres for Table III; 1,300 to 1,680 millimetres for Table V; 1,350 to 1,700 millimetres for Table VI; 1,350 to 1,650 millimetres for Table VII; 1,350 to 1,540 millimetres for Table VIII groups. Thus there was a range of from 1,300 to 1,700 millimetres for the entire group. The summary of the ranges of preadolescent maximum is present in Table I.

Table II presents the distribution of the ranges of adolescent cycle maximum. The range for the entire group was from 90 to 300 millimetres; 102 to 215 for Group I; 96 to 250 for Group II; 105 to 250 for Group III; 90 to 300 for Group IV; 89 to 280 for

TABLE I

MAXIMUM PREADOLESCENT GROWTH (k) IN HEIGHT AND AGE OF MENARCHE
(1st cycle maxima by groups [k])

Group	Age at Menarche	Height Maximum			
		Below 1350	1350-1399	1400-1449	1450-1499
I	Before 11-6	1	2	5	4
II	11-6 to 11-11	1	1	2	12
III	12-0 to 12-5	2	3	6	8
IV	12-6 to 12-11	4	6	13	14
V	13-0 to 13-5	2	5	12	14
VI	13-6 to 13-11	0	4	7	3
VII	14-0 to 14-5	0	2	2	10
VIII	After 14-5	0	2	1	1
Totals		10	25	48	66

TABLE I (Continued)

Height Maximum					
1500-1549	1550-1599	1600-1649	1650+	Highest	Total
7	2	1	0	L=1300 H=1600	23
3	0	1	0	L=1300 H=1600	20
10	5	0	0	L=1310 H=1550	34
13	3	3	0	L=1300 H=1600	56
22	6	2	1	L=1300 H=1680	64
14	3	0	1	L=1350 H=1700	34
8	0	0	0	L=1350 H=1650	23
5	0	0	0	L=1350 H=1540	9
82	19	7	2	L=1300 H=1700	263

TABLE II

MAXIMUM ADOLESCENT GROWTH (k) IN HEIGHT AND AGE OF MENARCHE
(2nd cycle maxima by groups [k])

Group	Age at Menarch	Below 100	100-149	150-199	200-249
I	Before 11-6	0	8	8	3
II	11-6 to 11-11	1	8	5	3
III	12-0 to 12-5	0	10	15	6
IV	12-6 to 12-11	1	16	26	9
V	13-0 to 13-5	1	19	28	9
VI	13-6 to 13-11	0	12	15	2
VII	14-0 to 14-5	0	14	4	3
VIII	After 14-5	0	5	2	1
Totals		3	92	103	36

TABLE II (Continued)

250-299	300+	Lowest	Highest	Total	1 Cycle
0	0	102	215	19	4
3	0	96	250	20	0
1	0	105	250	32	2
1	1	90	300	54	2
4	0	89	280	61	3
1	0	117	270	30	4
0	0	105	215	21	2
1		120	260	9	0
11	1	89	300	256	17

Group V; 117 to 270 for Group VI; 105 to 215 for Group VII; and 120 to 260 millimetres for Group VIII.

The distribution of the final height maximum range for each group is presented in Table III. The range for the entire group was from 1,420 to 1,828 millimetres. Group I had a range of 1,420 to 1,745; Group II had 1,546 to 1,755 millimetres; Group III had 1,539 to 1,729; Group IV was from 1,500 to 1,756; Group V was from 1,504 to 1,828; Group VI was 1,473 to 1,821; Group VII had from 1,525 to 1,760; and Group VIII had a range of from 1,525 to 1,705 millimetres. The ranges of maxima for the preadolescent, adolescent, and total height among the eight groups did not differ in any significant way.

To find out whether the rate of growth in height increased or decreased with increasing age at which menarche occurred, the rates of growth were investigated.

Table IV presents the summary of rates of preadolescent growth in isochrons. The rate ranges from 5.0299 to 24.20 isochrons for the entire group. The ranges of rates among the groups do not seem to differ remarkably, except that Groups I and III had very slightly higher rates.

In Table V the ranges of rates of height growth for the adolescent cycle are summarized. The range for the entire group was from 1.7526 to 10.5818 isochrons. There were no apparent

TABLE III

MAXIMUM DEVELOPMENT (k) IN HEIGHT AND AGE OF MENARCHE
(total maximum by groups)

Group	Age at Menarche	Below 1450	1450-1499	1500-1549	1550-1599
I	Before 11-6	1	1	2	8
II	11-6 to 11-11	0	0	1	10
III	12-0 to 12-5	0	0	1	11
IV	12-6 to 12-11	0	0	7	18
V	13-0 to 13-5	0	0	7	14
VI	13-6 to 13-11	0	1	6	5
VII	14-0 to 14-5	0	0	2	8
VIII	After 14-5	0	0	1	1
Totals		1	2	27	75

TABLE III (Continued)

1600-1649	1650-1699	1700+	Highest Max.	Lowest Max.	Total
5	4	2	1745	1420	23
2	6	1	1755	1546	20
13	8	1	1729	1539	34
13	14	4	1756	1500	56
16	16	11	1828	1504	64
10	9	3	1821	1473	34
10	2	1	1710	1525	23
5	1	1	1705	1525	9
74	60	24	1828	1420	263

TABLE IV

RATE OF PREADOLESCENT GROWTH IN ISOCHRONS AND AGE AT WHICH MENARCHE OCCURRED
(2nd cycle rates by groups [k])

Group	Age at Menarche	Below 6.50	6.50-8.49	8.50-10.49	10.50-12.49	12.50-14.49
I	Before 11-6	0	1	5	7	3
II	11-6 to 11-11	0	4	3	11	1
III	12-0 to 12-5	1	3	11	6	7
IV	12-6 to 12-11	0	13	17	15	3
V	13-0 to 13-5	1	14	22	15	2
VI	13-6 to 13-11	1	2	11	9	4
VII	14-0 to 14-5	0	3	7	4	2
VIII	After 14-5	1	0	3	0	2
Totals		4	40	79	67	24

TABLE IV (Continued)

14.50-16.49	16.50-18.49	18.50-20.49	Over 20.49	Lowest	Highest	Total
1	1	0	1	8.3864	24.20	19
0	0	1	0	6.9476	18.9	20
1	1	1	1	6.4108	23.8686	32
4	1	1		6.7525	19.7277	54
2	4	0	1	6.4186	20.5722	61
2	1	0	0	6.4108	16.6162	30
4	0	1	0	6.8131	19.7826	21
1	1	0	0	5.0299	17.68	9
25	9	4	3	5.0299	24.20	246

TABLE V

RATE OF ADOLESCENT GROWTH IN ISOCHRONS
AND AGE AT WHICH MENARCHE OCCURRED
(1st cycle rates by groups [k])

Group	Age at Menarche	Below 2.50 (Lowest)	2.50-3.49	3.50-4.49
I	Before 11-6	2 (2.225)	9	4
II	11-6 to 11-11	2 (1.7526)	6	10
III	12-0 to 12-5	2 (2.2597)	15	9
IV	12-6 to 12-11	3 (2.0642)	33	10
V	13-0 to 13-5	7 (2.0316)	30	18
VI	13-6 to 13-11	4 (2.2525)	10	13
VII	14-0 to 14-5	2 (2.4466)	12	6
VIII	After 14-5	3 (2.2571)	3	1
Totals		25	108	71

TABLE V (Continued)

4.50-5.49	5.50-6.49	6.50-7.49	7.50+ (Highest)	Total
2	3	2	1 (7.74)	23
2	0	0	0 (5.1869)	20
5	1	0	2 (10.5818)	34
3	6	1	0 (6.8585)	56
2	3	4	1 (8.3085)	64
2	3	2	0 (7.3821)	34
1	0	2	0 (7.25)	23
2	0	0	0 (5.1458)	9
18	16	8	2	

differences in the ranges of height growth among the groups in respect of the chronologically different menarcheal ages.

The next parameter to be investigated was meant to serve to discover whether the point from which an adolescent began to grow on any phase of development was related to the time at which the menarche occurred. Hence, the incipiencies of height growth were examined.

The summary of incipiencies of growth for the preadolescent cycle is presented in isochrons in Table VI. Group I had incipiency range from -0.35 to +28.82; Group II was from +4.46 to +35.76; Group III had -34.49 to +29.21; Group IV was from -3.39 to +30.25; Group V was -5.55 to +30.11; Group VI was -5.22 to +27.13; Group VII was from -12.28 to +25.06; and Group VIII had from -3.47 to +27.30 isochrons.

The range for the entire group was from -34.49 to +35.76. There was no noticeable difference in incipiencies peculiar to the consistent increase of chronological age at which menarche occurred. The lowest incipiency was found in Group III (-34.49 isochrons), and the highest, in Group II (+35.76 isochrons).

In the adolescent cycle the range of incipiencies for the total group was from -32.19 to +246.48 isochrons. There were also no peculiarities found between the ranges of incipiencies within each

TABLE VI

BEGINNING OF GROWTH (i) IN HEIGHT FOR THE PRE-ADOLESCENT CYCLE AND AGE OF MENARCHE
(1st cycle incipiencies by groups [k])

Group	Age at Menarche	Before 0.50	0.50-5.49	5.50-10.49	10.50-15.49
I	Before 11-6	1	1	1	1
II	11-6 to 11-11	0	1	0	2
III	12-0 to 12-5	1	0	0	8
IV	12-6 to 12-11	2	2	4	2
V	13-0 to 13-5	4	2	2	9
VI	13-6 to 13-11	1	1	0	10
VII	14-0 to 14-5	1	0	1	1
VIII	After 14-5	1	0	1	1
Totals		11	7	9	34

TABLE VI (Continued)

15.50-20.49	20.50-25.49	25.50+	Lowest	Highest	Totals
2	6	7	- 0.35	28.82	19
4	10	3	4.46	35.76	20
8	9	6	-34.49	29.21	34
7	27	10	- 3.39	30.25	54
11	19	14	- 5.55	30.11	61
6	8	4	- 5.22	27.13	30
8	10	0	-12.28	25.06	21
2	2	2	- 3.47	27.30	9
48	91	46	-34.49	35.76	246

group and the varied chronological ages at which menarche occurred. The summary of these findings is presented numerically in Table VII.

Examination of Tables VI and VII reveals that neither the distribution of the rates nor that of the percentages tended to indicate any directional pattern in favour of the progressively increasing group age; hence, no special statistical method was required to analyze them.

In order to determine whether the percentage of height development would provide a reliable index to the advent of menarche such as would not fluctuate with the variations in the rate at, the maximum to, and the point from which the individual begins to develop as well as the time at which the menarche occurred, the percentages of growth in height on each phase of development were analyzed. The means and standard deviations of the percentages for each phase of development were computed. These statistical treatments were chosen in order to determine the average percentage of growth around which the menarche occurred; and also, to obtain a measure of dispersion of these percentages.

Group I had a range of 91.20 to 98.78 percent. Group II was from 93.18 to 98.44 percent; Group III was from 93.07 to 99.85 percent; 91.50 to 99.63 percent for Group IV; 92.15 to 99.72 percent for Group V; Group VI had a range of 92.76 to 99.48 percent; 94.85

TABLE VII

BEGINNING OF GROWTH (i) IN HEIGHT FOR THE ADOLESCENT CYCLE AND AGE OF MENARCHE
(2nd cycle incipiencies by groups [k])

Group	Age at Menarche	Below -50.49	-50.50 to -79.49	-75.50 to -100.49	-100.50 to 125.49
I	Before 11-6	0	3	9	4
II	11-6 to 11-11	3	3	7	6
III	12-0 to 12-5	4	5	10	6
IV	12-6 to 12-11	2	19	16	9
V	13-0 to 13-5	3	16	21	13
VI	13-6 to 13-11	2	3	13	6
VII	14-0 to 14-5	0	4	7	1
VIII	After 14-5	1	0	3	0
Totals		15	53	86	45

TABLE VII (Continued)

125.50 to 150.49	150.50 to 175.49	175.50 to 200.00	Over 200	Lowest	Highest	Total
0	2	0	1	-66.32	-246.48	19
0	1	0	0	-43.04	-175.30	20
4	1	1	1	-45.66	-246.16	32
4	2	1	1	-44.81	-212.54	54
3	1	3	1	-41.46	-213.30	61
5	1	0	0	-47.31	-169.80	30
4	4	0	1	-51.44	-224.64	21
3	1	0	1	-32.19	-213.74	9
23	13	5	6	-32.19	246.43	246

to 99.45 percent for Group VII; while Group VIII had a range of 95.39 to 99.20. There was no noticeable difference between the mean percentage of development in height among the groups. However, there was a slight increase with age at menarche in the lowest figures of the percentage ranges with increase of age at which menarche occurred. This increase was nevertheless not consistent with the increase of menarcheal age. The statistical analysis of percentages of growth in height for this cycle is presented in Table VIII.

Table IX shows the statistical analysis of percentages of achieved growth in height for the second cycle of development.

In Table XI the percentages of achieved adolescent growth in height at menarche are presented in groups according to menarcheal ages. The range of percentages was from 3.38 percent to 98.28 percent. The mean for the whole group was 75.95 percent (137) with a standard deviation of 13.12. There was a tendency for the lowest figures of the ranges to increase with the increase menarcheal group age. This tendency, though present in the highest figures of the ranges, was not very consistent (138) with the increase of group menarcheal age.

Table XII presents the distribution of percentages of the total height growth achieved at the advent of menarche for each

TABLE VIII

ANALYSIS OF DATA: FIRST CYCLE PERCENTAGE OF DEVELOPMENT
(N = 246)

Range = 91.20 through 99.85
Mean = 96.573
Standard Deviation = 1.73

TABLE IX

ANALYSIS OF DATA: SECOND CYCLE PERCENTAGE OF DEVELOPMENT
(N = 263)

Range = 3.38 through 98.29
Mean = 75.95
Standard Deviation = 13.12

TABLE X

PERCENTAGE OF PREADOLESCENT GROWTH IN HEIGHT ACHIEVED AT MENARCHE, AND AGE AT WHICH MENARCHE OCCURRED
(1st cycle % at menarche)

Group	Age at Menarche	Lowest	Below 90	91.49	92.49	93.49	94.49
I	Before 11-6	88.15	0	1	2	1	3
II	11-6 to 11-11	93.18	0	0	0	1	4
III	12-0 to 12-5	93.07	0	0	0	1	0
IV	12-6 to 12-11	91.50	0	0	1	0	4
V	13-0 to 13-5	92.15	0	0	1	2	3
VI	13-6 to 13-11	92.76	0	0	0	1	4
VII	14-0 to 14-5	94.85	0	0	0	0	0
VIII	After 14-5	95.39	0	0	0	0	0
Totals			0	1	4	6	18

TABLE X (Continued)

95.49	96.49	97.49	98.49	99.49	99.50+	Highest	1 C.	Total
1	7	2	0	2	-	98.78	4	23
2	4	5	4	0	-	98.44	-0	20
3	12	7	4	4	1	99.85	-2	34
13	14	8	8	4	2	99.63	-2	56
5	16	15	10	3	6	99.72	-3	64
4	2	4	9	6	0	99.48	-4	34
2	5	3	9	2	0	99.45	-2	23
1	2	2	2	2	0	99.20	0	9
31	62	46	46	23	9			

TABLE XI

PERCENTAGE OF ADOLESCENT GROWTH IN HEIGHT ACHIEVED AT MENARCHE, AND AGE AT WHICH MENARCHE OCCURRED
(2nd cycle % of k)

Group	Age at Menarche	Below 21	21-25	26-30	31-35	36-40	41-45	46-50	51-55
I	Before 11-6	2	1	0	1	1	1	1	3
II	11-6 to 11-11	1	0	1	0	0	0	1	0
III	12-0 to 12-5	0	0	0	0	0	1	0	0
IV	12-6 to 12-11	0	0	0	0	0	0	0	2
V	13-0 to 13-5	0	0	0	0	0	0	0	2
VI	13-6 to 13-11	0	0	0	0	0	0	0	0
VII	14-0 to 14-5	0	0	0	0	0	0	0	0
VIII	After 14-5	0	0	0	0	0	0	0	0
Totals		3	1	1	1	1	1	2	7

TABLE XI (Continued)

56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Lowest	Highest
0	1	1	3	1					3.38	84.29
2	0	5	4	2	0	3	1		16.03	91.71
0	4	5	7	6	4	3	2	0	41	92.36
3	2	5	7	15	13	6	1		51.37	92.24
0	3	5	14	13	11	9	3	1	51.90	96.40
1	2	0	2	3	7	9	6	0	55.97	95.03
0	0	0	3	7	2	4	4	1	73.88	98.29
0	0	0	2	1	1	1	2	2	74.90	98.06
6	12	21	42	50	39	35	19	4		

TABLE XII

PERCENTAGE OF TOTAL GROWTH IN HEIGHT ACHIEVED AT MENARCHE AND AGE AT WHICH MENARCHE OCCURRED

Group	Age at Menarche	Range	84.49	85.49	86.49	87.49	88.49	89.49
I	Before 11-6	83.52 95.24	1	0	1	1	1 (1)	2
II	11-6 to 11-11	86.90 95.94	0	0	0	1	0	0
III	12-0 to 12-5	89.97 98.17	0	0	0	0	0	0
IV	12-6 to 12-11	88.60 97.44	0	0	0	0	0	1
V	13-0 to 13-5	90.26 96.90	0	0	0	0	0	0
VI	13-6 to 13-11	91.76 97.53	0	0	0	0	0	0
VII	14-0 to 14-5	93.29 98.54	0	0	0	0	0	0
VIII	After 14-5	95.08 97.05	0	0	0	0	0	0
Totals		83.52 98.54	1 1	0 0	1 1	2 2	1 (1) 2	3 3

TABLE XII (Continued)

90.49	91.49	92.49	93.49	94.49	95.49	96.49	97.49	98.49	99.49	Totals	
2	1	2 (1)	2	5 (1)	1	0 (1)	0	0	0	19 (4)	23
2	0	2	4	8	2	1	0	0	0	20	20
1	0	2	5 (1)	11	8	3	1 (1)	1	0	32 (2)	34
0	2	1	7	18	16 (1)	6	3	0	0 (1)	54 (2)	56
1	0	4	8	9	14	21 (1)	4 (2)	0	0	62 (2)	64
0	0	1	3	7	4	6 (2)	10 (1)	1 (1)	0	30 (4)	34
0	0	0	1	3 (1)	3	9	2	2	1 (1)	21 (2)	23
0	0	0	0	0	4	3	2	0	0	9	9
6	3	12 (1)	30 (1)	61 (2)	52 (1)	47 (4)	22 (4)	4 (1)	1 (2)	246 (17)	263
6	3	13	31	63	53	51	26	5	3	263	

menarcheal age group. As with the preadolescent and adolescent cycles of development, the tendency for the range of percentages to increase slightly with decrease of chronological age at menarche is indicated.

The range of percentages for the total group (263 cases) was from 83.52 to 98.93, with a mean of 94.4524 percent and a standard deviation of 2.08.

Although the preadolescent cycle had a shorter range, and therefore the least dispersion of percentages of development at menarche, the total development phase was chosen for further and final analysis for practical reasons. Therefore, the mean and standard deviation were computed for each menarcheal age group on this phase.

The range for Group I was from 83.52 to 95.60, with a mean of 91.26 percent and a standard deviation of 3.1094.

Group II had a range of 86.90 to 95.94 percent with a mean of 93.05 and a standard deviation of 2.1008. In Group III a range of 89.97 to 98.17 and a mean of 94.29 percent are shown with a standard deviation of 1.5445. A mean of 94.41, a range of 88.60 to 97.44 percent, and a standard deviation of 1.568 represents the range for Group IV. Group V has a range of 90.26 to 96.90 with a mean of 94.875 percent and a standard deviation of 1.5155.

In Group VI the range was 91.76 to 97.53 with a mean of 95.588 percent and a standard deviation of 1.5926. Group VII had a range of percentage of 93.29 to 98.58 with a mean of 95.913 and a standard deviation of 1.5579. Group VIII ranged from 95.08 to 97.05 percent, a mean of 95.78 percent and a standard deviation of 0.7862.

These tables show no significant difference in the upper limits of the range of percentages of each group, but a slight and inconsistent increase in the figures of the lower limits of the ranges. Nevertheless, the mean for each of the eight groups fell within one standard deviation of the mean for the whole group. This was an evidence of stability and closeness between the means of each group and of the entire group. A statistical analysis of the percentages of total development is presented in Table XIII.

For the purpose of verifying the findings current in the literature, the mean age at which menarche occurred was computed for the entire group. This was found to be 13.06 years of age, with a standard deviation of 1.501 years, and a range of from 10 years and 1 month to 16 years and 1 month. The mean ages for each group were: 10.976, 11.704, 12.143, 12.70, 13.116, 13.667, 14.136, and 15 years, respectively. The correlation between the percentage of total

TABLE XIII

ANALYSIS OF DATA: PERCENTAGE OF TOTAL DEVELOPMENT

Group	Age at Menarche	N	Range of %
I	Before 11-6	23	83.52-95.60
II	11-6 to 11-11	20	86.90-95.94
III	12-0 to 12-5	34	89.97-98.17
IV	12-6 to 12-11	56	88.60-97.44
V	13-0 to 13-5	64	90.26-96.90
VI	13-6 to 13-11	34	91.76-97.53
VII	14-0 to 14-5	23	93.29-98.58
VIII	After 14-6	9	95.08-97.05
Totals		263	83.52-98.93

Ra/% = 0.384.

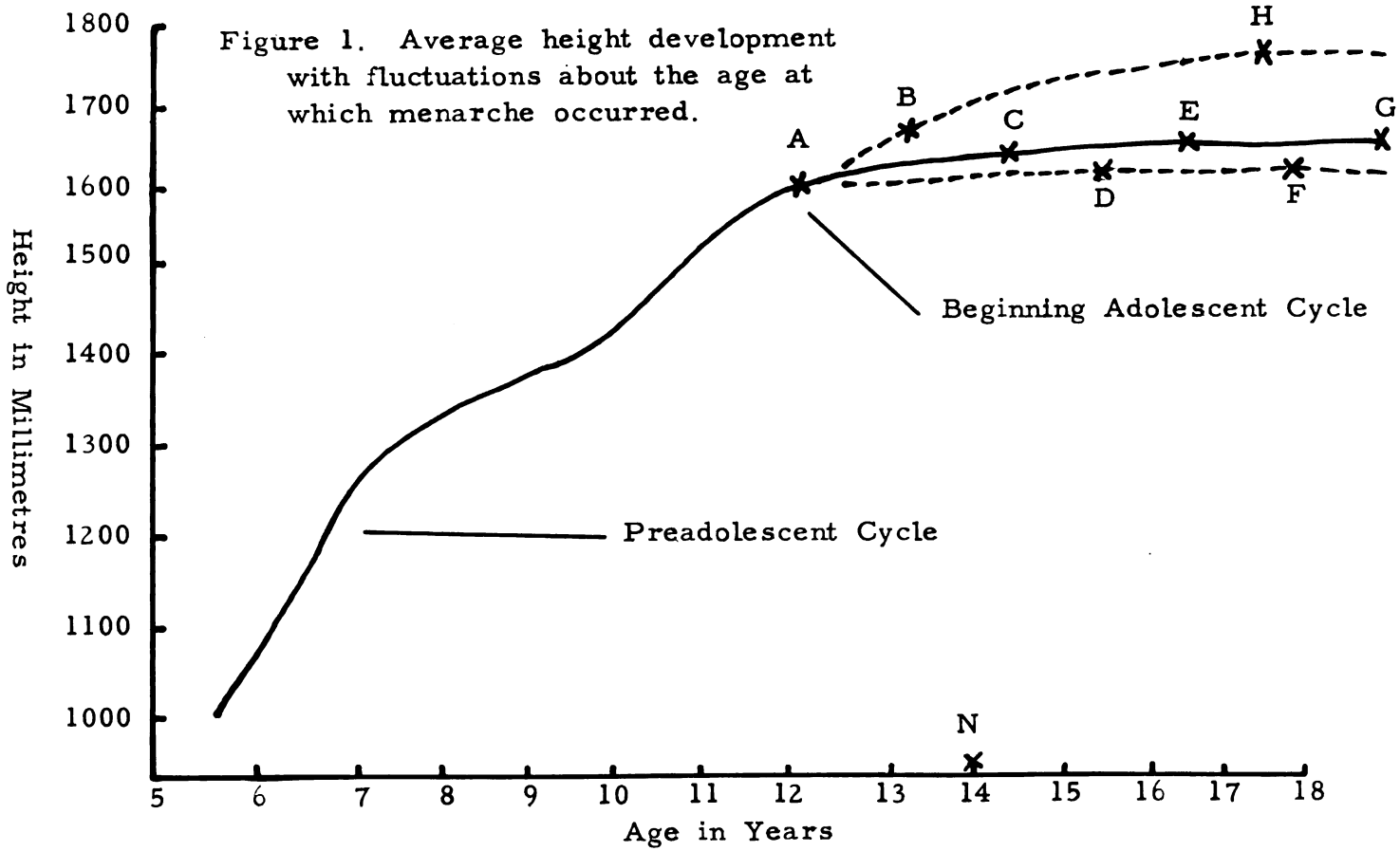
TABLE XIII (Continued)

Mean %	S.D.%	Mean Age	S.D. Age
91.26	3.1094	10.976	0.38
93.05	2.0118	11.704	0.1246
94.29	1.5445	12.143	0.14442
94.41	1.568	12.700	0.1577
94.875	1.5155	13.116	0.1328
95.588	1.5926	13.667	0.15106
95.913	1.5579	14.136	0.11786
95.78	0.7862	15.0	0.425
94.4524	2.08	12.8933	0.88

development and age at menarche was 0.384. These analyses are presented in their respective columns in Table XIII.

Figure 1 shows an average growth curve for both the pre-adolescent and the adolescent cycles, with the usual deviations about the years in which menarche occurred. Points A, C, and E show perfect fit and 0 deviation. Point B indicates a negative deviation, while points D and F indicate positive deviations of the measures from the curve of best fit at such points. This illustration was a part of the step taken to verify a previous finding in the literature that the Gompertz growth curve indicated a tendency for the growth in height to fluctuate around the age at which menarche occurs.

A general tendency for measures to show negative deviations at the point or points one or two years before menarche, and to drop to normal after its occurrence was clearly evident. Moreover, the tendency for cases with large negative deviations at these points to have relatively lower adolescent percentage of development was quite in evidence. Lack of adequate methods of analysis, coupled with the lack of supplementary data, discouraged further probing into this aspect of the study. However, because this latter tendency was related to the low percentage of adolescent growth, it could be interpreted to be an evidence of disturbed emotional state.



B = negative deviation.
C, E, G = zero deviation on course traced by the curve of best fit.
D and F = positive deviations.
A, B, H and A, D, F = other possible course, but not of best fit.
N = mean age at which menarche occurred.

* See Figure 2, page 141.

In order to verify the numerous assertions and findings in the literature that the season of birth has some relationship to the individual life pattern, and also that the menarche occurs lease in the summer and most in the winter, the seasons of birth and of menarche were analyzed. The fall quarter had the most births--70; the most menarche cases--79; and the most cases whose menarche occurred in the same season as their birth--37. The summer, spring, and winter follow in their respective order of menarche occurrences; spring, summer, and winter in order of frequencies of cases of births. The distributions of menarche and birth occurrences are tabulated in Tables

Table XIV shows the number of births and of menarche occurring in each season and the number of cases whose menarche seasons corresponded with the seasons in which they were born.

TABLE XIV

SEASON OF MENARCHE AND BIRTH
(N = 249)

	Season*			
	A	B	C	D
Births	66	62	70	52
Menarche	51 18	71 21	79 36	49 12

* Seasons are as follows: A = March-May; B = June-August; C = September-November; D = December-February.

Note: Thus 90 cases, or 36.14%, had menarche in the season in which they were born. D had the most births, but in descending order were C, B, D, and lastly, A.

CHAPTER VII

SUMMARY

The knowledge that growth in different phases leads to some ultimate maturational point led to the assumption that there must be a relationship between one phase of development and a maturational phenomenon. This study was therefore undertaken to discover the relationship between the menarche and the achieved growth in height of adolescent girls.

Two hundred sixty-three cases of the Harvard Longitudinal Study whose accurate annual height measurements, dates of birth and of menarche were obtained from the Harvard data now available at the Child Development Laboratory of the Bureau of Research and Service of Michigan State University, East Lansing, Michigan. These data were cross-checked with those published by Dearborn and Rothney to insure accuracy in the recording.

Growth equations portraying the achieved growth in height for each case were written utilizing the Courtis adaptation of the Gompertz function--$y = k (rt \pm i)$. Here y = achieved growth, k = maximum of a cycle, r = rate, t = time, i = incipiency or starting point, and = isochronic value. This method was used because

its efficiency as well as its accuracy in describing the course of biological growth has been proven both imperically and in principle.

The chronological age at which menarche occurred was substituted for time in the height equation of each case respectively and the achieved growth at the time was obtained for each cycle. The achieved development in each cycle was used to compute the achieved percentage of development over the maximum for the preadolescent, adolescent, and total development at the time when menarche occurred. The cases were arranged in eight groups according to the chronological ages at menarche. There was an interval of six months between the groups.

Because of the insufficiency of data, seventeen of the cases could only be fitted the adolescent cycle equation, where as the rest had the preadolescent cycles also.

In order to determine the amplitude of development in height at the onset of menarche the percentages of development were analyzed.

To find the average age at menarche mean age for the time of menarche of the entire group was computed to discover whether the rate of growth, the starting point, and the maximum toward which an individual develops influenced the percentage of development,

the rates, the incipiencies, and the maxima were analyzed statistically.

To verify the number of seasonal births and menarche occurrence, the dates of birth and of menarche were classified according to seasons.

These analyses led to the following findings:

1. The mean age at which menarche occurred was 13.06 years. There was, however, an age range of from 10.08 to 16.08 years in the group, and the mean was similar to the figures reported in the literature.
2. Menarche was found to occur when an adolescent girl has achieved 94.45 percent of her maximum development in height.
3. The mean percentage of height development at menarche for the eight menarcheal age groups only varied from 91.26 to 95.91 percent, thus falling within one standard deviation of this mean for the entire group. This was a very high index of similarities between each group mean and the mean of the entire group.
4. The range of percentages of total development was found to become narrower with the increase of the age at which menarche occurred.

5. With a low positive correlation of 0.38 between the ages and percentage of height development at menarche, age was considered to have no significant relationship with the percentage of development achieved when menarche occurred.

6. The adolescent cycle had the widest range of percentages of development achieved at menarche: 3.38 to 98.29. The mean was 75.95 percent. While these figures were similar to those once reported in the literature, this phase of development in height was thus considered to be rather very unstable and unsuitable for prediction.

7. The mean percentage of height development for the pre-adolescent cycle was found to be 96.57, with a range of from 91.20 to 99.85 percent. While this phase was probably more stable because of its shorter range of percentages, the "total development" phase was preferred for further analysis because of its greater practical and predictive values.

8. The frequencies of occurrences of menarche for the four seasons of the year were: fall, 79; summer, 71; spring, 51; and winter, 49. Therefore, this study did not find

summer to have the lowest number of occurrences of menarche as frequently reported in the literature.

9. There was a tendency for measurements in height taken a year or two before the advent of menarche to show marked negative deviations from the derived curve of best fit, thus indicating sudden spurt followed by a drop-back to normal in height. This tendency coincided in time with that in which blood pressure and the basic rate of metabolism rise as reported in the literature.

10. Further analyses of this tendency for measurements at this period of life to fluctuate considerably about the curve of best fit showed that cases with high negative deviations generally had a relatively low adolescent percentage of height development at menarche. But lack of supplementary data prevented further inquiry. Hence, it is necessary to speculate that this tendency might be due to a disturbed emotional state.

The maximum to which the individuals grew, the rate at and the point from which development in

height progressed were not found to vary with the ages at which menarche occurred.

CHAPTER VIII

IMPLICATIONS AND CONCLUSIONS

1. The findings of this study seem to indicate a need for studying the relationship of menarche to other phases of development, such as weight.
2. This study would have been more fruitful were there supplementary data to which the upheavals and fluctuations in growth about the curve of best fit around the menarche years could be related. There is no doubt that the revealed sensitivity of the Gompertz function could patternize and successfully relate each pattern to specific differences due to emotional impact upon a stage of development. Thus the emotional and behavioural outcome of homeastasis at such a phase or other phases of total development could be discerned. Meaning could also be attached to the tendency for the growth curve to show high spurt and drop, respectively, around the ages where menarche occurs.
3. This study confirms the Courtis adaptation of the Gompertz function as an accurate method of illustrating the course of

natural growth, thus rendering it imperative to have more research to discover initial stages at which many learning activities naturally take place.

4. This study establishes the basis for predicting the advent of menarche in an adolescent girl. It should, therefore, prove of great value for counseling.
5. This and many other related studies in the field have established the bases for investigating the various facets of the development concept. These should provoke much thought among the educators and the authorities concerned in view of the current practices of admission and grading in schools.
6. While the concept of mental age still seems to be valid in the light of growth and development, to conceive that it is possible to establish an index of natural mental endowment such as denoted in the I.Q. by sampling growth on a single stage on one phase of development is untenable.

The following conclusions were drawn:

1. Menarche occurs in a girl when she attains approximately 94 percent of her total development in height.
2. The chronological age at which menarche occurs in an adolescent girl does not in any way affect this percentage of development.

3. The rate at which adolescent girl, the incipiency from, and the maximum height to which she grows do not vary consistently with the varying ages at which menarche occurs.

4. Because of the wide range of ages at which the menarche occurs among the group, the use of age was not found to be an accurate method of predicting the advent of menarche.

5. The Courtis adaptation of the Gompertz function, besides being an accurate technique for tracing the natural course of human growth, also indicates a tendency for measures to rise and drop back to normal before and after menarche, respectively. Such a tendency has been reported in studies of the rate of metabolism and blood pressure at the same period of life. Hence it is assumed that the Gompertz function might perhaps be sensitive to similar conditions and causes.

6. Since the extreme fluctuating tendencies corresponded to low adolescent percentage of height growth, emotional disturbance was suspected to be the main contributing factor.

7. Most menarche cases occurred in the fall season rather than the winter, and the least number of cases occurred in the summer rather than the winter, which was not in accordance to cases reported in the literature.

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APPENDIX A

TABLE XV

HEIGHT GROWTH CONSTANTS OF GIRLS WHOSE MENARCHE OCCURRED BEFORE 11 YEARS 6 MONTHS*

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
344	1	1550	5.5459	+ 9.10	11-4
	2	157	8.85	- 66.32	
382	1	1350	3.2941	+ 25.35	11-1
	2	202	10.115	- 70.12	
549	1	1350	6.5	- 0.35	11-4
	2	205	9.5489	- 77.24	
621	1	1450	4.58	+ 11.43	11-1
	2	45	8.3864	- 68.16	
842	1	1400	5.8515	+ 0.81	10-9
	2	102	12.6019	-100.27	
1002	1	1400	3.8351	+ 22.67	10-5
	2	215	10.4208	- 75.81	
1286	1	1500	2.3689	+ 28.42	11-4
	2	195	16.3232	-155.42	
1590	1	1450	3.3119	+ 19.95	10-7
	2	188	10.1187	- 99.35	
1635	1	1450	2.225	+ 28.82	11-3
	2	147	11.8232	- 93.74	
1663	1	1520	3.1685	+ 24.83	11-5
	2	160	13.4647	-109.51	
1716	1	1430	2.7685	+ 25.77	10-9
	2	135	16.5693	-152.36	

TABLE XV (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
98.51 51.03	94.14	± 7.1	12
95.94 73.90	93.04	± 1.25	12
98.78 40.30	91.13	± 3.4	10
96.08 18.50	89.03	± 2.3	10
96.62 55.18	93.81	± 3.3	11
96.24 46.90	89.66	± 4.5	11
92.31 35.03	85.72	± 6.6	11
97.24 70.73	94.08	± 2.1	11
91.20 67.40	88.98	± 6.1	12
95.60 78.64	93.99	± 3.5	11
92.51 21.70	86.77	± 7.83	13

TABLE XV (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
1832	1	1300	3.4304	+ 20.60	11-0
	2	197	12.2887	-103.00	
2167	1	1500	2.9507	+ 24.28	11-5
	2	188	12.1425	- 95.87	
2290	1	1500	3.6316	+ 19.60	11-4
	2	127	10.9850	- 81.06	
2345	1	1600	3.0505	+ 23.45	10-7
	2	145	12.2469	-109.47	
2429	1	1450	2.75	+ 27.14	11-5
	2	141	11.5369	- 90.98	
2484	1	1500	4.0199	+ 16.77	11-3
	2	129	14.0209	-120.27	
2610	1	1400	4.1027	+ 18.25	10-7
	2	168	10.5993	- 78.32	
2114	1	1500	2.7561	+ 24.65	10-1
	2	157	24.20	-246.48	
	Cases with Data for Only One Cycle Equation				
1243	2	1544	7.4667	- 32.02	11-1
1297	2	1420	7.744	- 22.23	10-9
1384	2	1560	5.9765	- 7.50	10-5
3321	2	1620	5.3640	- 1.68	11-0

* Group I, menarche cases before 11-6.

TABLE XV (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
94.28 44.75	87.78	± 3.3	13
94.08 75.73	92.00	± 4.2	12
95.47 76.96	94.04	± 3.8	11
96.23 84.29	95.24	± 6.3	12
94.40 71.13	92.33	± 4.1	12
96.00 62.27	93.31	± 4.6	11
95.87 50.53	89.86	± 3.0	9
91.93 3.38	83.52	± 8.2	10
Cases with Data for Only One Cycle Equation			
	88.15	± 5.6	10
	95.60	± 2.9	9
	91.95	± 2.6	6
	93.70	± 5.7	10

TABLE XVI

HEIGHT GROWTH CONSTANTS OF GIRLS WHOSE MENARCHE OCCURRED BETWEEN 11 YEARS 6 MONTHS AND 11 YEARS 11 MONTHS*

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
220	1	1420	3.2282	+ 20.37	11-9
	2	175	12.3483	-117.84	
273	1	1450	3.6139	+ 21.15	11-9
	2	41	12.2886	-101.58	
309	1	1425	4.4732	+ 19.25	11-8
	2	250	7.0369	- 43.04	
386	1	1350	4.3812	+ 21.16	11-6
	2	202	9.5987	- 65.76	
558	1	1450	5.0762	+ 10.67	11-9
	2	195	6.9476	- 45.19	
912	1	1300	3.670	+ 24.45	11-9
	2	290	7.7608	- 51.77	
1008	1	1450	3.3920	+ 23.20	11-8
	2	38	11.2425	- 91.09	
1087	1	1500	3.7568	+ 21.46	11-10
	2	192	11.3131	- 94.51	
1479	1	1450	3.7196	+ 16.83	11-10
	2	140	12.4633	-106.39	
1495	1	1480	3.3663	+ 24.30	11-10
	2	20	7.6619	- 49.66	
1719	1	1450	3.6553	+ 20.35	11-11
	2	140	10.209	- 81.89	

TABLE XVI (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
94.27 26.80	86.90	± 2.8	11
96.59 75.78	94.78	± 4.6	10
98.43 66.80	93.73	± 4.8	11
98.44 79.33	95.94	± 2.5	12
98.24 59.17	93.62	± 4.5	11
97.69 67.73	92.20	± 5.6	10
95.02 67.93	92.83	± 2.4	9
97.28 67.45	93.91	± 2.9	10
95.52 71.80	93.46	± 3.4	10
96.76 71.64	93.75	± 4.7	11
96.69 68.70	94.21	± 4.1	12

TABLE XVI (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
2094	1	1450	5.1869	+ 4.46	11-7
	2	134	13.5606	-120.18	
2248	1	1450	3.8911	+ 12.98	11-11
	2	96	10.8753	-105.68	
2966	1	1450	2.587	+ 27.21	11-9
	2	215	12.0175	- 90.51	
3043	1	1450	3.8611	+ 17.32	11-7
	2	130	10.6181	- 82.38	
3162	1	1500	3.2574	+ 22.84	11-10
	2	135	11.2914	- 79.09	
3164	1	1600	3.11	+ 21.85	11-9
	2	155	12.1407	-109.61	
3211	1	1450	3.7784	+ 17.61	11-6
	2	100	18.9	-175.30	
3239	1	1500	2.4272	+ 28.60	11-11
	2		11.93	- 91.60	
3322	1	1400	1.7526	+ 35.76	11-10
	2	255	8.7873	- 55.38	

* Group II, menarche between 11-1 to 11-11.

TABLE XVI (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
96.87 60.43	93.81	± 1.44	10
94.83 16.03	89.91	± 2.3	9
93.87 88.14	93.15	± 4.4	10
96.02 70.68	93.92	± 2.7	9
95.75 91.71	95.41	± 3.5	10
94.32 47.85	90.20	± 3.4	12
95.62 74.10	94.26	± 6.5	12
93.83 88.04	93.25	± 6.0	10
93.18 85.56	92.02	± 10.4	11

TABLE XVII

HEIGHT GROWTH CONSTANTS OF GIRLS WHOSE MENARCHE OCCURRED BETWEEN 12 YEARS AND 12 YEARS 5 MONTHS*

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
18	1	1310	5.28	+ 14.92	12-1
	2	246	9.1746	- 62.58	
43	1	1420	3.8	+ 20.49	12-0
	2	215	11.9493	-112.12	
101	1	1400	3.3757	+ 21.36	12-0
	2	161	10.3402	- 81.66	
135	1	1410	10.5818	- 34.49	12-3
	2	240	9.198	- 74.32	
226	1	1450	4.0412	+ 14.76	12-1
	2	160	12.865	-115.92	
270	1	1350	4.7714	+ 15.08	12-3
	2	250	9.5103	- 75.98	
510	1	1340	3.1701	+ 12.76	12-3
	2	245	6.79	- 45.66	
1007	1	1550	2.925	+ 23.68	12-4
	2	138	14.1929	-135.50	
1126	1	1450	3.9347	+ 17.99	12-4
	2	183	9.3180	- 94.90	
1419	1	1500	3.3564	+ 21.69	12-4
	2	180	9.1846	- 74.90	
1571	1	1400	3.2642	+ 22.19	12-5
	2	150	8.5087	- 65.47	

TABLE XVII (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
97.38 85.13	95.44	± 2.9	10
97.33 41.45	89.97	± 4.2	12
95.96 74.92	93.79	± 5.4	11
99.85 64.83	94.79	± 1.9	10
96.58 67.90	93.73	± 3.0	9
98.72 70.55	94.31	± 4.9	8
99.01 62.40	93.38	± 5.3	11
95.02 67.93	92.83	± 3.1	12
97.44 69.23	94.31	± 2.6	12
96.41 64.80	93.04	± 3.1	8
96.26 69.75	93.74	± 2.0	8

TABLE XVII (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
1615	1	1500	3.2039	+ 22.38	12-0
	2	138	11.2274	- 91.48	
1675	1	1500	3.2266	+ 26.44	12-0
	2	165	7.4830	- 45.72	
1689	1	1500	2.7544	+ 26.73	12-5
	2		11.2947	- 92.34	
1803	1	1450	3.1067	+ 23.31	12-4
	2	123	17.7292	-165.79	
1877	1	1500	3.2903	+ 21.13	12-3
	2	157	10.3850	- 81.89	
1973	1	1500	3.6410	+ 18.71	12-5
	2	140	13.5590	-123.49	
2063	1	1350	3.9082	+ 19.97	12-2
	2	189	9.8081	- 78.58	
2151	1	1530	3.9899	+ 16.43	12-3
	2	105	18.6847	-178.06	
2266	1	1450	2.5743	+ 26.03	12-0
	2	200	6.4108	- 48.29	
2497	1	1350	5.2076	+ 12.02	12-1
	2	207	8.6499	- 60.02	
2522	1	1550	3.4901	+ 19.14	12-0
	2	139	14.2970	-129.45	
2538	1	1500	3.160	+ 22.62	12-1
	2	113	11.960	-102.18	

TABLE XVII (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
95.52 76.66	93.96	± 4.7	11
97.07 78.30	95.20	± 5.2	11
95.57 84.70	94.65	± 4.3	11
95.85 90.29	95.49	± 4.0	12
95.78 80.59	94.39	± 2.4	8
96.70 79.86	95.31	± 6.4	12
97.68 71.18	94.48	± 4.0	10
97.11 88.30	96.58	± 4.6	12
95.50 64.40	91.76	± 4.4	7
98.89 79.06	96.26	± 3.2	10
95.62 74.26	93.84	± 4.9	11
95.50 74.66	94.05	± 5.5	12

TABLE XVII (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
2707	1	1500	4.4293	+ 15.35	12-1
	2	173	15.2635	-138.49	
2795	1	1450	2.8866	+ 25.48	12-0
	2	172	12.0697	-100.51	
2914	1	1400	2.4949	+ 28.81	12-2
	2	152	23.8686	-246.16	
2933	1	1450	4.9135	+ 10.63	12-1
	2	150	13.7819	-128.82	
2965	1	1500	4.3251	+ 19.56	12-4
	2	135	12.940	-104.23	
3046	1	1450	4.3434	+ 14.92	12-3
	2	170	7.0080	- 46.24	
3226	1	1450	3.4444	+ 19.73	12-4
	2	125	9.9730	- 82.15	
3299		1400	2.2597	+ 29.21	12-0
		160	10.6010	- 77.69	
3338		1550	2.9672	+ 25.70	
		179	12.711	- 98.67	
		Cases with One Cycle			
392	2	1565	5.9127	- 17.25	12-5
2060A	2	1566	8.630	- 39.64	12-2

* Group III, cases with menarche between 12-0 and 12-5.

TABLE XVII (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
97.97 81.55	96.29	± 1.9	12
95.20 78.78	93.46	± 2.6	10
94.74 78.78	93.17	± 2.3	9
98.18 75.45	96.31	± 2.3	11
98.63 92.36	98.17	± 3.3	6
97.81 68.23	94.69	± 1.9	11
96.08 71.28	94.10	± 5.8	12
93.07 86.76	92.44	± 3.5	10
95.83 92.03	95.43	± 2.3	9
	Cases with One Cycle		
	92.97	± 5.3	12
	97.14	± 0.5	7

TABLE XVIII

HEIGHT GROWTH CONSTANTS OF GIRLS WHOSE MENARCHE OCCURRED BETWEEN 12 YEARS 6 MONTHS AND 12 YEARS 11 MONTHS*

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
11	1	1450	5.525	+ 6.07	12-10
	2	190	11.4660	-106.78	
62	1	1350	6.3465	+ 5.10	12-9
	2	250	6.9138	- 44.87	
258	1	1400	3.9646	+ 14.93	12-6
	2	105	18.1055	-184.41	
272	1	1400	6.8585	- 3.39	12-11
	2	163	7.65	- 54.38	
313	1	1400	2.6732	+ 27.72	12-9
	2	181	9.5986	- 70.59	
411	1	1340	3.522	+ 22.21	12-10
	2	205	7.2683	- 51.57	
497	1	1450	5.9895	- 0.71	12-6
	2	208	8.9262	- 75.39	
754	1	1350	4.2191	+ 18.38	12-8
	2	220	6.7525	- 44.81	
836	1	1300	3.670	+ 24.45	12-6
	2	300	7.9327	- 53.57	
838	1	1425	3.0	+ 25.16	12-6
	2	160	9.7057	- 74.38	
984	1	1530	2.4753	+ 26.25	12-10
	2	160	11.3216	-100.12	

TABLE XVIII (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
99.09 70.05	95.73	± 3.0	11
99.63 76.72	96.06	± 4.3	10
96.87 73.82	95.28	± 2.4	12
99.60 79.02	97.44	± 2.5	11
95.93 89.31	95.19	± 5.5	11
97.65 73.30	94.43	± 5.5	11
98.78 58.37	93.67	± 2.4	10
98.41 71.07	94.58	± 5.6	8
98.24 81.03	95.00	± 5.8	10
96.25 83.23	94.95	± 4.7	12
94.10 80.25	92.78	± 6.6	11

TABLE XVIII (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
991	1	1400	5.9125	+ 6.12	12-9
	2	215	8.2764	- 57.89	
1017	1	1400	3.8643	+ 18.14	12-10
	2	156	11.5440	-104.53	
1023	1	1350	4.1063	+ 20.03	12-10
	2	232	7.514	- 56.37	
1038	1	1450	3.1122	+ 22.23	12-11
	2	195	10.8822	- 96.04	
1114	1	1450	3.0595	+ 24.38	12-11
	2	248	14.9261	-145.95	
1158	1	1430	2.0642	+ 28.41	12-6
	2	166	10.6711	- 95.61	
1198	1	1350	4.9245	+ 6.73	12-6
	2	150	12.9487	-124.62	
1263	1	1325	3.537	+ 23.85	12-8
	2	243	10.995	- 88.20	
1372	1	1400	3.3168	+ 23.12	12-7
	2	175	7.9030	- 60.10	
1374	1	1480	3.1095	+ 21.20	12-6
	2	154	19.7277	-212.54	
1633	1	1500	3.0437	+ 23.32	12-7
	2	158	9.7214	- 79.09	
1638	1	1400	2.8972	+ 22.92	12-10
	2	157	7.3131	- 53.02	

TABLE XVIII (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
99.42 84.26	97.40	± 5.0	10
97.73 77.32	95.70	± 2.5	12
98.61 69.33	94.31	± 3.9	9
96.18 78.83	94.10	± 3.4	12
96.68 85.15	94.70	± 5.3	8
91.50 63.17	88.60	± 7.7	11
97.85 61.58	94.20	± 2.7	9
97.93 88.60	96.49	± 2.7	11
96.98 67.48	93.71	± 2.9	12
95.18 51.37	91.07	± 3.9	10
95.85 76.58	94.03	± 5.2	12
95.19 71.23	92.81	± 6.0	10

TABLE XVIII (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
1655	1	1525	2.9929	+ 25.57	12-8
	2	158	10.6137	- 89.11	
1735	1	1450	2.60	+ 25.83	12-11
	2	182	15.0452	-139.22	
1789	1	1450	2.7589	+ 25.26	12-8
	2	176	12.2576	-111.91	
1880	1	1450	3.5455	+ 21 22	12-11
	3	207	8.9356	- 63.80	
1916	1	1400	2.1815	+ 30.25	12-11
	2	175	9.1291	- 77.36	
1978	1	1350	2.8657	+ 22.94	12-9
	2	151	10.3930	- 97.87	
2050	1	1500	3.1815	+ 21.92	12-11
	2	175	11.6122	-102.76	
2134	1	1500	3.9133	+ 12.50	12-9
	2	123	9.5126	- 82.65	
2139	1	1325	3.0319	+ 26.64	12-11
	2	200	7.4799	- 50.74	
2169	1	1425	2.7277	+ 23.17	12-11
	2	132	15.5860	-156.54	
2176	1	1550	4.7053	+ 7.08	12-8
	2	124	13.3769	-128.78	
2280	1	1400	2.7789	+ 23.79	12-11
	2	109	9.9275	- 85.47	

TABLE XVIII (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
96.55 80.65	95.01	± 2.5	12
94.86 92.24	94.61	± 3.3	11
95.25 76.96	93.30	± 3.9	12
97.56 89.16	96.56	± 7.4	10
94.34 70.73	91.95	± 3.4	10
94.87 53.33	90.74	± 4.3	12
96.49 84.64	95.22	± 4.0	11
96.16 65.60	93.84	± 4.7	12
97.25 81.55	95.21	± 6.1	13
94.33 79.70	93.06	± 5.9	9
96.48 70.98	94.56	± 3.6	11
95.00 75.73	93.64	± 4.6	12

TABLE XVIII (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
2314	1	1500	3.0963	+ 21.70	12-6
	2	133	9.7282	- 70.47	
2354	1	1600	3.0505	+ 23.45	12-10
	2	145	12.2469	-109.47	
2355	1	1500	3.4604	+ 19.12	12-10
	2	122	8.2569	- 69.29	
2382	1	1450	2.8550	+ 26.92	12-6
	2	142	11.1457	- 91.38	
2443	1	1450	2.94	+ 22.18	12-11
	2	125	9.3353	- 79.24	
2520	1	1535	3.3024	+ 19.28	12-11
	2	122	11.9252	-108.68	
2536	1	1600	2.7464	+ 26.59	12-9
	2	156	12.0203	-108.03	
2544	1	1400	2.9561	+ 25.40	12-6
	2	175	9.6459	- 71.89	
2670	1	1450	3.3632	+ 23.71	12-9
	2	159	8.6633	- 64.50	
2856	1	1530	3.7641	+ 16.17	12-8
	2	149	10.8241	-100.43	
2886	1	1500	2.83	+ 23.94	12-11
	2	155	10.1738	- 83.07	
3131	1	1500	2.785	+ 23.30	12-11
	2	154	9.73	- 79.90	

TABLE XVIII (Continued

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
95.33 88.62	94.80	± 2.8	8
96.23 84.29	95.24	± 6.3	12
96.56 65.63	94.20	± 4.7	11
96.23 84.70	95.16	± 4.7	10
95.23 72.58	93.46	± 6.6	12
95.98 80.67	94.75	± 5.9	11
95.86 80.40	94.48	± 6.0	12
96.14 85.70	94.98	± 4.4	12
97.51 81.65	95.96	± 5.2	11
96.67 59.98	93.39	± 4.1	11
95.40 85.29	94.44	± 5.8	11
94.79 81.42	93.53	± 4.7	9

TABLE XVIII (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
3132	1	1600	3.2871	+ 18.45	12-10
	2	120	15.6847	-158.08	
3136	1	1550	3.0	+ 24.16	12-11
	2	161	14.3283	-132.90	
3176	1	1450	2.9158	+ 24.24	12-7
	2	141	8.1333	- 57.26	
3216	1	1450	4.93	+ 2.16	12-7
	2	90	8.0364	- 65.41	
3247	1	1500	2.6333	+ 26.38	12-7
	2	150	8.8998	- 67.33	
3319	1	1500	2.9950	+ 21.31	12-11
	2	140	10.4128	- 90.41	
3334	1	1450	2.5891	+ 25.34	12-9
	2	131	12.2925	-114.02	
		Cases with One Cycle			
147	2	1580	5.6644	- 78.59	12-6
1535		1655	5.6556	- 10.87	12-6

* Group IV, cases with menarche between 12-6 to 12-11.

TABLE XVIII (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
95.42 76.48	94.13	± 2.7	7
96.35 87.73	95.73	± 3.6	12
95.55 80.10	94.22	± 4.5	11
96.78 56.77	94.42	± 4.4	9
94.90 79.35	93.52	± 3.6	8
95.15 78.40	93.72	± 4.4	11
94.30 75.56	92.73	± 6.8	11
	Cases with One Cycle		
	99.74	± 2.8	6
	95.06	± 5.0	5

TABLE XIX

HEIGHT GROWTH CONSTANTS OF GIRLS WHOSE MENARCHE OCCURRED BETWEEN 13 YEARS AND 13 YEARS 5 MONTHS*

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
38	1	1450	4.1709	+ 13.48	13-1
	2	125	17.806	-193.04	
59	1	1370	4.3756	+ 8.97	13-0
	2	238	7.7955	- 60.24	
61	1	1430	3.4462	+ 23.92	13-2
	2	270	6.5473	- 44.69	
106	1	1450	2.7736	+ 26.71	13-1
	2	215	7.5714	- 57.47	
115	1	1450	3.3010	+ 20.80	13-2
	2	142	11.2838	-102.32	
171	1	1300	6.5546	- 0.94	13-1
	2	230	8.4422	- 66.55	
179	1	1350	6.6436	- 0.61	13-0
	2	250	6.7148	- 46.70	
292	1	1450	2.8871	+ 26.88	13-0
	2	227	10.4799	- 84.86	
333	1	1400	4.1881	+ 17.75	13-0
	2	200	9.6004	- 82.29	
334	1	1430	5.3970	+ 3.48	13-2
	2	166	9.7387	- 88.61	
361	1	1300	6.0788	+ 6.13	13-0
	2	272	9.1711	- 74.66	

TABLE XIX (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
97.80 68.90	95.49	± 4.2	11
97.27 71.95	93.53	± 5.0	11
98.06 72.95	94.06	± 7.0	12
96.38 73.03	93.39	± 3.6	11
96.81 81.33	95.48	± 4.2	12
99.58 77.92	96.34	± 1.5	7
99.62 70.73	95.13	± 4.0	10
96.17 88.88	95.23	± 51.	12
98.54 75.13	95.63	± 2.6	11
98.84 68.35	95.68	± 1.7	11
99.60 79.22	96.12	± 3.2	11

TABLE XIX (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
494	1	1400	6.2039	+ 3.83	13-1
	2	220	8.2582	- 66.38	
653	1	1350	4.3713	+ 16.27	13-0
	2	180	8.968	- 70.25	
668	1	1400	7.2522	- 5.55	13-0
	2	280	7.19	- 51.73	
732	1	1600	4.43	+ 11.45	13-4
	2	160	8.4196	- 74.43	
892	1	1400	3.5477	+ 19.48	13-1
	2	176	9.4470	- 81.40	
940	1	1480	3.5485	+ 18.02	13-1
	2	145	11.4115	-107.42	
947	1	1425	2.2193	+ 30.11	13-5
	2	169	7.9233	- 54.24	
1026	1	1500	3.0642	+ 24.85	13-0
	2	204	8.7685	- 66.97	
1036	1	1600	4.405	+ 12.15	12-1
	2	175	10.7374	- 98.97	
1041	1	1455	6.6348	- 3.55	13-1
	2	175	9.6242	- 85.67	
1065	1	1500	3.8079	+ 20.15	13-0
	2	205	11.7383	-108.08	
1100	1	1360	3.8405	+ 19.28	13-3
	2	185	12.2737	-116.89	

TABLE XIX (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
99.59 73.18	95.99	± 1.9	8
98.67 82.27	96.73	± 4.0	11
99.72 73.40	95.36	± 2.4	10
98.27 63.27	95.06	± 4.7	11
97.27 74.38	94.73	± 4.3	13
96.86 73.66	94.83	± 3.9	10
95.09 89.66	94.48	± 5.3	12
96.93 83.35	95.30	± 7.8	11
98.14 72.80	95.61	± 1.7	10
99.51 69.78	96.32	± 4.0	8
98.12 79.13	95.84	± 2.6	11
98.22 81.28	96.18	± 5.0	12

TABLE XIX (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
1125	1	1550	2.275	+ 26.63	13-3
	2	150	16.7178	-177.07	
1191	1	1680	3.2867	+ 21.22	13-2
	2	148	9.953	- 86.54	
1259	1	1510	2.9552	+ 22.90	13-3
	2	194	11.2587	-109.27	
1287	1	1430	2.5825	+ 28.48	13-2
	2	220	9.1061	- 75.98	
1308	1	1400	3.62	+ 17.85	13-0
	2	155	10.4253	- 85.75	
1309	1	1400	3.16	+ 21.29	13-0
	2	172	9.9027	- 82.33	
1320	1	1400	2.6915	+ 25.43	13-0
	2	164	8.2576	- 65.94	
1339	1	1550	3.0245	+ 20.71	13-5
	2	150	11.7811	-110.29	
1352	1	1450	4.0446	+ 14.47	13-3
	2	158	10.0738	- 90.39	
1433	1	1500	2.1026	+ 28.99	13-2
	2	170	8.4475	- 65.49	
1440	1	1450	2.5	+ 29.00	13-5
	2	156	6.4186	- 41.46	
1491	1	1550	2.6386	+ 25.89	13-4
	2	195	7.6675	- 60.77	

TABLE XIX (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
93.36 79.00	92.12	± 5.3	10
97.16 79.18	95.68	± 3.6	11
96.02 69.00	92.96	± 5.4	10
96.19 78.05	93.82	± 3.6	11
97.00 87.08	96.01	± 3.5	11
96.14 82.37	94.66	± 3.8	11
95.34 72.65	92.97	± 7.5	12
95.72 84.50	94.77	± 4.0	12
97.80 76.34	95.71	± 2.1	10
93.30 81.33	92.10	± 4.8	11
96.21 79.53	94.58	± 5.0	10
95.62 72.73	93.07	± 4.0	7

TABLE XIX (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
1498	1	1550	3.934	+ 15.05	13-2
	2	136	13.104	-124.52	
1504	1	1500	2.7021	+ 26.02	13-5
	2	182	9.6816	- 85.29	
1537	1	1500	3.7879	+ 15.00	13-0
	2	130	11.592	-111.62	
1539	1	1480	2.598	+ 26.09	13-4
	2	145	12.4329	-115.67	
1542	1	1450	3.3005	+ 15.02	13-3
	2	102	10.1722	- 97.51	
1572	1	1530	2.5784	+ 24.23	13-3
	2	122	17.7525	-172.18	
1795	1	1520	2.2292	+ 27.83	13-1
	2	133	9.4677	- 74.61	
1869	1	1500	3.5	+ 18.98	13-2
	2	157	11.8691	-106.67	
1883	1	1500	3.2838	+ 18.50	13-5
	2	89	7.2116	- 61.31	
1931	1	1500	3.667	+ 15.39	13-0
	2	132	12.2383	-117.64	
2035	1	1485	2.9163	+ 24.58	13-1
	2	142	10.4133	- 81.72	
2047	1	1500	2.9	+ 21.22	13-4
	2	153	17.2161	-185.94	

TABLE XIX (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
97.52 84.84	96.50	± 3.3	10
96.12 79.37	94.30	± 5.8	12
96.79 66.80	94.42	± 5.3	8
97.49 87.41	96.62	± 5.3	11
94.51 61.67	92.33	± 3.1	7
94.32 96.40	94.49	± 7.5	12
93.50 86.41	92.92	± 6.1	12
97.05 86.92	96.14	± 3.3	11
96.23 52.77	93.83	± 7.6	11
96.40 72.78	94.49	± 2.3	9
96.27 91.97	95.88	± 2.3	9
95.09 77.26	93.41	± 4.6	11

TABLE XIX (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
2145	1	1450	4.2211	+ 12.66	13-3
	2	133	10.7949	- 94.36	
2252	1	1350	2.0316	+ 28.28	13-2
	2	180	11.0202	-102.18	
2278	1	1500	2.6584	+ 24.82	13-0
	2	102	10.4862	- 92.91	
2305	1	1500	2.6584	+ 24.82	13-0
	2	102	10.4862	- 92.91	
2379	1	1500	2.9534	+ 22.95	13-2
	2	132	9.3475	- 88 90	
2463	1	1500	3.5197	+ 20.34	13-3
	2	155	9.5101	- 87.65	
2471	1	1450	3.2443	+ 20.35	13-1
	2	117	20.5722	-213.30	
2492	1	1400	3.2512	+ 21.01	13-1
	2	104	11.2119	- 99.63	
2710	1	1500	3.2941	+ 21.66	13-4
	2	194	10.4712	- 88.90	
2765	1	1525	2.8873	+ 24.95	13-4
	2	157	15.1159	-148.61	
3248	1	1550	3.0961	+ 24.95	13-4
	2	157	15.1159	-148.61	
3262	1	1525	2.3543	+ 26.97	13-1
	2	148	11.9103	-109.98	

TABLE XIX (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
97.92 85.69	96.90	± 2.4	8
92.15 76.06	90.26	± 4.6	9
94.84 76.98	93.76	± 8.3	11
95.72 95.16	95.70	± 5.4	10
95.95 51.90	92.46	± 5.8	12
97.55 64.85	94.50	± 4.2	11
96.30 92.69	95.98	± 4.4	12
96.57 83.33	95.68	± 6.7	12
97.19 88.11	96.16	± 5.0	12
96.53 90.38	95.96	± 3.7	12
97.16 82.93	95.76	± 4.6	11
93.97 81.38	92.83	± 2.8	11

TABLE XIX (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
3304	1	1500	2.4965	+ 28.22	13-2
	2	173	9.943	- 89.06	
3306	1	1450	3.1527	+ 22.37	13-1
	2	151	13.05	-126.80	
		Cases with One Cycle			
557	2	1508	8.3085	- 43.56	13-0
860	2	1520	5.6734	- 11.16	13-4
1853	2	1570	4.8410	- 2.64	13-3

* Group V, cases with menarche at 13-0 to 13-5.

TABLE XIX (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
95.64 71.45	93.19	± 3.3	11
96.59 77.96	94.88	± 3.7	11
	Cases with One Cycle		
	96.86	± 1.3	7
	96.86	± 3.0	10
	95.80	± 5.8	9

TABLE XX

HEIGHT GROWTH CONSTANTS OF GIRLS WHOSE MENARCHE OCCURRED BETWEEN 13 YEARS 6 MONTHS AND 13 YEARS 11 MONTHS*

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
54	1	1500	2.2525	+ 25.48	13-6
	2	172	10.3005	- 81.66	
71	1	1400	6.4596	- 5.22	13-7
	2	176	9.9726	- 97.86	
219	1	1450	2.6342	+ 23.97	13-7
	2	151	13.7833	-137.82	
346	1	1350	3.6461	+ 23.40	13-11
	2	270	7.2907	- 47.31	
506	1	1350	3.9907	+ 16.01	13-10
	2	150	9.0149	- 77.42	
689	1	1375	4.3460	+ 12.29	13-9
	2	160	9.8333	- 86.46	
909	1	1400	4.397	+ 14.51	13-7
	2	210	9.1275	- 79.55	
921	1	1400	3.3166	+ 17.79	13-9
	2	130	7.0405	- 61.37	
1268	1	1500	4.3762	+ 11.21	13-6
	2	182	11.1872	-107.40	
1330	1	1400	3.9604	+ 12.27	13-6
	2	135	10.6337	-100.71	
1334	1	1420	3.68	+ 18.72	13-9
	2	160	8.7584	- 65.64	

TABLE XX (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
92.76 93.75	92.82	± 5.4	12
99.48 62.60	95.37	± 3.2	10
95.02 86.56	94.25	± 2.8	11
98.80 91.18	97.53	± 5.2	12
98.39 83.70	96.93	± 2.0	7
98.54 85.80	97.13	± 4.3	9
98.80 78.92	96.21	± 4.8	10
96.51 55.97	93.07	± 2.0	8
98.24 77.42	96.02	± 1.6	9
97.24 75.84	95.31	± 2.3	8
98.06 91.96	97.47	± 4.5	10

TABLE XX (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
1489	1	1500	4.0479	+ 13.89	13-11
	2	148	12.1498	-121.04	
1528	1	1550	4.1589	+ 11.88	13-8
	2	162	9.7132	- 85.75	
1630	1	1400	3.3119	+ 19.95	13-10
	2	188	10.1187	- 99.35	
1654	1	1500	5.0842	+ 1.50	13-11
	2	138	10.6342	-100.91	
1797	1	1700	2.8121	+ 22.56	13-8
	2	121	16.6162	-169.80	
1899	1	1450	2.5829	+ 22.64	13-9
	2	140	14.4826	-147.44	
2213	1	1500	2.27	+ 26.68	13-11
	2	137	12.2047	-119.09	
2269	1	1450	2.5743	+ 26.03	13-6
	2	200	6.4108	- 48.29	
2403	1	1500	3.7624	+ 14.16	13-11
	2	117	14.5612	-142.93	
2404	1	1550	4.625	+ 11.05	13-8
	2	161	9.7525	- 85.80	
2459	1	1500	3.7642	+ 14.53	13-11
	2	120	14.0206	-148.93	
2498	1	1350	2.7449	+ 21.48	13-6
	2	123	14.9706	-150.38	

TABLE XX (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
98.23 84.89	97.09	± 2.6	11
97.94 83.37	96.55	± 7.1	11
97.24 70.73	94.08	± 2.1	11
98.55 83.49	97.25	± 1.9	8
95.60 93.71	95.44	± 8.90	12
94.08 89.21	93.65	± 6.1	12
94.26 88.27	93.77	± 8.7	10
95.50 64.40	91.76	± 4.4	11
97.44 95.03	97.28	± 2.3	8
98.81 84.09	97.43	± 4.7	10
97.54 82.11	96.42	± 3.4	7
94.40 89.24	93.96	± 4.6	10

TABLE XX (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
2533	1	1500	3.3929	+ 21.71	13-8
	2	145	8.6577	- 72.81	
2561	1	1500	2.7327	+ 21.15	13-9
	2	152	10.5545	- 95.48	
2575	1	1500	3.5220	+ 19.45	13-11
	2	155	10.589	- 91.22	
3094	1	1500	2.4036	+ 26.75	13-6
	2	166	10.5604	- 91.62	
3230	1	1500	2.3770	+ 27.13	13-8
	2	170	9.3973	- 86.66	
3271	1	1425	2.6098	+ 23.30	13-6
	2	161	11.1267	- 98.73	
3307	1	1550	4.0148	+ 14.47	13-7
	2	136	12.5979	-121.43	
		Cases with One Cycle			
383	2	1635	5.8615	- 19.83	13-10
1989	2	1512	6.1088	- 18.36	13-8
1990	2	1533	6.7121	- 24.14	13-8
2949	2	1665	7.3821	- 39.51	13-11

* Group VI, cases with menarche between 13-6 and 13-11.

TABLE XX (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
97.81 80.97	96.29	± 4.5	12
94.50 86.92	93.83	± 6.8	10
97.89 92.97	97.40	± 4.4	10
94.75 88.41	93.88	± 3.8	12
94.96 73.58	92.75	± 2.3	8
94.40 88.99	93.83	± 6.0	12
97.99 86.93	97.09	± 6.6	11
	Cases with One Cycle		
	95.70	± 2.8	7
	97.07	± 5.5	10
	97.70	± 4.1	10
	96.47	± 4.5	6

TABLE XXI

HEIGHT GROWTH CONSTANTS OF GIRLS WHOSE MENARCHE OCCURRED BETWEEN 14 YEARS AND 14 YEARS 5 MONTHS*

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
6	1	1500	2.9771	+ 21.87	14-0
	2	147	12.4286	-127.24	
132	1	1400	3.4951	+ 20.13	14-2
	2	149	11.2906	- 99.62	
213	1	1490	3.0487	+ 23.65	14-2
	2	120	11.16	- 87.53	
228	1	1465	3.6722	+ 17.63	14-3
	2	170	8.8179	- 83.29	
260	1	1450	2.68	+ 22.89	14-2
	2	155	15.1165	-171.34	
287	1	1350	3.4309	+ 21.53	14-1
	2	215	6.8131	- 51.44	
337	1	1500	3.3960	+ 19.14	14-4
	2	210	7.44	- 61.97	
415	1	1450	3.9899	+ 12.34	14-5
	2	140	9.4564	- 93.71	
697	1	1450	6.6563	- 12.28	14-2
	2	130	9.4192	- 82.30	
700	1	1350	3.7944	+ 18.51	14-2
	2	200	8.5522	- 71.17	
896	1	1475	2.9796	+ 20.63	14-2
	2	125	11.9257	-127.04	

TABLE XXI (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
96.59 82.95	95.39	± 2.7	10
98.12 95.32	97.88	± 0.9	10
97.52 98.29	97.58	± 4.6	11
98.14 74.80	95.72	± 3.6	9
95.54 75.88	93.64	± 5.1	11
98.15 79.08	95.53	± 3.9	11
97.74 79.37	95.50	± 4.2	11
98.18 75.43	96.23	± 5.4	10
99.45 88.67	98.54	± 3.4	9
98.55 87.37	97.10	± 3.6	11
96.33 73.88	94.56	± 6.4	10

TABLE XXI (Continued)

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
939	1	1500	3.6364	+ 16.14	14-0
	2	145	15.1565	-164.92	
1377	1	1440	2.9059	+ 22.75	14-4
	2	138	15.6970	-174.01	
1502	1	1500	4.1698	+ 9.33	14-2
	2	145	8.0636	- 70.56	
1759	1	1500	3.6214	+ 17.62	14-3
	2	148	9.8255	- 96.59	
1780	1	1450	3.3263	+ 18.14	14-1
	2	105	15.09	-153.98	
1800	1	1470	3.005	+ 18.71	14-1
	2	128	19.7226	-224.64	
1849	1	1450	2.4466	+ 24.88	14-1
	2	159	13.5446	-146.27	
1903	1	1450	2.78	+ 22.50	14-5
	2	141	13.4072	-136.95	
1923	1	1500	2.7326	+ 23.89	14-2
	2	168	10.0754	- 99.02	
2904	1	1500	2.4799	+ 25.06	14-2
	2	142	10.9833	-104.75	
		Cases with One Cycle			
367	2	1650	4.6471	- 8.68	14-4
680	2	1525	7.25	- 26.17	14-0

* Group VII, cases with menarche between 14-0 to 14-5.

TABLE XXI (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
97.57 83.73	96.35	± 5.6	11
96.83 88.40	95.53	± 3.2	10
97.88 77.58	96.11	± 4.1	9
98.04 77.02	96.18	± 2.1	11
97.02 92.45	96.72	± 3.3	9
95.60 91.25	95.24	± 3.6	9
94.83 79.00	93.29	± 5.5	12
96.22 93.10	95.92	± 3.2	10
96.23 77.64	94.37	± 4.3	11
95.24 88.34	94.64	± 4.3	8
	Cases with One Cycle		
	94.05	± 7.0	7
	98.93	± 4.4	10

TABLE XXII

HEIGHT GROWTH CONSTANTS OF GIRLS WHOSE MENARCHE OCCURRED AFTER 14 YEARS 6 MONTHS*

Case No.	Cycle	Max. (k) (mm.)	Rate (r) (Isoc.)	Incipiency (i) (Isoc.)	Age at Menarche
120	1	1420	3.3138	+ 18.86	14-6
	2	207	9.9849	- 99.90	
614	1	1375	5.1458	- 3.47	14-9
	2	150	12.84	-142.28	
686	1	1350	4.5143	+ 11.27	14-10
	2	260	5.0299	- 32.19	
918	1	1525	2.2571	+ 27.30	15-2
	2	180	12.9492	-144.62	
1695	1	1500	2.8719	+ 22.06	15-1
	2	125	10.35	- 94.39	
1875	1	1450	2.4555	+ 23.27	15-2
	2	136	17.68	-213.74	
2485	1	1500	2.99	+ 18.25	14-11
	2	135	14.667	-167.14	
2991	1	1500	2.3322	+ 25.88	16-1
	2	148	13.269	-144.04	
3169	1	1540	4.1463	+ 9.18	14-6
	2	120	9.0136	- 88.11	

* Group VIII, cases with menarche after 14-5.

TABLE XXII (Continued)

% Development in Cycles	% Development Both Cycles	Average Deviation (A.D.)	No. of Measures
97.53 79.80	95.27	± 4.1	11
98.57 83.47	96.39	± 2.4	10
99.20 74.90	95.28	± 6.0	6
95.82 89.34	95.13	± 6.1	12
97.13 95.89	97.05	± 2.9	10
95.39 91.71	95.08	± 5.2	10
96.32 91.88	95.96	± 0.4	11
96.51 98.06	96.66	± 5.3	12
98.05 75.30	96.39	± 5.0	10

TABLE XXIII

SEASON OF BIRTH AND OF MENARCHE
IN MENARCHEAL AGE GROUP

Season of Menarche*	Season of Birth*				
	A	B	C	D	Total
Age at Menarche: Before 11-6					
A	1	1	3	1	6
B	2	2	1	2	7
C	1	1	1	1	4
D	2	2	1	1	6
Totals	6	6	6	5	23
Age at Menarche: 11-6 to 11-11					
A	1	1	2	0	4
B	0	2	4	1	7
C	0	0	0	1	1
D	6	0	1	0	7
Totals	7	3	7	2	19
Age at Menarche: 12-0 to 12-5					
A	4	0	2	5	11
B	2	1	1	2	6
C	4	2	5	0	11
D	0	0	3	2	5
Totals	10	3	11	9	33

TABLE XXIII (Continued)

Season of Menarche*	Season of Birth*				
	A	B	C	D	Total
	Age at Menarche: 12-6 to 12-11				
A	4	5	2	0	11
B	0	1	4	6	11
C	2	0	11	6	19
D	3	7	0	4	14
Totals	9	13	17	16	55
	Age at Menarche: 13-0 to 13-5				
A	5	1	0	2	8
B	12	10	0	1	23
C	1	8	12	0	21
D	0	3	5	3	11
Totals	18	22	17	6	63
	Age at Menarche: 13-6 to 13-11				
A	1	2	2	1	6
B	0	1	4	4	9
C	3	0	4	5	12
D	2	1	0	2	5
Totals	6	4	10	12	32
	Age at Menarche: 14-0 to 14-5				
A	2	0	1	1	4
B	4	3	0	0	7
C	1	6	1	0	8
D	0	0	1	0	1
Totals	7	9	3	1	20

TABLE XXIII (Continued)

Season of Menarche*	Season of Birth*				
	A	B	C	D	Total
	Age at Menarche: After 14-5				
A	0	0	0	1	1
B	0	1	0	0	1
C	1	0	2	0	3
D	0	0	0	0	0
Totals	1	1	2	1	5
	Total				
A	18	10	12	11	51
B	20	21	14	16	71
C	13	17	36	13	79
D	13	13	11	12	49
Totals	64	61	73	52	250

* Seasons are as follows: A = March-May; B = June-August; C = September-November; D = December-February.

TABLE XXIV

FREQUENCY OF TOTAL SEASONAL BIRTH AND TOTAL MENARCHE IN MENARCHEAL AGE GROUPS

Age at Menarche	Season*					
	A		B		C	
	Men.	Birth	Men.	Birth	Men.	Birth
Before 11-6	6	6	7	6	4	5
11-6 to 11-11	4	7	7	4	1	6
12-0 to 12-5	11	10	6	3	11	11
12-6 to 12-11	11	10	11	13	19	17
13-0 to 13-5	8	19	23	21	21	17
13-6 to 13-11	6	6	9	5	12	9
14-0 to 14-5	4	7	7	9	8	3
After 14-5	1	1	1	1	3	2
Total Seasonal Menarche	51		71		79	
Total Seasonal Births		66		62		70
Birth and Menarche	18		21		36	

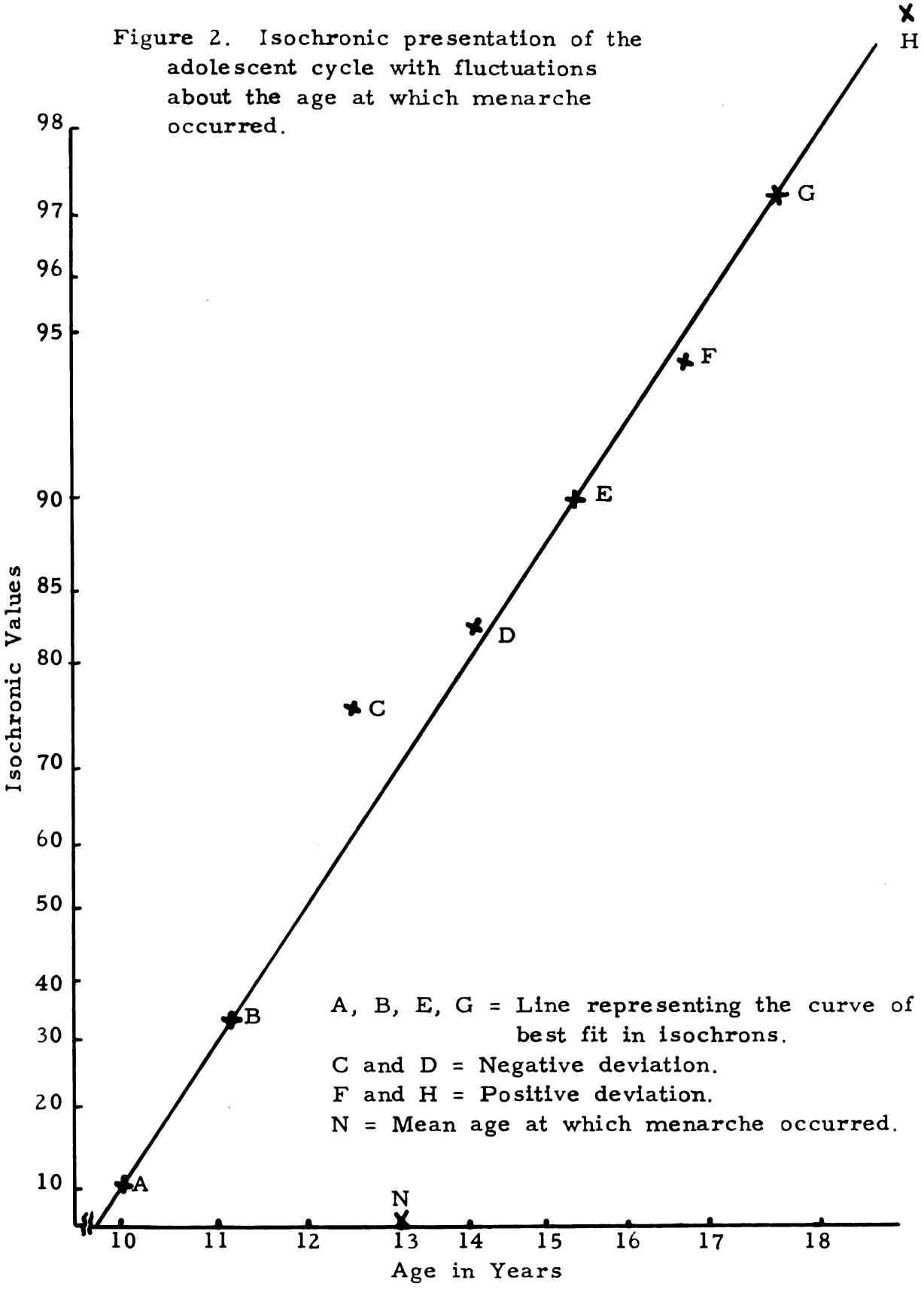
* Seasons are as follows: A = March-May; B = June-August; C = September-November; D = December-February.

TABLE XXIV (Continued)

D		Total In Season Menarche	Total Menarche	Total Birth
Men.	Birth			
6	6	7	23	23
7	2	7	19	19
5	9	13	33	33
14	15	18	55	55
11	6	28	63	63
5	12	10	32	32
1	1	6	20	20
0	1	3	5	5
49		87		
	52		250	250
12		87		

APPENDIX B

Figure 2. Isochronic presentation of the adolescent cycle with fluctuations about the age at which menarche occurred.



* See Figure 1, page 63.

Date Due
