

THE PHYSICAL GROWTH OF 4-H CLUB MEMBERS*

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One H inscribed on the clover leaf emblem of the 4-H clubs means health. Good health has long been an objective of the club, and club members pledge "my health to better living."

Better living is more than absence from disease—it is a positive state of physical fitness and well-being. It consists of at least four factors:¹ 1. growth and body development, 2. organic fitness, 3. motor fitness, and 4. body protection. All these factors are considered in the health and fitness program for 4-H members in Illinois. However, this report is limited to the problems, and particularly the measurement, of growth and body development.

The bases for good health are conditions favorable to both physical and mental growth. Dr. Krogman², interested in growth of body, said, "We are obliged to take measures to determine whether or not our youth are reaching that goal." Weighing and measuring are the usual methods

of determining whether boys and girls are developing normally.

More emphasis has been put upon retarded than upon accelerated growth. Wetzel³ found growth failure in 30 percent of the children and recommended medical examinations in order to determine the causes. He cited a case of a girl who incurred a 259,000 calorie fuel debt during three years of lagging growth. It took ten months of careful treatment which cost \$850 to bring her back to a normal growth pattern.

Recently emphasis is being placed upon the losses in adult life due to obesity, much of which originates in faulty habits of eating and exercising learned during youth. Farmers particularly see fat as desirable, because they see fat hogs, cattle, and sheep going to market and thus fattening their pocketbooks. To them a fat animal is a healthy animal. If human beings were to be marketed as soon as they are grown, fat on them might be as profitable as on cattle. But with human beings and horses, a long work life is desirable, and fat is a dangerous handicap.

If some standard was available and if measurements were made

* The help in statistical analyses of W. Touchberry and E. E. Hixson of the Dairy Science Dept. and D. R. Saunders of the Psychology Dept., Univ. of Ill., is gratefully acknowledged.

¹ Cureton, Thomas K., What is physical fitness?: *Jour. Health and Phys. Ed.* 3:111, March, 1945.

Hall, D. M., Illinois 4-H club members go all out for fitness: *Rural Sociol.* 12:61, 1947.

Hall, D. M., Fitness can be fun: *Better Farming Methods*, p. 29, Feb. 1947.

² Krogman, W. M., *Growth of man: Lab. Biol.* 20:1-967, 1941.

³ Wetzel, Norman C., *Treatment of growth failure in children: Cleveland, Ohio, N.E.A. Service Inc.*, 1948.

quarterly or semiannually, as Merideth⁴ recommends, we might more easily detect poor growth. Furthermore, the consequences which the British Inquiry⁵ found to be "physical deterioration in the adult population" could have been avoided had the poor growth been discovered and treated in childhood.

Height and weight have long been used as measures of growth, but many who have used height-weight-age tables have felt that the tables did not take into account differences in body type and therefore were not entirely satisfactory in discovering those needing treatment. Several attempts have been made to correct height-weight tables for body type. Shuttleworth⁶ proposed differentiation by maturity classes because he found different growth patterns for individuals who mature early and those who mature late. Jorgenson and Hatlestad⁷ calculated 33 different indexes for body type and concluded the ponderal index ($\sqrt[3]{\text{Weight/Height}}$) devised by Levi to be the most satisfactory. McCloy⁸ found this index and Wolff⁹ found a closely related one (Weight/Height^3) to vary less with age than other height-weight combinations.

We plotted the ponderal index on Wetzel's grid¹⁰ and found it cor-

responded closely with his physique classes.¹¹

THE GROWTH CHART

The average weight-by-height classes for age taken from the Baldwin-Wood tables plotted a very slight S-shaped curve on double logarithmic paper. The ponderal indexes for the different weight-height classes were curvilinear, too.¹²

The ponderal indexes for the average height-weight classes from Baldwin-Wood tables showed nearly a straight line on the Growth Chart for ages 10 to 18 years. The Illinois data for 12,000 cases followed the 76-type channel closely between ages 10 to 19 years. Both the Baldwin-Wood and Illinois data were so-called cross-sectional data.

The Harvard data,¹³ repeated measures on the same persons over a 10-year period, were longitudinal data. These data were identified by the period of most rapid growth. Approximately 85 percent of the boys and girls measured completed their spurt in height within one year. For those making a rapid gain in height, the index showed a drop, sometimes as much as 2 points, and then returned to its former figure.

Brody¹⁴ states that the acceleration in height represents a compensation in growth for those children who were relatively undernourished earlier in life. If this is the case, then

⁴ Merideth, H. V., The reliability of anthropometric measurements: *Child Devel.* 7:262-72, 1936.

⁵ Mumford, A. A., *Healthy growth*: London, Oxford University Press, 1927.

⁶ Shuttleworth, Frank K., Physical and mental growth of boys and girls: *Soc. for Res. in Child Devel. Mono.* V4³ and V2³, Washington, D. C., 1939.

⁷ Jorgenson, N. M., and Hatlestad, S. Lucille, The determination and measurement of body build in men and women college students: *Res. Quart.* 11:60, Dec. 1940.

⁸ McCloy, Charles H., Appraising physical status; the selection of measurements: *Studies in Child Welfare* 12:2, University of Iowa, Iowa City, 1936.

⁹ Wolff, George, A study of height in white school children: *Child Devel.* 13:65, 1942.

¹⁰ Wetzel, Norman C., Physical fitness in terms of physique, development and basal metabolism: *Jour. Am. Med. Assoc.* 116:1189, March 22, 1941.

¹¹ Hall, D. M., and Wittenborn, J. R., Motor fitness tests for farm boys: *Res. Quart.* 13:432, Dec. 1942.

¹² Hall, D. M., *Keeping fit*: Ill. Exten. Serv. Cir. 615, Univ. of Ill., Urbana, 1946.

¹³ Dearborn, Walter F., Rothney, John W. M., and Shuttleworth, Frank K., Data on the growth of public school children: *Mono.* 1, Soc. for Res. on Child Devel. vol. 3, Nat. Res. Council, Washington, D. C., 1938.

¹⁴ Brody, Samuel, *Bioenergetics and growth*: New York, Reinhold, 1945.

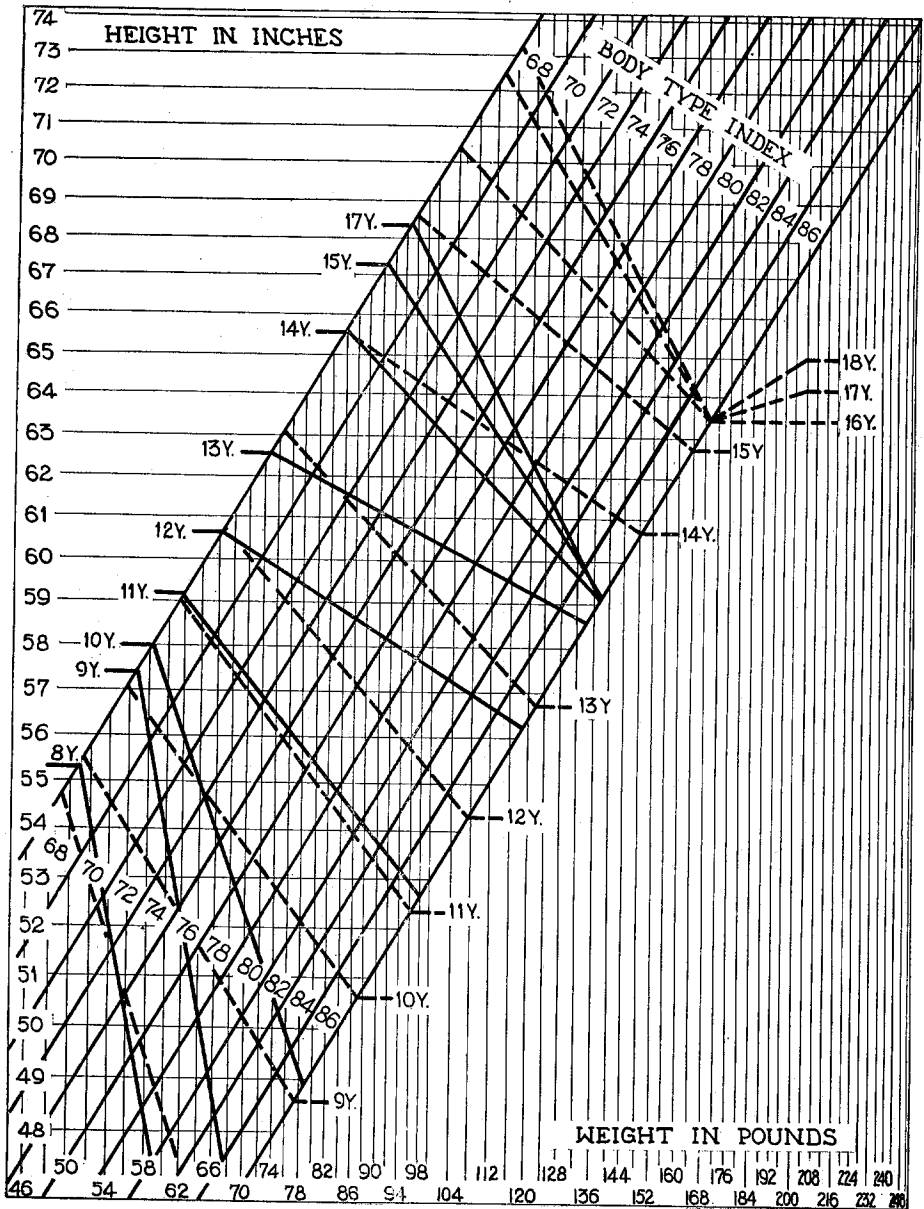


FIG. 1.

healthy children should show no spurt or drop in index value.

During the period 10 to 17 years of age, the average ponderal index for the Harvard boys remained nearly constant, but for the girls it increased about two points after 14 years. The evidence on healthy growth indicates that the ponderal index should remain relatively constant after 10 years of age. Furthermore, if a child has grown to maturity on his schedule, any change in weight and index thereafter indicates a loss in fitness.

The two measures of growth, height and weight, when combined into the ponderal index and plotted on double logarithmic paper, formed a series of linear channels. Since the index is constant between 10 and 19 years of age, one is able to identify deviations from the normal by plotting a person's growth in weight and height on figure 1. Frequent plots of height-weight should form a straight line within the body-type channel.

At this point one naturally asks, "How far up the channel should the growth line progress each year?" The answer is found in the lines crossing the body-type channels. The solid lines for girls, the dashed lines for boys, show up-channel growth progress from year to year.

These cross lines were adjusted slightly from two regression equations. First, from about 14,000 cards punched from the Harvard data, we calculated as if these were cross-sectional data and predicted weight for each height-body type-age group for both boys and girls. Then we did the same for the Illinois cross-sectional data. The predicted weights

were almost identical. The predicted weights for each age were plotted on the body-type chart and a straight line was drawn through the points. These cross-channel lines show the different growth rates for different body types during the same age period.

The body-type chart may serve as a screening device to select those who need further examination. Those persons whose growth lines deviate to the right or left or whose acceleration up-channel is very different from the indicated amounts should be examined to determine the causes.

Other signs of unhealthy growth given by Turner¹⁵ are pale, sallow skin, dull hair, dark circles under eyes, thin spindly arms and legs, stringy or flabby muscles, pinched or anxious expression, dull eyes, slouchy posture, pale mucous membranes, decayed teeth, spongy gums, nervousness, poor concentration ability, disturbed sleep, and obesity.

GROWTH CYCLES

To measure healthy growth one must understand the growth cycle. The growth cycle is curvilinear, although during a short period it may appear as a straight line. Courtis¹⁶ describes the growth cycle as a period of specific maturation during which all the elements and acting forces were constant. When modifying influences act, a new cycle is begun.

¹⁵ Turner, C. S., Precision and reliability of underweight measurements: *Am. Jour. Health* 19:669, 1929.

¹⁶ Courtis, S. A., What is a growth cycle?: *Growth* 1:155, 1937.

Courtis, S. A., Maturation units for the measurement of growth: *School and Society*, Nov. 16, 1929.

Courtis, S. A., Growth and development in children: *Advances in health education: Rept. of 7th Health Ed. Conf., Ann Arbor, Michigan, 1934.*

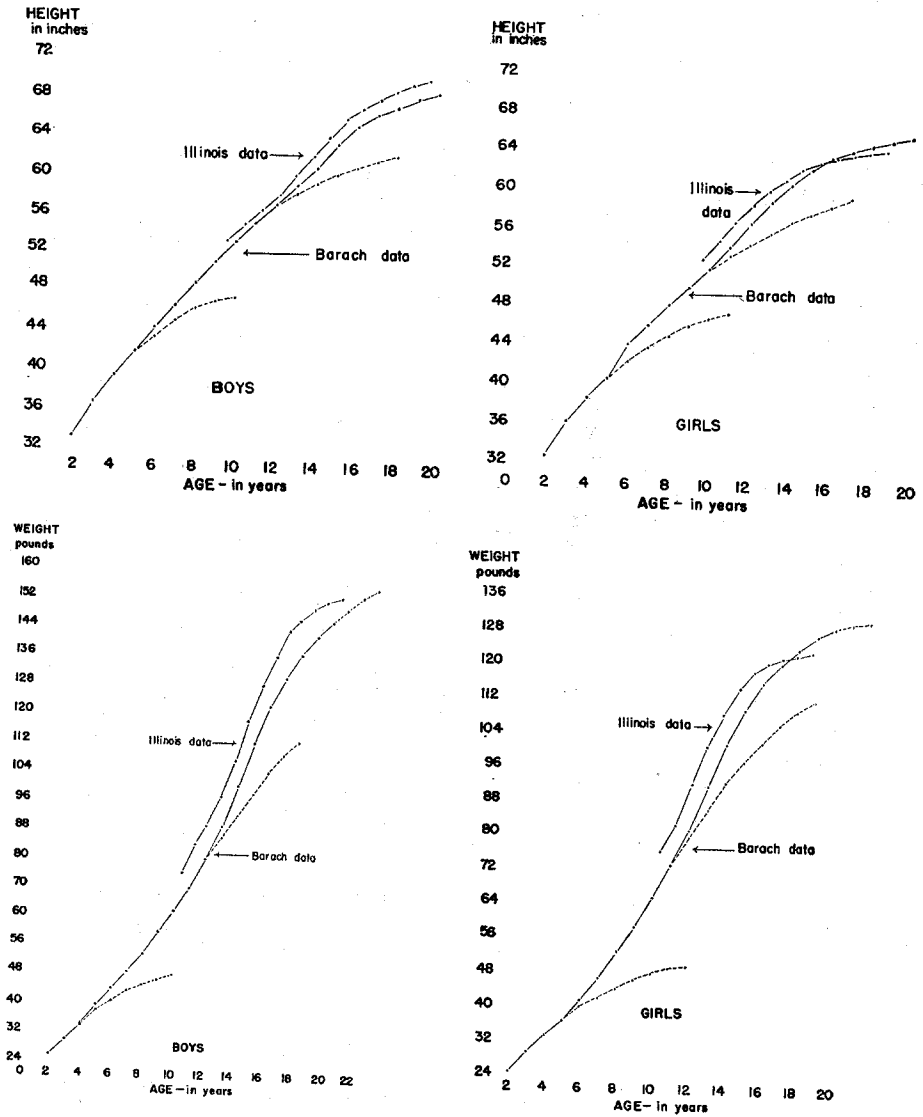


FIG. 2.

Courtis writes the equation $Y=Krt^i$ in which K is the maximum at maturity, i is the degree of development at the beginning of the cycle, r is the rate, t is time and Y is the achieved development at any specified time. Courtis calls the growth unit an "isochron." He changes isochron to percent by means of a table, and then wrote the growth equation $Y=K [rt+i]$ which he solved by simple arithmetic.

Scammon¹⁷ showed a compound curve for height which consisted of three cycles, namely infancy, childhood, and adolescence. Theoretically any change in the conditions might cause a cycle, but a true cycle must be established by supporting evidence, such as the disappearance of baby fat, the growth in muscular tissue, the atrophy of the thymus, and the development of the genitalia during the adolescence cycle.¹⁸

Barach¹⁹ summarized height and weight data for over 400,000 cases, which Baker²⁰ then smoothed into growth curves. We calculated the isochronic growth curves for the Barach data and have plotted them along with the curves for Illinois boys and girls (fig. 2). These are compound curves, showing three cycles for Barach's data and two cycles for the Illinois data.

A person's best weight is his weight when he is in good physical condition. This means bony, muscular, and fatty tissues must be prop-

erly proportioned. Theoretically, the weight of a person in good condition is proportional to the size of his skeleton. If we could determine how much a person should weigh, and then use this weight in determining his body type, we could then determine which channel his growth line should follow as he grows older. This is our next problem.

We are taking certain skeletal measures which McCloy²¹ said "have demonstrated their right to be included in the final battery" for predicting weight. These we propose to work into a multiple regression equation for predicting the weight of a person in good health. This study will be reported later.

Our sample data were collected at "Keeping Fit" field days, which presumably attracted those interested in physical activity. We judged them to be neither inferior nor superior in condition. However, we intend to exclude from the regression equations persons suspected of being at low fitness levels.

Sound programs are built upon facts. If we desire a sound physique—a sturdy body properly proportioned in bone, muscle, and fat—which can do a day's work without exhausting its reserves, then we must collect and interpret for boys and girls the facts about their growth.

It seems clear that if normal persons are to grow according to schedule, they must do at least three things:

1. They must eat the proper amounts of the right kinds of foods.

¹⁷ Scammon, R. E., The first seriatim study of human growth: *Am. Jour. Phys. Anthro.* 10:329, 1927.

¹⁸ Shuttleworth, Frank K., The adolescent period: *Mono. of Soc. for Res. in Child Devel.*, vol. 3, no. 3, Nat. Res. Council, Washington, D. C., 1938.

¹⁹ Barach, J. H., Normal standards in the treatment of young persons with diabetes: *Am. Jour. Dis. Children* 69:92, 1945.

²⁰ Baker, G. A., Graduation of growth curves: *Growth* 9:299, 1945.

²¹ McCloy, Charles H., Appraising physical status: the selection of measurements: *Studies in Child Welfare* 12:2, University of Iowa, Iowa City, 1936.

2. They must take plenty of exercise.

3. They must get enough sleep.

Nature and society conspire to interest us in the way we are growing up. We have many muscular tasks to learn. During our first six years we must learn to eat, talk, walk, run, and otherwise control our bodies. During the next six years, we must learn to coordinate our movements more precisely. During the third six-year period, our interests turn to physique, strength, attractiveness, stamina, and motor skills. These are some of the developmental tasks²² each of us must learn if he grows up properly.

²² Havighurst, R. J., *Developmental tasks and education*: Univ. of Chi. Press, Chicago, 1948.

“Optimal growth,” declared Dr. Mills,²³ “seems to require an active tissue combustion level. The body being only 20-25 percent efficient, and being very sensitive to the internal accumulation of heat, must and does bank its fires when any prolonged difficulty in heat dissipation is encountered. Such finds a coincidental reduction, in rate of growth and development, in resistance to infection, in production of immune bodies and a drop in the energy for thought and action.”

It is essential that we know and control the conditions of healthy growth.

²³ Mills, C. A., *Further evidence of reversal in human growth tide*: *Human Biol.* 13:363, 1941.