Methods of Assessing Child Growth

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METHODS OF ASSESSING CHILD GROWTH

being

A Master's Report Presented to the Graduate Faculty of the Fort Hays Kansas State College in Partial Fulfillment of the Requirements for the Degree of Master of Science

by

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Date August 5, 1961
Approved

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METHODS OF ASSESSING CHILD GROWTH  
(An Abstract)  

by  
Jerry J. McCollough  

The purpose of this report is to review some of the available literature pertaining to methods of assessing child growth in the elementary and secondary schools. Since the administration of a child growth assessment program often becomes the responsibility of the classroom teacher, this report could be used as a guide in the selection of an assessment device.

This report consists of a short historical background of the various methods of assessing growth, development, and nutritional status. The importance of establishing an adequate program of growth assessment is substantiated by the reviews of various authors. Seven methods of assessment are given consideration in Chapter III and specific emphasis is given the Wetzel Grid technique in Chapter IV.

It was found in this report that the lengthy anthropometric measurements and complex formulas, necessary in using most methods of assessment, are already taken into consideration in the Wetzel Grid technique. The Wetzel Grid was found to be an adequate means of growth assessment, as well as, a method of growth prediction. Because of the simplicity of administration and the reliability of the Wetzel Grid, it is therefore recommended as a means of assessing growth, development, and nutritional status for individuals of the elementary and secondary schools.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the Purpose</td>
<td>1</td>
</tr>
<tr>
<td>Limitations</td>
<td>2</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>2</td>
</tr>
<tr>
<td>Methodology</td>
<td>3</td>
</tr>
<tr>
<td>II. NEEDS FOR ASSESSING CHILD GROWTH</td>
<td>4</td>
</tr>
<tr>
<td>Historical Background</td>
<td>4</td>
</tr>
<tr>
<td>The Importance of Assessing Growth</td>
<td>5</td>
</tr>
<tr>
<td>III. METHODS OF ASSESSING CHILD GROWTH</td>
<td>11</td>
</tr>
<tr>
<td>Wood-Baldwin Age-Height-Weight Tables</td>
<td>14</td>
</tr>
<tr>
<td>Pelidisi Formula</td>
<td>15</td>
</tr>
<tr>
<td>ACH Index of Nutritional Status</td>
<td>16</td>
</tr>
<tr>
<td>Pryor Width-Weight Tables</td>
<td>19</td>
</tr>
<tr>
<td>Wellesley Weight Prediction Method</td>
<td>22</td>
</tr>
<tr>
<td>Cureton's Index of Nutritional Status</td>
<td>23</td>
</tr>
<tr>
<td>Meredith's Height-Weight Interpretation Chart</td>
<td>25</td>
</tr>
<tr>
<td>IV. THE WETZEL GRID AS A SPECIFIC METHOD</td>
<td>28</td>
</tr>
<tr>
<td>Statistical Background of the Grid Technique</td>
<td>29</td>
</tr>
<tr>
<td>Description and Purpose of the Grid Technique</td>
<td>32</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>PAGE</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Advantages of the Grid Technique</td>
<td>36</td>
</tr>
<tr>
<td>Disadvantages of the Grid Technique</td>
<td>39</td>
</tr>
<tr>
<td>Conclusions</td>
<td>40</td>
</tr>
<tr>
<td>V. SUMMARY</td>
<td>42</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>46</td>
</tr>
<tr>
<td>APPENDIX A. Wellesley Weight Prediction Table for Women</td>
<td>51</td>
</tr>
<tr>
<td>APPENDIX B. Ross Developmental Chart for Girls</td>
<td>52</td>
</tr>
<tr>
<td>APPENDIX C. Ross Developmental Chart for Boys</td>
<td>53</td>
</tr>
<tr>
<td>APPENDIX D. The Wetzel Grid</td>
<td>54</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

I. STATEMENT OF THE PURPOSE

The purpose of this report is to review some of the available materials pertaining to methods of assessing child growth in the elementary and secondary schools. Since nearly all growth and development takes place during the years when the individual is enrolled in school, it becomes necessary that each individual child be evaluated by some growth measurement device. If growth assessment of each individual is to be carried out adequately by the school, it will in turn be necessary that the school develop a program of growth assessment and place it in the hands of trained personnel.

According to Remmers and Gage, the evaluation of the physical aspects of pupils is recognized as a function of teachers in school laws of most states. However, these authors also state that classroom teachers have been found to possess little knowledge of their pupils' physical aspects and are not aware of the various growth assessing methods by which these aspects may be determined. Since all teachers should be alerted to the various methods of assessing child growth, it is also the purpose of this report to combine into a single source the reviews of several growth assessment methods.

II. LIMITATIONS

The material used in this report is limited in that it pertains to only a few of the various methods of assessing child growth. Since this report may be used as a guide for classroom teachers of the elementary and secondary schools, it is written, as nearly as possible, in layman terms. There are many aspects to the problem of child development, especially during the adolescent years, so it is not the purpose of this report to recommend types of referral or medical advice. This report will, however, make an attempt to show some of the available techniques of child growth assessment and enumerate the predictions, proven results, advantages, and disadvantages of these few techniques.

III. DEFINITION OF TERMS

The terms "assessment" and "evaluation", as used synonymously throughout this report in relation to child growth, imply measurement since status is being determined. H. Harrison Clarke, in his book Application of Measurement to Health and Physical Education, states that status must be determined before conclusions concerning the thing measured can be drawn and before comparisons can be made. As it is the intention of child growth assessment techniques to determine status and make comparisons with established norms, the terms "assessment" and "evaluation" will appear numerous times in the text of this report.
IV. METHODOLOGY

In searching for related materials on the subject of child growth assessment it was found that no specific guide is available in the field of the problem. It was therefore necessary to look through the general guides and indexes under various sub-headings such as child growth, child development, growth testing, and the various assessment methods by specific title. The following guides and indexes were used with considerable success in the preparation of this study: the card catalog; the Reader's Guide to Periodical Literature; and the Educational Index. In addition to these primary sources a considerable amount of literature and information was received from: Newspaper Enterprise Association, 1200 West Third Street, Cleveland 13, Ohio.
CHAPTER II

NEEDS FOR ASSESSING CHILD GROWTH

I. HISTORICAL BACKGROUND

The earliest measurements reported on the growth in size of children were based on longitudinal data for individual children and the information afforded by these measurements was inadequate for many purposes due to the lack of normative material.Reasonably accurate measurements on large numbers of children were reported prior to 1900 by several investigators and by 1920 there appeared an extensive array of accumulated data.

The early measurements, as included by Monroe\(^1\), were taken under a great variety of conditions and with methods which were almost completely unstandardized. After the anthropologists worked out a set of rules for standard anthropometric procedures in 1912, subsequent measurements were obtained with much greater exactitude. Although standard procedures were used after 1912, there was still considerable lack of agreement on certain measurements. This was due to the fact that at times inadequate descriptions were given of both the samples measured and the conditions under which the data was collected.

Even now it is not always possible to make exact comparisons and interpretations of data that was collected by various researchers.

Likewise, it is not always possible for the inexperienced researcher to be able to collect and interpret the data which should be formulated concerning the growth of children. In this case the inexperienced researcher being referred to is the regular classroom teacher upon whom we must rely for the accumulation of growth records of the classroom pupils. With increased knowledge and proper supervision the collection of anthropometric measurements of children, which have been needed for over a half century, may be accomplished through the use of the devices included in the latter chapters of this report.

II. THE IMPORTANCE OF ASSESSING GROWTH

In the world today an increasing amount of emphasis is being placed on the education of the individual child. Educational aims and objectives have, within the last two decades, been made vastly broader and the amount of emphasis placed on the individual child scholastically has increased accordingly. The most recent trend in education has seemingly been to educate the individual child academically first and physically last. By this it is implied that academic subjects have been developed and stressed to the degree that in many situations physical education and health education have been completely and perhaps erroneously omitted.

It is also found that with the apparent plunge into total academic schooling for the individual, the classroom teacher finds it nearly impossible to spend the needed time for the evaluation of each
student in terms of physical growth and performance. Since it must be realized that physical growth and performance are needed for the high level achievement of academic progress, perhaps more and more intensive study will be devoted to the problems of growth failure.

Krogman², in his article "Physical Growth and Development in Relation to Student Success," wrote that there is reason to believe that the organic demands of the heightened tempo of pubertal growth changes may deplete the reservoir of available bodily energy to the point where extra-organic demands of school and society can be met by only a minimum response. As a result, the "learning curve", as a whole, may decelerate as the growth curve, as a whole, accelerates. As stated by Jackson and Kelly³, "growth is a manifestation of life in the young and its rate and quality are related importantly to the general health and welfare of the individual."

A basic knowledge of physical growth and the assessing of this growth is important for several reasons. Estimates of a child's age are constantly being made on the basis of size, and this child is treated, and expected to react, accordingly. There are many other aspects, however, that determine physical growth besides chronological age. There are numerous and complex hereditary factors that contribute


to the determination of the basic growth tendencies and potentialities. Even when these potentialities are present, the course and extent of growth may be altered by a variety of environmental influences. Of the numerous environmental influences, Monroe reports that those having the most profound effects on the course of child growth are health, certain types of illnesses, and nutritional conditions.²

During the period of adolescence, when there are times of very rapid growth, the probability of nutritional imbalance is great. At all ages, reports Jackson and Kelly⁵, nutritional deficiencies would more likely be recognized in the individual if an accurate record of the child's growth were kept and appraised regularly. With nearly all diseases there is some impairment of growth, and consequently the proper interpretation of growth values may make possible early recognition of a disease and continued observation may give a good index as to the success of remedial therapy. Jackson and Kelly also state that in order to expedite evaluation it is helpful for the inexperienced observer, as well as the experienced observer, to have a graph of some type showing the norms of growth for infants, children, and young adults. This is another of the typical examples which verify the urgent need for the assessing of child growth by one of the proven methods of growth evaluation.

²Monroe, loc. cit.

⁵Jackson and Kelly, loc. cit.
In situations where health and physical education instruction is offered throughout the elementary and secondary schools, it is possible to incorporate into this program the use of evaluative devices to determine child growth. Where the elementary schools are classroom confined and under the supervision of only the classroom teacher, it becomes the responsibility of this teacher to observe and evaluate each pupil as nearly as possible.

The classroom teacher is found to be in the ideal position for the assessing of child growth due to the close relationship that is evident in a confined classroom. The classroom teacher knows many of the personal traits of the pupils by observation and personal contact. Due to the apparent lack of proper background knowledge in the field of health and physical growth, however, the classroom teacher is confronted with a responsibility which can only be accomplished adequately if some type of in-service training and supervision is available.

Teachers should be concerned with the physical aspects of pupils because of the relationship of physical aspects to school attendance and performance, vocational choice, and emotional and social adjustment. All teachers should accept the encouragement of the medical profession, as well as the person responsible for the school health program, and serve to the best of their capacity in evaluating each pupils' physical growth and achievement. Although most teachers are not usually aware of the methods used to evaluate child growth and
nutritional status, they can be readily trained to fulfill their functions of cooperating with the school nurse, being alert to the pupils' physical needs, referring pupils to physicians, keeping histories of pupils, and making routine inspections and measurements. It is with the cooperation of these teachers that the needs for growth assessing may be realized and adequately met.

The needs for a program of growth assessment are found to be very closely related to the aims of a health appraisal program and must be obvious to all educators and teachers. The aims of health appraisal, as outlined by The Twentieth Yearbook of the American Association of School Administrators, are as follows:

1. To identify pupils in need of medical treatment.
2. To identify pupils who have problems relating to nutrition.
3. To identify pupils who are poorly adjusted and in need of special attention.
4. To measure the growth of children and to assist them in attaining optimum growth.
5. To identify pupils with nonremediable defects who may require modified programs of education.
6. To identify pupils who may need a more thorough examination than those given at the school.
7. To identify pupils who may be best cared for apart from the regular school situation.

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Using these seven aims of appraisal, to support the previously reviewed needs for a growth assessment program, it becomes apparent that some method of growth assessment should be established in all school systems. The needs for such a program have been evident for more than fifty years and the importance of the program is increasing in proportion with the expansion of educational opportunities. The development of an adequate program should therefore be based on one of the assessment methods reviewed in the following chapters of this report.
CHAPTER III

METHODS OF ASSESSING CHILD GROWTH

From the days of ancient civilization to the present day, body symmetry and proportions have been areas of interested study. In the early period, the measurement of one body segment as a guide to body proportions was used for aesthetic purposes. Larson and Yocom\(^1\) wrote that it has been only within a comparatively short period of time that a study of body proportions has been investigated from the standpoint of the scientist rather than the artist.

During the past one hundred years a considerable amount of anthropometric data has been collected. However, these data are of little use to modern anthropometry. The assessment of physical status and the predicting of body weight by means of these data were virtually impossible since the measurement was based upon height alone.

The chief fault of early anthropometry, according to Mc Cloy\(^2\), is that it failed, except for height measurement, to take account of innate individual differences of body build, and insisted that all persons of a given age, sex, and height should be alike in other body

\(^{1}\)Leonard A Larson and Rachael D. Yocom, Measurement and Evaluation in Physical, Health, and Recreation Education (St. Louis: The C.V. Mosby Company, 1951), p. 120.

measurements. These early studies of body measurement were primarily concerned with the prediction of normal weight and the use of deviations from the normal weight to indicate deviations from normal health.

Perhaps the first measures of body proportions were the age-height-weight tables. These tables, although not valid in assessing the bone, muscle, and fat proportions of an individual, did yield gross body weight in relationship to a norm which does not consider body build. Due to the fact that body build was not considered in these early measurements, a great deal of disapproval and opposition was present.

This opposition was based on the fact that an individual may be a tall and slender type while another individual of the same age may inherently be of a short and stocky build. Because of the inherited characteristics of these two individuals, they do not conform to the norm. By interpretation of the early age-height-weight tables there would be reason to believe that a condition of undernourishment prevailed for the one individual and an overweight condition for the other individual.

After some use of these early tables, it became evident that many children who, according to the tables, were over-weight or under-weight obviously were quite healthy, normally proportioned, and in good nutritional condition. The realization of the inadequacy of height, weight, and age alone led to further research of indices for the prediction of a child's optimal weight.
In an attempt to improve the apparent inadequacies of early age-height-weight tables, several studies were carried out whereby correlations of soft tissues were made with skeletal structures. Franzen\textsuperscript{3} and Mc Cloy\textsuperscript{4,5}, in their individual studies, demonstrated the inadequacy of the age-height-weight tables as an index of growth, development, and nutrition, and pointed to the necessity for appraising development from a skeletal reference of the individual.

Since the time of these studies, many attempts have been made to establish methods by which assessment of growth, development, and nutritional status could be made. Some of these methods have been proved useful, while others have shown deficiencies in their measurement attempts. Beginning with the Wood-Baldwin Age-Height-Weight Tables and progressing chronologically toward the present, the following sections of this chapter attempt to review several of the most commonly used methods of assessing growth, development, and nutritional status.

\textsuperscript{3}Raymond Franzen, "Physical Measures of Growth and Nutrition," \textit{American Child Health Association}, Monograph No. 11, 1929, p. 138.


For many years students of applied anthropometry have made an attempt to formulate methods of using anthropometry as a measurement in the assessment of physical status. The earliest of these measurements were concerned with the prediction of normal weight and the use of deviations from the normal weight to indicate deviations in the normal health.

The methods by which the Wood-Baldwin Age-height-weight Tables were established are based on these earliest methods of physical appraisal. In establishing these tables, a large number of people with the same sex, age, and height were individually weighed. The average weight was then computed from these group measurements and recorded as the normal weight for all persons having the same sex, age, and height.

Mathews, in his book, verifies that this method of appraisal was constructed on the basis of sex, age, weight, and height. McCloy and Young added that although the Wood-Baldwin is perhaps the best

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6 T.D. Wood and B.T. Baldwin, Age-Height-Weight Tables (New York: American Child Health Association, 1918).


known of the age-height-weight tables, there is no allowance made for body build. Since this is true, the norms for extreme ectomorphs and for extreme endomorphs are the same as long as the age, height, and sex are identical.

While the students of applied anthropometry in America were striving toward the possibility of a better method of assessing physical status, the concern of anthropometry in the countries of Europe was much different.

II. PELIDISI FORMULA

During World War I the governments of the Central Powers, particularly Austria, informed their people that the conflict would soon end in their victory. When the war continued through the next few years, widespread malnutrition was evident due to the fact that food conservation had not been practiced.

To meet the need for a method of locating nutritional deficiency among the people of Austria, a formula was developed in 1918 by Pirquet\(^9\), which showed that the cube of the sitting height in centimeters is approximately ten times the weight in grams of a normal person. Hence, by knowing the sitting height and weight of an individual, the nutritional status could be computed by the Pelidisi Formula.

Pelidisi = \frac{10 \times \text{Weight (in grams)}}{\text{Sitting Height (in cm.)}} = 100\%

The pelidisi of a well-nourished child should be very close to one hundred per cent. An obese child may go as high as one hundred and ten per cent, while thin children will average from eighty-eight to ninety-four per cent. Generally speaking, a child with a pelidisi between ninety-five and one hundred per cent may be considered well-nourished. An adult with a pelidisi below one hundred per cent is undoubtedly under-nourished and if the per cent rises to above one hundred and four, the adult individual is perhaps over-nourished.

III. ACH INDEX OF NUTRITIONAL STATUS

After various anthropometric measurements were made on over ten thousand children between the ages of seven and twelve, Franzen and Palmer\textsuperscript{10} selected seven measures as having the greatest significance in determining the amount and quality of soft body tissue in relation to skeletal build. These seven measures were: hip width, chest depth, chest width, height, weight, upper arm girth, and subcutaneous tissue over the biceps muscle.

\textsuperscript{10}Raymond Franzen and George Palmer, \textit{The ACH Index of Nutritional Status} (New York: American Child Health Association, 1934).
Due to the amount of required skill and knowledge needed to find these seven items of measurement, a simpler set of elements was developed known as the ACH Index. The ACH Index consists of three measures of anthropometry which are: upper arm girth, chest depth, and width of the hips.

In the May 1934 issue of Research Quarterly there appears an article written by Ross L. Allen concerning the ACH Index. This article was included in the 1938 Mental Measurements Yearbook, edited by Buros\(^1\), and mentioned that the ACH Index was devised to select the most serious defects of malnutrition for further and more thorough examination by a physician. The ACH Index was reportedly the practical suggestion of the American Child Health Association to replace the height-weight-age tables which had been proved through research, by the American Child Health Association, to be a very poor measurement of nutritional status.

Mathews\(^2\), in his review of the ACH Index, wrote that it may be used as a screening device to select a fourth of the children measured. To the fourth selected as possibly malnourished, the original seven anthropometric measures would be applied before medical referral was made. The ACH Index is not to be used in place of a complete medical


examination, for it is merely a screening device which is dependent upon the opinion and decision of a physician.

This method, although prone to missing some of the extreme cases, was claimed by Franzen and Palmer\textsuperscript{13} to be much better than the age-height-weight methods which were published previously. As an illustration of the apparent improvement, the test authors stated that when the ACH Index selects three-fifths of the extreme cases, the age-height-weight methods, used in a comparable manner, selects only one-fifth of the extreme cases. If perhaps this statement is true, the ACH Index may then be recognized as being superior to the earlier age-height-weight tables which were published.

Within two years after the publication of the ACH Index of Nutritional Status, another study was conducted in an effort to determine a more adequate basis than age-height-weight tables for the formulation of nutritional status. This study brought about the construction of tables based on the assumption that appropriate body weight as an index of nutrition should take into account not only sex, height, and age, but also the nature of the bony framework and the body structure. The outcome of this study and the tables which were subsequently constructed, were published in 1936 as the Pryor Width-Weight Tables.

\textsuperscript{13}Franzen and Palmer, loc. cit.
IV. PRYOR WIDTH-WEIGHT TABLES

In the October 1936 issue of Research Quarterly there appeared a review, written by B. France, concerning the Pryor Width-Weight Tables. This review was included in the 1938 Mental Measurements Yearbook, edited by Buros, and gave the following opinion of the place of assessment methods in the school program:

It will doubtless be but a very short time before all those interested in health and physical development will come to feel that no accurate estimations of nutrition can be made unless and until width-weight, as well as, height-weight measurements have been computed. This newer knowledge of the proper estimations of health will revolutionize life for children. It will bring to light the truth about each child's nutritional condition. It will release some from the bondage of being forced to eat unwanted and unneeded food while at the same time it may clearly show parents and teachers the advisability of reducing fattening foods for some boys and girls not now considered to be over-weight.

The first Pryor Width-Weight Tables were published by the Stanford University Press in 1936 and were designed for boys and girls of ages one to sixteen and for men and women between the ages of seventeen and twenty four. In the original Pryor Width-Weight Tables the standards for normal weight were based on height and on the width of the hips, with no allowance made for fat. Although height and hip width were much less highly correlated with weight than height and the measurement of the chest, the Pryor standards on these tables were still advanced over the previously published age-height-weight standards.

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1Buros, op. cit., p. 231.
Maintaining that determination of appropriate body weights should take into account not only the factors of sex, height, and age, but also the nature of the body structure and of the bony framework, Pryor\textsuperscript{15} revised the tables in 1940. The tables were reconstructed from data obtained from a study of 10,000 children and young adults and were established for ages one through forty.

It was reported by Mathews\textsuperscript{16} that following a study of various body measurements, which might be used as indices of body build, the bi-iliac diameter or width of the pelvic crest was selected as the most important and least variable measurement of body width. Clarke\textsuperscript{17} added that this measurement was more reliable since it does not change with the shifts in posture and with respiration.

Using this measurement as a basis, Pryor computed the following formula as a proposed width-length index:

\[
\text{Width-Length Index} = \frac{\text{Bi-iliac Diameter}}{\text{Standing Height}} \times 1000
\]

\textsuperscript{15}Helen B. Pryor, \textit{Width-Weight Tables} (Stanford University, California: Stanford University Press, 1940).


The Pryor Width-Weight Tables are based on sex and age plus chest width, hip width, and standing height. The equipment needed to administer these tests are: a stadiometer, or other methods of height measurement; weight scales; and a straight arm sliding caliper, calibrated in centimeters.

The directions for administering the tests, which make up the Pryor Width-Weight Tables, were listed as follows:

Age: Age is recorded to the nearest birthday.

Weight: Weight should be taken without clothes and recorded to the nearest pound. When it is necessary to measure with clothes, the necessary allowance for weight of clothing should be made.

Height: Standing height is measured without shoes, with the individual standing as tall as possible. The height should be recorded to the nearest inch.

Chest Width: The subject stands relaxed, breathing normally, with arms at the side of the body. The tester stands facing the subject with the sliding caliper held horizontally at breast level and with the arms of the caliper resting, without pressure, on the sides of the thoracic cage. The measurement is taken at the end of a normal expiration and recorded to the nearest tenth of a centimeter.

Hip Width: This measurement is made from the front with the two arms of the caliper pressed firmly against the widest point of the iliac crest. In testing girls, tilt the calipers slightly upward; in testing boys, tilt the calipers slightly downward. The measurement should be taken without intervening clothes and recorded to the nearest tenth of a centimeter.

When scoring an individual, it must first be determined whether the individual has a narrow, medium, or broad chest by referring to the tables for that particular age and sex. In the proper chest width table, opposite the height measurement and under the bi-iliac diameter measurement, is found the appropriate weight for this specific individual.
A very similar method of weight prediction was also developed in 1940 at Wellesley College of Wellesley, Massachusetts. This weight prediction method included standing height and chest width, which were also included in the Pryor Width-Weight Tables, but substituted chest depth in place of hip width in hopes of finding a more effective predictor of weight.

V. WELLESLEY WEIGHT PREDICTION METHOD

The Wellesley Weight Prediction Method is based on the findings of a study by Ludlum and Powell\textsuperscript{18}, which found that height, chest depth, and chest width were the most effective items in the predicting of weight. These measures were applied to 1,580 women from nineteen colleges throughout the United States and by comparing these measurements to the actual weights, the following formula was obtained:

\[
\text{Weight} = 2.6 \times \text{Sum of the Measurements} - 154.3
\]

Ludlum and Powell\textsuperscript{19} reported that the coefficient of multiple correlation between the actual and the predicted weights was .712, with a predictive index of 30. Height correlated with actual weights

\textsuperscript{18}F.E. Ludlum and Elizabeth Powell, "Chest-Height-Weight Tables for College Women," \textit{Research Quarterly}, 11:55, October, 1940.

\textsuperscript{19}\textit{Ibid.}, p. 57.
was .567, with a predictive index of 17. From these statistics it may be concluded that the chest-height-weight tables with a predictive index of 30 are approximately twice as good as the age-height-weight tables developed earlier.

The descriptions of the measurements used in formulating the Wellesley Weight Prediction Table, as found in the Appendix, are:

**Height:** Standing; measurement recorded to the nearest half inch.

**Chest Depth:** Measurement to the nearest half centimeter of the horizontal distance between the midsternal and midspinal lines at the lower end of the sternum.

**Chest Width:** Horizontal midaxillary distance at the same level as for the chest depth; recorded to the nearest half centimeter.

On the assumption that the methods of weight prediction thus far developed had not taken into consideration bone, muscle, and fat symmetry, Cureton and his associates developed a method of analyzing and predicting weight by means of these three measurements. In 1947 this method was published as a means of improving and supplementing the measurements already in use.

**VI. CURETON'S INDEX OF NUTRITIONAL STATUS**

Cureton and his associates\(^{20}\) presented in their index of nutritional status, measurements of bone, muscle, and fat as a basis for weight analysis. In this method of analyzing normal weight from the

anthropometric measurements, girths are measured with a tape pulled
tight around a limb in which the muscles have been made firm.

Weight prediction is also made on the basis of these skeletal
measurements and the difference between the actual and predicted weight,
known as residual, is determined. A person who weighs over the pre-
dicted weight has more flesh than the average person with a similar
skeletal structure. Inversely, a person who weighs less than the pre-
dicted weight has less soft tissue than other persons of similar body
structure.

Larson and Yocom\textsuperscript{21}, in their review of Cureton's Index of Nutri-
tional Status, reported that a positive residual may mean either good
muscular development or excessive fat, or both. A large residual due
to muscular development, however, is desirable. A negative residual
may mean poor muscular development, small amounts of fat, or both. A
negative residual, however, may be indicative of a condition of poor
body nutrition.

While Cureton and his associates were developing and testing
their method of measuring nutritional status, another researcher was
collecting data in the University of Iowa experimental schools at
Iowa City, Iowa. The data, collected between the years of 1930 and
1945, led to the formulation and publication of the Meredith Height-
Weight Interpretation Chart.

\textsuperscript{21}Larson and Yocom, \textit{op. cit.}, p. 127.
VII. MEREDITH'S HEIGHT-WEIGHT INTERPRETATION CHART

Between the years of 1930 and 1945 data was collected, in the University of Iowa experimental schools, on a group of white American children of northwest European ancestry. These individuals were living under better than average conditions from the standpoint of nutrition, housing, and health care.

The Meredith Height-Weight Interpretation Chart22, more popularly known as the Physical Growth Record, was constructed for boys and girls extending from early childhood through adolescence. The chart consists of growth curves established by computing the average height and weight, at various age levels, of a large number of children. These weight and height averages were then plotted separately against age, resulting in charts which indicate the average height-age and weight-age curves for all boys and girls between childhood and adolescence.

Also included on the Meredith charts, are the normal variations from the computed averages. The charts show five "normal" zones for height, including: tall, moderately tall, average, moderately short, and short. The charts likewise show five "normal" zones for weight, which are: heavy, moderately heavy, average, moderately light, and light. These normal zones on the charts offer an opportunity in locat-

ing those individuals whose measurements show deviation from the expected growth pattern.

To use this method of assessment, the height and weight of the individual are plotted on the chart to give coordinate points. If the two points do not fall in the corresponding zones, such as tall and heavy, or short and light, and if the measures of the child's height and weight abruptly jump from one zone to another, referral should be made to the proper medical authority.

The recording of data upon the individual height-weight records should be accomplished three times during the school year. The ideal times would probably be at the beginning of the school year, one at the middle of the year, and again near the end of the school year. If an individual has made no progress on the record through increases in height and weight during any of these three periods, this also indicates that referral should be made to a trained physician.

These individual height-weight records and graphs, together with a description of technics for weighing, measuring, and interpreting the data, may be obtained from either the American Medical Association or from the National Education Association.

Meredith\textsuperscript{23}, in summarizing the role of the height-weight charts, cautions the user not to regard this method as a sufficiently comprehensive anthropometric program to meet the needs of all schools. It was,
however, recommended by Meredith for use by schools where it was not considered practical to adopt a program calling for more measurements than height and weight. Even though this method was not designed for use by all schools, it was recommended by the National Committee on School Health Policies\(^{24}\), as one of two possible growth charts which should be given careful consideration as a school growth assessment device.

After having given considerable recognition to these seven previously mentioned methods of assessment, which do not include charts distributed by medical concerns and insurance companies, it seems apparent that a more thorough method should be sought. Having studied the possibilities of finding a more thorough method of assessment, it was decided that a comprehensive coverage of the Wetzel Grid should be included in Chapter IV of this report.

\(^{24}\)National Committee on School Health Policies, Suggested School Health Policies, Third Edition (Washington, D.C.: The Joint Committee on Health Problems in Education of the National Education Association and the American Medical Association, 1956.)
Within the preceding half century, various attempts have been made toward the formulation of an adequate method of assessing growth, development, and nutritional status. The earliest methods of assessment were based almost entirely upon the measurements of height, weight, and age. As the years progressed, many different anthropometric measurements were used in an effort to find more valid predictive measures. Each of these measurement devices became progressively improved as new anthropometric features were included. However, there still existed a need for a more reliable instrument of growth assessing.

Today much of the information in medical records which refer to physical status, is summed up in very general phrases such as "well developed" and "well nourished". In spite of the countless attempts to standardize various physical dimensions, Souther and her associates wrote that physicians, school officials, and laymen have come more and more to treat simple physical measurements, such as height and weight, as all but worthless. Even as far back as 1918, Manny wrote that


tables of height and weight, even when used in conjunction with a physician's medical estimate, have been found to possess no more than sixty per cent overall reliability in differentiating between persons of satisfactory and unsatisfactory physical status.

Norman C. Wetzel, a medical doctor of Cleveland, Ohio recognized as early as 1927 that the conventional age-height-weight chart hanging on the wall of his examination room was actually little more than a useless decoration. Realizing that the many individuals he examined each day did not measure up to specified norms, Wetzel was intent on designing a chart which would use height and weight to establish an individual's physique or body build and indicate how well that individual was keeping up with his own expected pattern of growth. With this idea in mind, he set out on a long trail of research, study, and testing which in 1940 was climaxed with the publication of the Wetzel Grid for Evaluating Physical Fitness.3

I. STATISTICAL BACKGROUND OF THE GRID TECHNIQUE

The statistical background of the Wetzel Grid has been formulated in a number of ways. The primary study upon which it was based included more than twenty-five thousand paired sets of measurements on four thousand children who were individually analyzed by testing.

Among the data collected there were twelve thousand sets of measurements on two thousand and ninety-three Cleveland, Ohio school children. The measurements of these school children were compared with clinical appraisals rendered by the school physicians.

When analyzing the comparisons between the grid technique and the clinical appraisals, Wetzel\textsuperscript{4} found the gross agreement between these estimates to be approximately 87.5 per cent. This figure was significantly higher than the 60 to 65 per cent agreement found by Franzen\textsuperscript{5} and Jones\textsuperscript{6}, when analyzing earlier methods of appraisal.

In the individual cases where there was a discrepancy between the grid estimates and the clinical appraisals, it was found by further observation that one half of these cases occurred among children whose growth curves fell into the "fair" channel of the Wetzel Grid. These individuals were classified by Wetzel\textsuperscript{7} as the children on whom physicians themselves find it difficult to agree in more than fifty per cent of the cases. Consequently, the agreement between the Grid process and the physicians appraisal on subjects in all other channels, could rise to a height of approximately 94.5 per cent.


\textsuperscript{7} Wetzel, loc. cit.
As a further check, the Grid method was tested on the voluminous data reported from the materials of the Harvard Growth Study made by Dearborn and his associates. The Grid technique was also checked on many smaller group studies and finally against the mean value of more than 400 reports in literature dealing with growth and nutrition of large groups of children under various conditions.

Wetzel, in his 1948 address to the Canadian National Council on Physical Fitness, clarified the usage of the more than 400 reports in literature by stating these few facts:

Since it has been assumed by some that the validity of the Grid has been tested only against the data of local American children, it will again be stated that the Grid has been tested against the mean value of 400 reports in literature dealing with growth and nutrition of large groups of children under various conditions. As an informed student would have known, the "more than 400 reports" comprised practically all articles published the world over, since Quetelet's time, which contained usable weight and height values with corresponding ages. Some reports were based on less than 25 children; many on several thousand subjects; and a few numbered from 10,000 to 100,000 children. Altogether, observations on over 4,500,000 boys and girls were accounted for, with representation for every major geographical and ethnic level including groups in Scandanavia, Russia, Italy, India, Germany, and China.

This data, which was collected on many different groups and individuals, was reported to have been quite significant in helping to establish the validity of the Grid. The most significant evidence,

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however, was contributed by observations on over 8,000 children. Each of these children were individually known and followed for periods of time ranging from 6 to 20 years, by using long term records and clinically controlled conditions.

The method by which the Wetzel Grid technique was devised is not precisely known, but considering the background of collected data, based on research reports dating from 1835 to 1937, it seems apparent that its formulation was derived by way of valid procedures. With the validity of the Wetzel Grid statistically shown, it is now possible to give a description of the Grid and to review the purposes as shown in recent literature.

II. DESCRIPTIONS AND PURPOSES OF THE GRID TECHNIQUE

The Wetzel Grid, developed by Norman C. Wetzel, is a chart on which the height and weight of an individual is recorded on two panels, the Grid Panel and the Auxodrome Panel. On the Grid face there is also included two other panels; one is space provided for the recording of dates, ages, weight, and height, and the second panel at the extreme right side of the chart is a basal metabolism panel.

On the Grid Panel, a scale for marking height in inches forms the horizontal axis and a scale for marking weight in pounds forms the vertical axis. Where these two figures for a given individual intersect, a coordinate is marked on the chart. This dot, obtained by using the measurements of height and weight, indicates the child's "develop-
mental level". This "developmental level" is indicated by numbers running diagonally across the height and weight chart of the Grid Panel.

This coordinate point on the Grid Panel also shows the child's body shape, as defined by the "physique channel" into which the dot falls. There are nine physique channels ranging from $A_4$ (obese) to $B_4$ (extreme thinness). These nine physique channels are indicated by the lines running diagonally across the Grid Panel.

Optimum growth and development are indicated when the child follows his expected pattern as determined by the original point of entry on the Grid Panel and subsequent entries. In top-quality growth and development a child will progress channelwise with remarkable precision. Owing to many different influences, acceptable variations in direction may amount to approximately one-half channel per ten levels of advancement. Deviations greater than this have been shown by Wetsel\(^\text{10}\) to be no longer due to chance, but are systematic and must be attributed to some assignable cause of trouble.

The speed of development is determined on the Auxodrome Panel by relating the individual's developmental level to his age. This relationship of developmental level to age indicates how far the child has traveled along the channel system and also identifies the particular auxodrome the child is on at the present time. Since all children do not reach the same level at the same age, the set of standard auxo-

\(^{10}\)Ibid.
AUXODROMES is calibrated to show what per cent of children in the general population may be expected to reach a given level at a given age. On the standard auxodrome, a healthy child's speed of development is approximately twelve levels per year with the accepted deviation being not more than three levels per year.

The coordinate point on the Auxodrome Panel, being the relationship of the developmental level and age, is aligned with the energy scale running vertically along the right edge of the Grid. This energy scale indicates basal heat production in calories per day normally expected for a boy or girl, respectively, at any given level no matter in which channel he or she may happen to be. These level-calorie relations, established by Wetzel\(^{11}\), form the basis for treatment of malnutrition since fuel debts may be computed from them.

The unique feature of the Grid as compared to other methods, such as Meredith's Physical Growth Record, is that the child is his own standard of comparison. It is one of the purposes of the Grid to identify, by means of the nine physique channels, differences in body type. Each child is placed, by a series of measurements, in the proper channel and body type. If the child is naturally tall and slender he will be in that specific channel and the progress can be charted according to what is normal, according to individuals of a similar body type.

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While addressing the Canadian National Council on Physical Fitness, Wetzel\textsuperscript{12} stated that the Grid technique was based upon \textit{two principles} and both of these should be clearly understood if administrative control on growth is to succeed. The first of these two principles is that the Grid is a test of the child's overall body growth and of his general physical condition.

The second of these two principles is concerning growth control. One of the most common pronouncements of purpose in enterprises that concern children is the declaration to promote growth. Viewed from the angle of control, the problem of growth promotion takes on an entirely different and practical meaning. The best method of promoting good growth in children is found to be the preventing of growth failure. The objective of growth promotion is most effectively found through the use of the Grid as a method of preventing this growth failure.

Bearing in mind the two principles of the Grid, namely, (1) individual test and retest, and (2) promoting good growth by prevention of growth failure, the organization and administration of an assessment program has only to put into operation these five cardinal steps: recognition, referral, study, treatment, and follow-up. In meeting these five cardinal steps, Wetzel\textsuperscript{13} claims that when taken in order each of these may be accomplished using the Grid as a common basis for action.

\textsuperscript{12}Wetzel, loc. cit.

\textsuperscript{13}Ibid.
After having studied these five cardinal steps of growth control, as integral parts of a single program, certain advantages are now more evident. By way of previous studies, it is possible to review the advantages and stated values of the Grid technique for assessing child growth and development.

III. ADVANTAGES OF THE GRID TECHNIQUE

The Wetzel Grid, being a direct reading control chart on the quality of child growth, is also a visual demonstration of whether or not growth is progressing satisfactorily. A single glance at the face side of the chart will reveal the speed and direction of growth and whether growth failure exists in that particular child. Also from the face side of the Grid an observer may easily determine the basic caloric requirements of an individual at any given developmental level.

The reverse side of the Grid has space for recording physical examinations, immunizations, laboratory tests, and other special examinations such as dental, vision, and hearing. Molly C. Pugh\textsuperscript{11}, agreed that the use of the Grid has shown its value at the University School, located on the campus of Ohio State University. She wrote, that in the hands of a trained physician, the Grid is a valuable assessment device and provides a graphic picture of a child's growth process.

Fried and Mayer\textsuperscript{15}, found that the Grid technique was especially useful in selecting institutionalized children who were most in need of special attention. At Bellefaire, the Cleveland Jewish Children's Home, the Grid is successfully used to single out children for special attention, closer inspection, and more frequent follow-ups.

In relation to institutionalized children, Fried and Mayer spoke of the Grid as an excellent means of bringing about a close understanding between the pediatrician and the non-medical personnel of the staff. After the examination of the children, the physician can use the Grid in illustrating to the staff personnel the progress of each individual. This rapport invites staff comments that are valuable because they afford information from other than a strictly medical point of view.

This same advantage is possible when the Grid is used in the public school situation. The examining physician, with the cooperation of the classroom teachers, can separate from the masses of children, those cases of growth failure which appear to be in need of the medical attention. The use of the Grid for a school screening purpose was suggested in a study by Wetzel\textsuperscript{16} of over 2,000 school children in Cleveland, Ohio.

\textsuperscript{15}Ralph Fried and Morris F. Mayer, "Grid Technique as a Tool for Improving Health Services to Institutionalized Children," The Journal of the American Medical Association, 161:1-5, May 5, 1956.

\textsuperscript{16}Norman C. Wetzel, "The Simultaneous Screening and Assessment of School Children," Health and Physical Education, December, 1942.
The Grid rating of these children agreed with pediatric diagnosis in 87.5 per cent of the cases. In another instance, out of 205 children classed as "poor" by pediatricians, the Grid isolated 203. To further substantiate this advantage of the Grid it was found by a third study of 371 subjects, called "poor" or "borderline" by physicians, that the Grid identified 94.5 per cent.

Another advantage of the Grid, which was pointed out by the various users of this technique, is the ability of the Grid to show exactly on how many developmental levels growth deficit exists. It can be estimated by the Grid how much time and effort must be expended to return the child to his correct developmental level. This can be accomplished by projecting a curve on the Auxodrome Panel, which would follow the nearest normal schedule from the initial entry to the most recent coordinate point. By comparing this near normal curve to the curve of an individual experiencing growth failure, it is possible to estimate the fuel debt area which needed to be retrieved for recovery.

Waltz17 in his article, "What a Growth Chart Can Tell You," wrote of two distinct advantages of the Grid technique. The first advantage listed was that the Grid can be used to look into a child's past as well as into his present. Used in this way it is possible to determine with reasonable accuracy just when some physical or emotional

upset first began to undermine the individual's health. As a second advantage, the author mentioned that the Grid is able to take into account expected changes in the course of growth during puberty and adolescence. By compensating for these individual spurts in growth, there is no indication made that the child is suddenly changing his particular growth pattern.

There are numerous advantages of the Wetzel Grid technique in assessing growth, development, and physical status; however, there is also found in recent literature several disadvantages which should be mentioned in the text of this report.

IV. DISADVANTAGES OF THE GRID TECHNIQUE

In surveying the available literature concerning the Wetzel Grid, a large percentage of the information upheld the values of this method. The authors reviewed were strongly in favor of the Grid technique as a method of evaluating growth, development, and physical status in the school situation.

The American Association of School Administrators\(^\text{18}\) reported that although the Grid technique is used in many school situations, others have been deterred from using it by factors of cost and time. A decision to use or not use this device in a particular school,

continued these authors, should result from a careful study of its contributions to the program by the school physician and other concerned school personnel.

At the University School, located on the campus of Ohio State University, the school physician and the school nurse studied the use of the Wetzel Grid when applied to the 450 students enrolled in grades kindergarten through twelve. Pugh\(^{19}\), who was then the school nurse, observed that although the Grid served as a screening device, it cannot be relied upon solely for indicating the students in need of further investigation. This author and nurse also disclosed that in the University School they were forced to conclude that the Grid was not an effective screening device, because of the evidence that it does not separate the children who need extensive investigation from those who require only simple health appraisal.

V. CONCLUSIONS

The simplicity of the Grid is well exemplified when it is compared with some of the other procedures recommended for assessing physical status and development. Franzen and Palmer\(^{20}\) disregarded height and weight, but measured arm girth, depth of chest and width of hips, which

\(^{19}\)Pugh, loc. cit.

are compared with standard tables. Stuart and Meredith\textsuperscript{21} measured the height, weight, hip width, chest circumference, leg girth, and thickness of two selected folds of skin and subcutaneous tissue. Meredith\textsuperscript{22}, in a more recent article, showed modified procedures of his original methods that use charts as well as percentile tables. It may be surmised that these anthropometric measurements do not give any more accurate information regarding the physical status or nutritional status of the individual than does the Wetzel Grid. Similarly, the use of mathematical calculations and formulas are of no more valuable use and have the disadvantage of not being graphic like the Wetzel Grid.

The Grid thus recommends itself as a means of making a further contribution toward the total education of pupils in that it offers a method of discovering those individuals suspected of not growing to capacity. When optimum growth is not evident within an individual, the education of this child is hampered to a great degree. Thus it becomes imperative that proper assessment of each pupil be accomplished on a regular schedule using the most competent method available.


CHAPTER V

SUMMARY

Nearly all growth and development takes place during the period of years when the individual is enrolled in school. The program of growth assessment must therefore be developed in the elementary and secondary schools in order to meet the needs of the individual pupil. The teachers of the elementary and secondary schools are an essential part of a growth assessment program through their ability to make observations and record collected data.

The selection of an adequate method of evaluation and the training of school personnel to administer this method are the greatest problems confronted in the establishing of a growth assessment program. The classroom teacher is in the ideal position for the assessing of child growth because of the close teacher-pupil relationship found in the regular classroom. Due to the lack of adequate training, however, the person responsible for the assessment program must be prepared to instruct and supervise these classroom teachers in the methods of child growth assessment.

Perhaps the most compelling reason for devoting more and more intensive study to the problem of growth measurement resides in the fact that physical growth has a direct relationship upon academic progress and achievement. With the apparent emphasis in education being toward higher academic achievement, it should be realized that physical growth
must likewise be developed. In order to avoid the threatening effects of growth failure on academic progress, an adequate growth assessment method must be established in the school program.

Since the beginning of the twentieth century several methods of growth assessment have been developed which were based on the anthropometric measurements of height and weight. These methods were succeeded by more recent devices which were also based on height and weight, but also took into account the body structure in terms of bone, muscle, and fat symmetry.

Having reviewed seven of these growth assessment methods, it seemed apparent that special emphasis should be placed on a more thorough evaluation method. In hopes of finding a method by which a school program of growth assessment might be established or improved, the Wetzel Grid was chosen as the method to be given emphasis in this report.

The Wetzel Grid is a direct reading control chart on the quality of child growth and is also a visual demonstration of whether or not growth is progressing satisfactorily. The simplicity of this method makes it advantageous of the other methods when selecting a device which will predict child growth and nutritional status, yet be easily administered by the classroom teacher.

When comparing the Wetzel Grid with other methods of assessing growth, development, and nutritional status, it was found that the lengthy anthropometric measurements and complex formulas, necessary in
other methods, have already been given consideration in the Wetzel Grid technique. The methods by which these measurements were computed, however, was not completely revealed by Wetzel in his handbooks and literature concerning the Grid technique.

It was also found in this report that these anthropometric measurements do not provide any information or conclusions which are not present when using the Wetzel Grid. The Grid technique lends itself as an adequate means of growth assessment, as well as, a method of growth prediction. Since maximum growth is a contributing factor in optimum academic achievement, the possibility of growth failure must be avoided. It is therefore recommended that the Wetzel Grid be considered as one of the more reliable methods to be used by the elementary and secondary schools in the assessing of individual growth, development, and nutritional status.
BIBLIOGRAPHY

A. BOOKS


Pryor, Helen B. *Width-Weight Tables.* Stanford University, California: Stanford University Press, 1940.


**B. PERIODICALS**


APPENDIX C.

ROSS DEVELOPMENTAL CHART FOR BOYS