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PHYSICAL PERFORMANCE OF HIGH SCHOOL BOYS AND COLLEGE MEN CLASSIFIED BY THE WETZEL "GRID FOR EVALUATING PHYSICAL FITNESS"

by

Robert M. Grueninger

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of Doctor of
Philosophy in the University of Michigan

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1948

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Robert M. Grueninger

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INTRODUCTION

INTRODUCTION

Ever since the pioneer work of Edward Hitchcock at Amherst and Dudley Allen Sargent at Harvard, physical performance has been studied, in this country, for the purpose of establishing standards whereby achievement in motor activities could be judged in terms of the body characteristics of the performer.

Although more than eighty years have passed since the first attempts were made to relate performance with body structure, the need for standards is still widely felt. Methods of physical classification remain, for the most part, unproven as regards their specificity for certain motor abilities; and, in greater or lesser degree, they are impractical for general application to physical education.

This statement is made with full cognizance of many worthy purposes that have been served by classifying subjects according to one or more measures of size and maturity or on the basis of performance itself, yet it must also be conceded that physical educators are not consistent in dealing with individual differences nor have they accepted a common method for the organization of pupils into homogeneous groups. It is not surprising, therefore, that one who is interested in the problem of performance should turn his attention to newer methods with the hope of defining more exactly the relations between performance and body make-up.

In 1940 two different methods of classifying the human form were published: Sheldon's method of "Somato-typing"[1] adults and Wetzel's Grid[2] for evaluating growth in children. Interestingly enough, both were developed outside the field of physical education. The former arose out of studies on constitutional psychology. It sought the classification of physique into seventy-six types which Sheldon admitted might be unwieldy for various purposes. By combining closely related types he suggested a reduction to nineteen, and referred to these as "a coarser mesh." Sheldon's ideas were immediately "adapted" by Cureton, who further reduced the original groupings to five in an attempt to determine relationships between performance and physique, as explained in Chapter I.

Wetzel's Grid Technique arose out of the field of pediatrics and had been designed to measure and appraise the growth of children. Among other things, this Grid method took direct account of body size as well as body

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[1] See Chapter I and subsequent chapters for references.

[2] Complete title is "Grid for Evaluating Physical Fitness in Terms of Physique (Body Build), Developmental Level and Basal Metabolism - A Guide to Individual Progress from Infancy to Maturity -". Copyright 1940, 1941 and 1948 by Norman C. Wetzel, M.D. In this thesis, the terms, "Grid," "Wetzel's Grid," and "Grid Technique," refer to this title.

shape or physique. It offered a simple and objective method of identifying both of these two important factors, either of which would hardly be expected to exert the same influence on performance. Previous methods had not provided for this distinction. Consequently, although the Grid Technique had originally been designed as a "control chart on child growth," its basic principles and operation furnished a simple means of re-investigating the question of performance and body structure among persons of all sizes and physique types.

Main Objectives: - Specifically, the first and main objective has been to measure and analyze different kinds of motor performance as represented in twelve well known "physical fitness tests" administered to 5860 high school boys and college men who have been classified according to physique and size by means of the Grid Technique.

In order to obtain still further evidence on the relations between physique, size, and performance, it seemed desirable, as a second objective, to supplement the direct observations on motor performance with information on the Grid ratings of approximately 5800 athletes who participated in eleven principal sports as members of interscholastic, intercollegiate, and professional teams.

Before describing the exact procedures which this study has employed, or any results to which it has come, much will be gained by giving first, a brief sketch of previous work that had been done on the relation between physical performance, body measurements, and in particular, on the physical characteristics of performers. This constitutes a natural opening into the problem. It will also provide a more comprehensible background against which the significance of the present results may be objectively judged. In this purpose, it is hardly necessary to mention or to refer to all previous work in the field; for the essential characteristics of earlier investigations can be sufficiently understood by outlining the results which mark the major steps in progress.

From the standpoint of the present study, however, one should note especially, what comparatively little stress had previously been laid on the explicit differentiation between body size and type, and how body type or physique has often been thought to represent the only important physical variable.

CHAPTER I

HISTORICAL REVIEW OF STUDIES ON PERFORMANCE, PHYSICAL CHARACTERISTICS, AND METHODS OF CLASSIFICATION

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HISTORICAL REVIEW OF STUDIES ON PERFORMANCE, PHYSICAL CHARACTERISTICS, AND METHODS OF CLASSIFICATION

Part I - Previous Attempts to Relate Performance with Body Measurements and Physical Characteristics of Performers

Many attempts have been made to describe relationships between physical performance and various body characteristics of the performers. Methods of studying the numerous aspects of this problem have ranged from those which relate performance to certain simple measures, such as weight or height, to those which make use of various combinations of body measurements, such as weight-height indices. In the latter case, it has generally been assumed that a given index does represent some attribute such as body build. The mere fact, however, that an investigator had proposed to relate performance with body build does not guarantee today that his results actually represent what he had presumed them to be because the measurement and identification of body build has not been convincingly settled up to the present time.

In other studies, performance has been correlated with measurements of almost every part of the body that might conceivably control or modify achievement. In still other cases, attempts have been made to compare performance on a qualitative rather than on a quantitative basis, and thus by means of purely descriptive terms rather than through the use of measurements. For example, instead of grouping performers in varying height or weight classes, some observers have preferred to use descriptive terms such as slender, tall, heavy, or short.

All of these diversified methods lead to considerable confusion when the results of different studies are compared, and that confusion is traceable, largely, to the inevitable lack of uniformity which such unstandardized techniques carry with them. It is, therefore, difficult to draw a clear historical line of succession showing the progression which studies on physical performance have taken. This does not imply, however, that such studies have failed to undergo evolutionary thought and development. It does mean that evolution in the field of tests and measurements has not proceeded in any simple manner. For the purposes of the present review it seems best to consider previous attempts on relating performance to the performer's body measurements and characteristics under the following broad headings:

A. The Concept of Athletic Types.

B. Descriptions and Body Measurements of Athletic Types.

C. Performance in Relation to Height and Weight.

D. Correlations between Performance and Anthropometric Measurements.

E. Performance and Somatotyping.

F. Performance in Relation to Grid Ratings.

A. The Concept of Athletic Types

The earliest attempts to distinguish physical proficiency in relation to body type can be credited to the Ancient Greeks. Inspired by a popular demand for athletic statues, and having already developed clear concepts of ideal physical beauty, the ancient sculptors succeeded in expressing a purely athletic type of physique.[1] The classic example is the Diskobolos by Myron. But the Greek artists, it is worth noting, were also aware of specialized athletic types. In fact, we may see the "thoroughbred" type of runner with relatively long limb and fine ankles; in other examples, we see the sturdier, heavier type of the pankrationists or the bulky body which typified the skillful boxer of the period.

This association between athletic skill and body type is often described by close observers of modern sports. Track and field athletics, perhaps more than other branches of competition seem to demand rather specific qualifications of size and body form. Consequently, people whose physical

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[1]E. Norman Gardiner, <u>Greek Athletic Sports and Festivals</u>, (London: Macmillan and Company, 1910), 88-95.

characteristics are best suited to particular muscular efforts in various events will tend, on the whole, to be the superior performers.

Several good examples of natural selection were observed by Cobb[1] at the Penn Relays in 1936. He noticed that the large, heavily muscled, somewhat paunchy athletes who competed in the shot put and hammer throwing events contrasted sharply with the tall, lean individuals who succeeded in the high jump.

The leading hurdlers were described as tall; the stellar distance men, medium to slender in build. Body build thus would appear to confer advantages in a few specialized events; and these advantages, it seems, cannot be secured by any amount of training or determination by those who are not so specifically gifted.

In some events, Cobb noticed a great diversity of body types and took this to mean that body build is sometimes less important than technique and the will to achieve. The sprinters and broad jumpers, for instance, showed the greatest diversity of physical types. Under such circumstances, it is obviously more difficult to determine the part played by body build itself.

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[1]W. Montague Cobb, "Race and Runners," Journal of Health and Physical Education, VII (Jan. 1936), 3.

B. Descriptions and Body Measurements of Athletic Types

The first scientific approach to the problem of identifying athletic types was reported by Sargent[1] in 1887. Explaining his own observations, based on anthropometric measurements of university students, he concluded that both athletic and nonathletic forms can be distinguished. Sargent, unlike Cobb, believed that physique changes could be produced by athletic practice: in particular, changes in weight, girth of chest, hips, thighs, arms, and shoulder breadth. Changes in neck girth, waist and calves, along with changes in the depth of the chest and abdomen, breadth of neck, waist and hips were less pronounced. "It must not be forgotten," he asserted, "that there is a development peculiar to the runner, jumper, wrestler, oarsman, gymnast, ball player, heavy-lifter, etc., and anyone familiar with athletics at the present day can easily recognize one of these specialists."[2]

Sargent admitted the importance of "natural" physique, and believed that physical characteristics related to sports might be acquired "in a measure" by prolonged practice; yet his fundamental thought nevertheless recognized the value of natural endowment as regards physique.

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[1]D.A. Sargent: "The Physical Characteristics of The Athlete," Scribner's Magazine, II:5 (Nov. 1887), 541-561

[2]Ibid., p. 542.

He stated clearly that "in many cases the special qualifications that made a man a first class athlete are gifts of nature."[1] In the last analysis, therefore, he attributed the kind of development resulting from the effects of athletic sports largely to the nature of the individual and his constitutional "bias."

Sargent offered some interesting comparisons between athletes and the so-called average man whose measurements he had collected in his studies of college men. These included 2,300 students of Harvard and Yale, 1,700 not having practiced athletics systematically: about 600 were members of athletic organizations for periods of one to four years. His descriptions of type were in reality descriptions of certain selected individuals, acknowledgement being mentioned of oddities of some persons who, although record holders, may not have possessed all the characteristics of the sport they represented. The typical short distance runner, for example, was described as a man who possesses relatively long limbs with a short body, full chest and small bones. Other types were described on the basis of measurements of leading contenders. It is worth-while to give a brief resume of some of Sargent's findings. The following characteristics are particularly interesting:

<u>The long distance runner</u> (in addition to the attributes of the runner already described):

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[1]<u>Loc</u>. <u>Cit</u>.

capacious lungs in a deep and mobile chest.

<u>The hurdler</u>: short leg, long thigh, comparatively short body, broad waist, deep chest, with considerable mobility in the chest and abdominal walls; gluteal muscles well developed as also the muscles of the thigh and leg; arms and shoulders relatively less developed.

<u>The pole vaulter</u>: development of arms and chest like that of the gymnast; short upper arm and forearm; relatively long and muscular thigh; bony framework smaller than the hurdler, but muscles proportionally larger.

<u>The high jumper</u>: relatively long thigh and short leg; small bone measurements; muscle measurements exceedingly large, short trunk; owes success to a light, bony framework and relatively large musculature.

<u>Football linemen</u> and <u>crew members</u> (participants in both activities): long body, short thigh, large bones, full chest, short upper arm, good lung capacity; exceeded by 80 per cent of 10,000 individuals in length of upper arm; but by only 25 per cent in length of lower arm.

<u>Wrestlers</u>: short stature, great muscle volume;

arms and legs short for length of body; depth of chest and abdomen proportionally small.

Football players: symmetrical in the lengths of different parts; length of trunk a trifle large compared to lower extremities; depth of chest and abdomen not great, i.e., about normal; lung capacity, deficient; all strength tests in region of maximum.

Lacrosse Players: harmonious development; arms short compared to other parts of body; upper arms and forearm length normal.

Perhaps the best that can be said of the foregoing results which Sargent emphasized is that they serve as an excellent introduction and background to the whole problem, that they are valuable from the historical point of view, and that they represent astute observation. It is very doubtful, however, whether these results could be applied with any particular success by the average worker of today; it seems that the modern physical educator would choose a somewhat more tangible working scheme.

Athletic Types. - About forty-five years later Kohlrausch,[1] one of the most eminent of European investigators, reported similar findings and discussed the relation to exercise to

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[1]Ferdinand August Schmidt and Wolfgang Kohlrausch: Physiology of Exercise, (Philadelphia: F.A. Davis Co., 1931), 197-209.

body build in about the same manner as Sargent. He wrote, "It is remarkable that the prominent representatives of the different sports have a definite build (physique) fitted or suited for their respective sport. This may have been developed in practicing for the sport but it may be hereditary. In the latter case we must accept it as a fact that his special fitness for a sport developed his inclination and desire for it, and so his hobby was discovered."[1] This statement is followed by a description of how exercise broadens shoulders, deepens and enlargens the chest and even lengthens the legs. These effects, however, are duly qualified by the remark that, "we have never heard that an athletic body has developed from a leptosomic one."[2]

In further studies, Kohlrausch compiled a table of body measurements to support his idea that every sport had its own body build.[3]

The weight thrower was found to be massive, the runner slender, the hurler (javelin, discus), tall and broad.

The "constitutional" type of the long distance runner was described as that of a rather small, gracile man with long legs and slender musculature.

The middle distance runner, however, was said to be noticeably different, by which Kohlrausch meant, somewhat

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[1] *Ibid.*, p. 199. [2] *Loc. Cit.* [3] *Ibid.*, p. 201.

taller, and still more slender, because his body and legs are comparatively long.

Exceptions to Kohlrausch's rule that each sport favors a specific type were the dash men, for he found that tall as well as short men, or slender as well as stocky individuals could make good records in these events.

For the most part, fairly slender men were found to participate in the 100 and 200 meter dashes, while the more successful men in the 400 meter dashes were heavier or more stocky.

Two types were found in the high jump; the tall and slender specialist and the "hurler" (weight throwing) type.

Wrestlers and heavy athletes according to Kohlrausch are very short, and the gymnast is likewise short with broad shoulders, but with small or narrow hips.

By contrast, the all-around athlete is rather large, broad shouldered, and similar to the Greek Apollo type with narrow hips. Between the gymnast and the all-around athlete are the boxers, soccer, basketball, and football players. The majority of this group are of medium height.

Lastly, the swimmer usually resembles the all-around athlete. He has a deep, broad and strong chest, broad shoulders; his hips, however, are normal and he has a fine, soft, elastic skin.

Olympic Contestants. - Measurements taken from scientifically prepared photographs of contestants in the 1928 Olympiad enabled Kohlrausch[1] to confirm his own earlier work as well as that of other investigators. Having been concerned with the question as to whether body build and performance are related, he assumed that the effect of body type would be revealed by a tendency of the superior athletes of all races to have physical qualifications advantageous to their own special events, even though the average make-up of their race* might differ considerably from that type. Kohlrausch measured three hundred athletes, including thirty women, at Amsterdam in 1928. While he acknowledged this number to be rather small for the purpose of statistical interpretation, he did include the best participants of each single sport. If differences in body build had been significant they would most likely have been found among these selected subjects. His report may be summarized as follows:

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[1]W. Kohlrausch. "Zusammenhange von Korperform und Leistung. Ergebnisse der Anthropometrischen Messungun an den Athleten der Amsterdamn Olympiade". Arbeitsphysiologie, 2 Band 197, 2 Heft, (Berlin, 1930), 187-204.

*The term "race" appears to be used broadly, and not in its strictest anthropological sense.

the average height of all participants was 1.73 M. This value lies above the general average of the participating races. Certain sports therefore appear more practicable for taller people. Some sports demand a small body, e.g., the weight lifters, 1.64-1.68 M. The wrestler's height was rather equally divided between 1.67 and 1.76 M. In the case of boxers, the height depended upon the weight class. Among the participants of the "long stretch" those under 1.70 M were predominant. Yet, only three of twenty-five oarsmen were below 1.76 M; again, only one of the throwers and but two jumpers were below 1.76 M. Cyclists, swimmers, and 100 meter runners were of various heights, large as well as small.

Runners and jumpers were found to be relatively light in weight. Throwers and water polo players were exceedingly heavy and the oarsmen were moderately heavy.

Two different types were discovered in boxing: In the same weight classes both taller and hence more lanky bodies as well as shorter and more stocky types were found. This was attributed to two fundamental differences in techniques: In the first case, to long reach boxers; in the second, to "in-fighters."

The chest girth of the weight athletes, throwers, and wrestlers was exceedingly large. Their hips were broad as is typical of sports that require a firm initial stance.

Runners had long legs, while wrestlers, throwers, and weight lifters had short legs. Like the latter, the swimmer also had short legs, but a long trunk.

The participants in sports that do not call for great height were about the anthropological average of the race they represented. In sports demanding large bodies the participants of small races were large as compared to the mean of their race. As a rule, each race tended to be well represented in the sports to which its body build was most suited. Examples: Middle distance runners were from the North lands whereas long distance runners, such as Japanese and Mexicans, stood out as especially small participants.

To support these findings Kohlrausch listed measurements on contestants in fourteen activities according to the nations they represented. The items recorded were: Weight, height, body index, vital capacity, ratio of breast circumference to height, upper arm circumference, calf circumference, shoulder width, foot breadth, leg length.

Tallness. - Observations somewhat similar in their general character to those of Kohlrausch, but limited, as regards body measurements, to the single item of tallness, were made by Riggs[1] who studied performance in athletes whose stature was 6 feet, 4 inches or more.

Football tackles, above 6 feet, 4 inches were found useful at the time when the game called for mass plays. In today's game, however, such men are easily drawn out of play.

Oarsmen, on the contrary, are never called upon to change direction and their long reach enables them to take long strokes.

In tennis, a long reach is a great advantage because it offsets somewhat a considerable lack of agility.

Basketball seeks out tall men, and baseball prefers tall men, but not as frequently as basketball. Nevertheless, 61 per cent of the better baseball players are 6 feet tall or taller.

Reach is an advantage in boxing, although not as important as the ability to move very quickly in every direction. Very tall men often cannot do this.

In competitive swimming, 6 feet, 5 inch men

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[1]Francis Behn Riggs, Tall Men Have Their Troubles Too, (Cambridge, Mass: Francis Behn Riggs, 1943), 23-28.

with long arms and relatively short legs are sometimes good in distance races, though generally poor in diving and sprinting.

Finally, in track, men of great stature find their best opportunities in throwing the hammer, putting the shot, jumping, and in middle distance running, other things being equal.

C. Performance in Relation to Height and Weight

Height-Weight Groups (Descriptive). - In contrast to the foregoing census-type of study, Cozens[1] reported on the performance of 601 college men whom he grouped into broad height-weight categories. Performance was measured in seven athletic ability tests. The men were classified not only as tall, medium, or short, on the one hand, but also as, slender, medium, and heavy on the other. Performance was thus compared according to the following nine groupings identified by key number:

Key No.		Key No.		Key No.	
(1)	Short Slender	(4)	Short Medium	(7)	Short Heavy
(2)	Medium Slender	(5)	Medium Medium	(8)	Medium Heavy
(3)	Tall Slender	(6)	Tall Medium	(9)	Tall Heavy

[1]Frederick W. Cozens, "A Study of Stature in Relation to Physical Performance," Research Quarterly, I, (Mar. 1930), 38-45.

The events Cozens studied were:

Baseball Throw	Standing Broad Jump
Football Punt	Parallel Bar Dips
Long Dive	Dodging Run

Quarter Mile Run

The tall (#3,6,9) and medium (#2,5,8) subjects were found to be superior to short men (#1,4,7). The heavy (#7,8,9) and medium (#4,5,6) weight men, as groups, were superior to those who were classified as slender (#1,2,3). A small negative correlation was found between slender men (#1,2,3) and ability to score high in the seven tests (bi-serial r = - .355). Conversely, a small but positive correlation was found to characterize the ability of heavy men (#7,8,9) to score high in the same tests (bi-serial r = + .312). The correlation between being short and having ability to score high was small and negative (bi-serial r = - .251).

In the slender group (#1,2,3), the tall (#3) were superior, medium (#2) next, and short (#1), inferior. In the medium (#4,5,6) group, the talls (#6) and mediums (#5) were distinctly superior to the shorts (#4). The tall heavy (#9) and short heavy (#7) were not as capable as the medium heavy (#8).

Rank was not consistent in all events. The classes which excelled in various events were the following:

Baseball Throw - Medium heavy (#8)
(The tall-medium (#6) and tall-heavy (#9) scored a close second).

Football Punt - Tall heavy (#9).

Long Dive - Medium-heavy (#8).

Standing Broad Jump - Tall-medium (#6).

Dip - Short-medium (#4).

Dodging - Medium-heavy (#8) and short-heavy (#7).

Quarter Mile - Tall-medium (#6) and medium-heavy (#8).

Cozens recommended that the relation between physical differences and ability be seriously considered, and suggested the possibility of either refining the stature groups or making use of the existing classification for the purpose of developing a scoring scale for each event.

Bookwalter[1] used this same scheme to classify about 1400 girls, whose performance was measured in terms of a physical fitness score. His mean values worked out as follows:

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[1]Karl W. Bookwalter, "An Assessment of the Validity of Height-Weight Class Divisions for High School Girls," Research Quarterly, XV, (May, 1944), 146-148.

Short Slender (#1)	Short Medium (#4)	Short Heavy (#7)
72.20	78.63	57.50 (lowest)
Medium Slender (#2)	Medium Medium (#5)	Medium Heavy (#8)
68.44	72.32	63.14
Tall Slender (#3)	Tall Medium (#6)	Tall Heavy (#9)
79.61 (highest)	70.04	62.64

Performance in the medium weight group (#4,5,6) exceeds that of all other groups except #1 and #3. Being of medium weight seems therefore to be somewhat advantageous.

The difference between the highest score (79.61) and the lowest (57.50) was significant, the critical ratio being 4.25. It is interesting that these two groups (#3 and #7 respectively) represent directly opposite types.

Altogether Bookwalter's study showed that nine differences were significant (critical ratios 4.50-2.09), but it also showed that nine other critical ratios were as low as 1.23-1.88. While this system of classification could not therefore be completely validated, it did merit consideration, Bookwalter believed, because it is simple and seems to provide a reasonable case distribution.

Cozen's height-weight groupings were also employed by Hughes[1] in 1942, in analyzing physical fitness test

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[1]Byron O. Hughes, "Test Results of the University of Michigan Physical Conditioning Program, June 15 - Sept. 26, 1942," Research Quarterly, XIII (Dec. 1942), 498-511.

scores of university men. Hughes' results showed that tall men (#3,6,9) are generally superior as a group to those who are short (#1,4,7). Exceptions were found in the push-ups and pull-ups. In these events, the men of short (#1,4,7) and medium (#2,5,8) height groups scored best. A brief summary derived from Hughes' table of mean scores may be given in terms of rank order:

RIGHT GRIP	PULL-UPS	60 YARD DASH
Tall-heavy (#9)	Medium-medium (#5)	Short-medium (#4)
Medium-heavy (#8)	Short-medium (#4)	Tall-medium (#6)
Tall-medium (#6)	Medium-slender (#2)	Medium-medium (#5)
Short-slender (#1)	Tall-heavy (#9)	Short-slender (#1)

400 YARD RUN
Tall-medium (#6)
Medium-medium (#5)
Tall-heavy (#9)
Short-slender (#1)

PUSH-UPS	VERTICAL JUMP	STANDING BROAD JUMP
Short-medium (#4)) Tie Short-heavy (#7))	Tall-medium (#6)	Medium-heavy (#8)) Tie Tall-medium (#6))
Medium-medium (#5)	Medium-medium (#5)	Tall-heavy (#9)) Tie Medium-medium (#5))
Tall-slender (#5)	Short-slender (#1)	Short-slender (#1)
	Medium-slender (#2)	

Note: The order within each weight class was
Short
Medium
Tall

Note: The order within each weight class except for the superior score of Heavy & Medium class was
Tall
Medium
Short

Since the average scores for the different height-weight-combinations showed small but significant differences in performance, Hughes felt that classification of men into height-weight groups might serve useful purposes. The general significance of this conclusion is supported by Hughes' own results, as well as by those which have been previously mentioned. The only important reservation that the writer would make concerns the practicality and the validity of the broad height-weight classes which Cozens drew up. This aspect of the general problem of classification is discussed more fully in Chapter III.

Height-Weight Groups (3 classes). - In the preceding studies terms such as tall, medium, short, etc. were employed either singly, or in some combination, such as that of Cozens who proposed nine classifications. Cureton[1] on the other hand, though also relying on descriptive terms, limited his categories to three, and designated them as linear, medial, and lateral. He reported observations on 113 college men who were tested in track and field events.

Men of linear type showed better ability in the baseball throw, standing broad jump, 50 yard dash and 440 yard run.

The lateral types excelled in the shot put.

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[1]Thomas Kirk Cureton, Jr., "Body Build as a Framework of Reference for Interpreting Physical Fitness and Athletic Performance," Supplement to the Research Quarterly, XII, 2, (May, 1941), 317.

Since the table of means did not include the usual measures of reliability the significance of differences between the types is difficult to evaluate. Nevertheless, some effect, associated with body characteristics, is evident in the rank order of scores for each class.

The men of medial types, for example, were second to the linear individuals in four tests while those who were classified as lateral scored the least.

In the shot-put, won by the laterals, the medials are again seen to be second and the linear men, third. The differences in scores, although not large, would indicate that body type does exert an effect on performance.

Neck and Calf Girths; Arm Span. - In seeking further classification of the differences which he had noted among the linear, medial, and lateral types, Cureton, in another study[1] measured neck and calf girths as well as arm span. Such additional measurements, however, do not appear to have added materially to what was already known about the characteristic performance of the main types with which he worked. For example, so-called "taller, heavier and stronger men" would normally be expected to have a comparatively longer arm span, as

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[1] Loc. Cit.

well. That they should excel in the baseball throw, as Cureton found, is no doubt a result of longer span; but it is also an effect of being "taller, heavier and stronger." Studies such as these illustrate the great difficulty of appraising factors that affect performance, and of determining which are relevant, or mainly so.

Age-Height-Weight and other Measurements. - Still another example of how the problem of performance has been studied is to be found in Breitinger's observations on three thousand Munich high school boys.[1] In this investigation the measurements themselves, rather than some descriptive term, served to demarcate individual groups. Breitinger's intention was to learn whether correlations between what he called "body form" and physical achievement are sufficiently great to warrant the evaluation of pupils' fitness in terms of their physical characteristics. The boys were tested in five activities: 60 m. sprint, standing broad jump, running high jump, putting a 1000 gram medicine ball, "baseball" distance throw (schlagball).

1. Age. All of the tabulations showed an increase in achievement with increase in age. The increase in achievement in the scores varied in degree with the

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[1]Dr. Emil Breitinger, "Body Form and Athletic Achievement of Youths," Translated and Condensed by Ernst Thoma, Research Quarterly, VI (May, 1935), 85-91.

separate events and by varying amounts for different age periods in a given activity. In view of this relationship, Breitinger maintained that no greater lengths of age periods than one year should be used in judging the athletic achievement of youths and that classification for physical activities should never be based on membership in school classes.

2. Height. A positive correlation was found between height and achievement in sprinting, high jumping, broad jumping, and throwing the medicine ball. The baseball throw was found to be relatively independent of stature.

3. Weight. In sprinting, weight was found to correlate negatively for the groups under thirteen years and positive for the age groups between fourteen and eighteen years. The same relation was discovered in both jumping events. The medicine ball throw, on the contrary, proved to be positively correlated with weight at all ages, whereas the baseball throw had much the same relationship as

the sprints and the jumps. Achievement in throwing a baseball was found to be clearly positive with weight only for the subjects between fourteen and eighteen years of age.

4. Height and Weight Combined. Below age eleven a combination of height and weight showed negative correlation with sprinting ability. Between eleven and fourteen the correlation was positive but small. For groups above fourteen years of age, the correlations were uniformly positive. This, Breitinger believed, was an indication that body form, achievement and growth are closely interdependent. Further analysis of the scores showed height to be more important than weight in jumping whereas weight was the more important of the two factors in the throwing events.

5. Proportions of Extremities. Breitinger found a decrease in achievement in running and jumping, with increasing relative length of legs. This was more manifest in the sprints than in the jumping events. Little connection seemed to exist between arm length and throwing.

6. Chest Girth and Shoulder Breadth. Achievement depended on chest girth to about the same extent as it depended on weights. Very small differences in performance were noticed in relation to shoulder width. Breitinger observed that it is only when acceleration of body growth accompanies growth in width that relatively broad pupils are found superior to the more slender subjects.

7. Body Form. Relatively poor achievement on the part of long legged pupils, for example, was attributed to bodies of the leptosomic and asthenic types, whereas better than average performance of broadly built individuals indicated superiority of the eurysomatic types.

In general, Breitinger's correlations were rather low, a fact which he interpreted to mean that, besides body form, such elements as individual aggressiveness might also be involved in performance.

D. Correlations between Performance and Anthropometric Measurements

Studies grouped under this heading differ from those already discussed primarily by the fact that correlation techniques of one kind or another were employed, but also by the fact that body measurements were made according to recognized anthropometric procedure.

High Jump. - Krakower[1] measured body height, weight, length of legs, breadth of foot and girth of hips in an attempt to determine the "skeletal" characteristics of the high jumper. He compared non-track men to track athletes; and he found that the foregoing items had little influence on the height to which individuals jump, but he also found that those relationships which did exist seemed best reflected in a combination of stature, leg length and foot breadth.

In the Junior-Senior track group this three variable combination gave the highest multiple correlation, viz. + .4378. In the Freshman-Sophomore track group the same combination of measures gave a multiple r of .2560, though combinations of other variables gave higher r's, even as large as .2776.

In the non-track group, the men who jumped highest were taller, had longer legs and broader feet than those of the lowest performance percentile.

Height, leg length and foot breadth of experts

[1] Hyman Krakower, "Skeletal Characteristics of the High Jumper," Research Quarterly, XI (May, 1935), 75-84.

was greater than the corresponding measurements in the <u>non-track</u> group. Finally, a short body, broad feet and long legs distinguished the type of man who succeeded best in the high jump.

<u>Sprinting</u>. - In an extensive study involving the selection of thirty-three anthropometric measurements, Rogers[1] concluded that there is no such thing as a sprinting type of body build. Sprinting performance was tested by speed in running the one hundred yard dash. An attempt was also made to find the maximum speed attained at any one time in the dash, by means of a special timing apparatus. Comparisons were made between individual anthropometric traits and sprinting ability as measured (1) by the fastest 10 yards along the course; (2) by total time for running the whole distance.

No single physical trait seemed to be associated to any significant degree with either criterion, all correlations being low, none above .2. Better correlations were found with the fastest time than with the total time. But even when a group of nine anthropometric measures, which correlated higher than the others was used, the results were still low, reaching only .2685.

A comparison of the means of 10 physical traits among the 16 fastest and 16 slowest runners showed real

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[1]Laurence T. Rogers, "A Study of Relationships Between Certain Aspects of Physique and Sprinting Ability," Unpublished Doctor's Dissertation, New York University, 1933.

differences although no difference exceeded its probable error by 4.

Shot-Put, Running Broad Jump and Hurdling. - McMurray[1] sought to determine relationships between performance in the shot-put, running broad jump and hurdling and what he called "skeletal symmetry" as judged by various body measurements considered to have the greatest bearing in these events. He also attempted to determine whether improvement in performance had any connection with skeletal symmetry.

The data were taken from the performance of college men in the shot-put, running broad jump and hurdling. Correlations between single skeletal traits and each of the events, as well as relationships involving combined measures (ranging from two to seven variables) and even multiple correlations with all skeletal traits were low. The highest correlation with shot-put was weight, yielding a coefficient of .4554; shoulder width was second with .4071. Multiple correlations of all partial combinations ranged from .5067 to .5516. In the other events the results were considerably less informative.

In hurdling and broad jumping, weight seemed to be a handicap, as shown by low negative correlations; the best records were made by relatively lighter men.

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[1] J.G. McMurray, "The Relation of Skeletal Symmetry to Athletic Prowess," New York University, 1937. Unpublished Doctoral Dissertation.

The search for an association between improvement and skeletal symmetry was unrewarded. No substantial correlations were found.

Athletic and Nonathletic Groups. - Differences in anthropometric measurements were found by DiGiovanna[1] to distinguish specific athletic groups from normal student groups. The measurements used were weight, standing height, shoulder breadth, chest breadth, chest depth, hip breadth, arm span, arm girth, and leg length. Compared with the general student body, athletes possessed physical characteristics as grouped according to the following sports:

Baseball: shorter and greater arm girth.

Basketball: greater weight, height, sitting height, leg length, shoulder breadth, chest depth, and arm span.

Football -

Backfield: greater weight, chest breadth, chest depth, and arm girth.

Line: greater weight, height, sitting height, shoulder breadth, chest breadth, chest depth, and hip breadth.

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[1]Vincent DiGiovanna, "The Relation of Selected Structural and Functional Measures to Success in College Athletes," Research Quarterly, XIV (May, 1943), 199-216

<u>Gymnastics</u>: smaller in height, leg length, and hip breadth.

<u>Tennis</u>: no substantial differences.

<u>Track</u> and <u>Field</u> -

<u>Shot</u> and <u>Discus</u>: very much greater weight, shoulder breadth, chest breadth, and arm girth: - substantially greater height, sitting height, leg length, chest depth, hip breadth, and arm span.

<u>All other events</u>: differences between these men and the normal student group were not enough to locate any structural type characteristics of the track athletes. (This, in the light of other observations, including the findings in the present study, is remarkable.)

<u>One Sport Group</u>: no structural differences of any significance.

<u>Two Sport Group</u>: substantially greater weight, chest depth, and arm girth.

<u>Three Sport Group</u>: much greater weight, greater height, shoulder breadth, chest breadth, chest depth, arm girth, and arm span.

<u>Total Athletic Group</u>: no important structural differences.

Muscular strength and explosive power were also used to measure athletic performance. These factors along with body structure were found to be associated with success in certain kinds of athletics. They appeared, however, to be of varying importance since different sports have their own unique pattern for success.

Women's Sports. - In a similar approach, Beall[1] sought relationships between various structural measurements and performance by college women in basketball, swimming, tennis and the modern dance. The average measurements of successful performers were compared with those who were judged to be unsuccessful. In each activity these two groups were distinguished by real differences in mean body measurements which justified the conclusion that basketball players, swimmers, and tennis players differed from unsuccessful players in dimensions of various body parts.

Basketball players, for example, were distinguished by length of upper arm, hand breadth, total arm length, breadth and length of foot, and breadth of shoulders.

Swimmers differed from non-swimmers in hand breadth, shoulders, hips, depth of chest, circumference of chest, and body weight.

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[1]Elizabeth Beall, The Relation of Various Anthropometric Measurements of Selected College Women to Success in Certain Physical Activities, (New York: Teachers' College, Columbia University, Contributions to Education No. 774, 1939).

The tennis group excelled in standing height, sitting height, length of entire leg, and breadth of foot.

The modern dance group showed smaller dimensions than the unsuccessful dancers, but these differences involved only the length of upper arm and length of thigh.

A comparison of the four activity groups showed that basketball players excelled dancers in 13 out of 17 measurements.

Swimmers surpassed the dancers in 7 measurements; basketball players exceeded tennis players in 5 measurements while the tennis group was superior to the dancers in only 3 items. The only difference between swimmers and tennis players was in the broader hips of the swimmers.

These findings in spite of rather low correlations led to the conclusion that specific structural characteristics accompanied success in certain physical activities and that people who succeeded in one activity differed from those of another, yet no one type of body build was identified for any of the four activities that were studied.

Baseball Throw (women). - Watson[1] studied the relationships between nineteen anthropometric measurements

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[1]Katherine G. Watson, "A Study of the Relation of Certain Measurements of College Women to Throwing Ability," Unpublished Doctoral Dissertation, New York University, 1935.

of selected college women and their abilities to throw a baseball. The subjects were tested in both accuracy and distance throwing. The correlations between each of the separate measurements was exceedingly low for both events. All were below .20. The multiple correlations between 14 measurements and either test were like-wise very low; the correlation with distance being .2985 and the result for accuracy, only .2616. All correlations of individual body measurements, however, like the multiple correlations were positive. None was high enough to indicate an influence of real importance.

E. Performance and Somatotyping

Cureton[1] reached a number of conclusions in classifying college students into Sheldon's somatotype groups.[2] He used data from ten physical tests to study the relative performance of men who represented each of five different varieties of physique, as determined subjectively. A table of mean scores was set up so that the mesomorphic (well-muscled men) were flanked on one side by the endomesomorphic (between obese and muscular) and endomorphic types (obese), whereas on the other side were the mesomorphic-ectomorphic (between the muscular and extreme slender) and the ecto-morphic (extremely slender) types.

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[1]Cureton, op. cit., pp. 323-325.

[2]W.H. Sheldon, S.S. Stevens, and W.B. Tucker, The Varieties of Human Physique. (New York: Harper Brothers, 1940).

On the basis of mean scores for each group the ectomorphic type excelled in the strength index test. The rank order of scores showed an even diminution from one type to another with the lowest score being recorded for the endomorphic class. In total strength, i.e., wherein the scores were not adjusted by height-weight norms, the mesomorphs were high, whereas the scores for the others showed uniform reduction with progression toward extreme slenderness or extreme rotundity. In Cureton's hands Cozen's all-round athletic ability test again favored the mesomorphic class and also showed body type effects like those in the total strength test. Brace's motor ability test was partial to the ectomorphs. The mesomorphs were second and the endo-morphic class was low.

Track and field events were performed best by the mesomorphs, the ability to excel diminishing as body type approached extreme classes.

Aquatic ability was also better for the mesomorphs and those who were nearly mesomorphic in type.

Gymnastic achievement was found to be about equal for all types with the exception of the endomorphs, whose scores were exceptionally low.

Body flexibility was best among the ectomorphs and mesomorphic-endomorphic groups. Ability in this test also varied as before with respect to extreme types.

The lowest scores in the McCurdy-Larson Organic Efficiency Test were made by men of the ectomorphic class, while mesomorphic scores were considerably higher. In this test only one individual was classed as an endomorph, and his score exceeded all others.

Posture scores did not differ appreciably among various body types, although the mesomorphs scored slightly higher than the students of other types.

F. Performance in Relation to Grid Ratings

Only one study was found which employed the Wetzel Physical Fitness Grid.[1] Hall and Wittenborn[2] of Illinois tested 328 farm boys in five physical activities. The scores were organized in relation to the several varieties of physique determined objectively by Grid classification and performance was evaluated in terms of the mean scores made by respective groups. The test battery included the "L" test, chinning, push-ups, the vertical jump, and a test for leg strength which consisted of pressing downward on a platform scale. The latter was described as a jump, measured in pounds.

Curves showing the distribution of scores were much alike except for types B_4 and A_4. Because of similarities, all tests of the boys in types B_3 through A_3 were combined

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[1]See Chapter II for references concerning the Physical Fitness Grid.

[2]D.M. Hall and J.R. Wittenborn, "Motor Fitness Test for Farm Boys," Research Quarterly, XIII (Dec, 1942), 432-443.

and regarded as "near normals." These were compared to the thirteen boys of type A_4 who were described as obese. No curves were shown for types B_4. The obese boys were inferior to the near normals in all events. The table of scores for type B_4 shows that these boys were also poorer in ability than the "near-normals." Hall and Wittenborn concluded that the obese (A_4+) and poor physical subjects, (B_4) do react differently from the more nearly normal physiques.

In three of the tests the boys of class A_2 were superior. The subjects of physique class M scored <u>highest</u> in the chinning test while the A_3's were <u>high</u> in the "pounds" jump and A_2's high in the vertical jump. The investigators reported the mean scores shown in Table 1.

Inspection of this table reveals a definite tendency for differences in performance to vary systematically with body type - although the authors themselves placed no emphasis on this result. They considered the scores of classes A_3 to B_3 to be sufficiently alike so that their combined average value might be employed in comparison with the performance of A_4's. Regardless of how justifiable this procedure may have been for their own purposes, it tends to conceal effects that are plainly evident in their tabulated values. Even though the means of adjacent physique classes may not have been significantly different,

TABLE 1

THE AVERAGE SCORE IN TESTS FOR EACH PHYSIQUE CLASS AS REPORTED BY HALL AND WITTENBORN

Physique Classes	No. of Boys	Average "L" Test	Average Chins	Average Push-ups	Average Jumps Inches	Average Jumps Pounds
A_4	14	2.0 ± .36	.61 ± .33	.8 ± .24	9.1 ± .68	68.6 ± 4.4
A_3	11	2.5 ± .47	4.0 ± 1.3	4.1 ± 1.0	14.1 ± .47	85.4 ± 6.4
A_2	25	3.2 ± .28	5.2 ± .06	5.8 ± 1.0	15.2 ± .11	82.8 ± 5.0
A_1	39	3.0 ± .22	5.0 ± .67	5.3 ± .68	13.6 ± .72	73.1 ± 3.9
M	95	3.1 ± .14	5.6 ± .38	4.9 ± .40	13.6 ± .49	72.1 ± .22
B_1	85	2.9 ± .14	5.0 ± .08	4.6 ± .42	13.7 ± .48	68.7 ± .22
B_2	32	3.2 ± .25	4.8 ± .58	3.4 ± .29	13.3 ± .74	67.4 ± 1.2
B_3	23	2.6 ± .12	4.4 ± .70	2.2 ± .42	14.5 ± .69	67.4 ± 3.6
B_4	5	2.4 ± .63	2.8 ± 1.6	.8 ± .38	10.2 ± .97	59.4 ± 5.4

owing to class interval, size of sample, etc., their data do suggest that physique influences performance. It may be noted, that Hall and Wittenborn made no analysis of level influence, although they did undertake a fifteen variable factor analysis. Body size, therefore, was considered only to the extent that it might be governed by age, that is, only indirectly. From the results of their study, it is very likely that the true significance of physique escaped detection by overlooking the element of body size, as represented directly by level.

Interpretive - Recapitulation

Up to this point, only one broad phase of the subject of performance in relation to body characteristics has been reviewed, that phase having to do with exploratory attempts to determine how body structure either limits or enhances physical performance of expert athletes or even of ordinary contestants. In general, these studies have been carried out under the assumption that good performance would be favored by certain physical attributes and that it would be hindered by others. Many lay observers had long before suggested the possibility of such connections. What remained was to make a start.

If the underlying purpose of this work seemed reasonably clear (i.e., to study the role which various physical traits were thought to play), the results it achieved have left much that is still undecided today. This outcome, however, is not traceable to a dearth of facts, because an enormous amount of data have actually been reported. The present difficulty is to know which ones are relevant and what their real significance may be.

The work thus far reviewed represents the main trends of early development. Many reports, other than those specifically mentioned or explained, have also appeared; but their objectives, procedures and results have been similar. Little would be gained now by abstracting all published material since the particular nature of this phase of the problem is readily to be understood from the digest that has been given.

The results so far mentioned, have consistently borne out the contention of many observers, that a contestant's body make-up has much to do with his ultimate limits of performance. Before the full importance of this overall result had been clearly worked out, a number of investigators had already begun to focus their attention on methods of classification. This phase of the general problem is in itself distinctive and it has been singled out for separate discussion in Part 2 of this chapter.

Part II - Previous Studies and Methods of Classifying Performers

Motivation. - The basic distinction between the studies already described and those next to be outlined has not always been made clear. While it is true that both are part of the whole problem of performance, it is also true that they do represent two quite different lines of approach. Unless a clear distinction is made, therefore, one can be easily led into the error of confusing the purposes of one type of endeavor with those of the other.

It may be recalled that the investigations of performance so far described were exploratory in nature. In these efforts, physical performance was being catalogued. The main object was to learn which factors exerted the greatest affect on motor activity, and to identify ideal, average and poor performance. This process of cataloguing has never ceased; new tests and new facts are still being accumulated.

An entirely different motive is to be discerned, however, in even the earliest efforts at "classification." The incentive to classify was essentially that of making allowances for physical advantages which certain performers would have over others. The general endeavor of "classification" may be said to have been an attempt to bring different contestants to a comparable base from which their performance could be judged, and that by so doing "other things would be equal."

It has been said, for example, that "general physical capacities ... should be equalized by a classification scheme,"[1] or that "the purpose of classification is to equalize, so far as possible, the physical differences between individuals."[2] The definitions have not always been clearly stated and the methods have been quite diversified. It is desirable for this reason, to mention a number of classification schemes and to describe their intended purpose, as well as some of the results which are regularly credited to them. For convenience they may be discussed under two headings, namely, "informal methods," and "formal methods."

Informal methods. - These are noted purely for the sake of mentioning the simplest methods which have been employed from time to time in everyday sports and competition. Such schemes are represented by the groupings a teacher employs in separating smaller and larger children for their respective playground activities. They are mainly based upon differences in age, school grade, size, weight, or even upon obvious differences in "maturity" or ability to perform. Almost their chief purpose is to avoid accidents through unfair matching of strength.

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[1]N.P. Neilson and Frederick W. Cozens, Achievement Scales in Physical Education Activities for Boys and Girls in Elementary and Junior High Schools, (New York: A.S. Barnes and Company, 1934) 3.

[2]Charles Harold McCloy, The Measurement of Athletic Power, (New York: A.S. Barnes and Company, 1932) 96.

Formal methods. - In the historical development of the subject, essentially three different modes of approach to classification have been employed. For the sake of brevity, these may be termed, (A) Direct, (B) Indirect, methods of grouping performers, and (C) a combination of these.

A. Direct methods of classification. In these methods, contestants are classified on the basis of their own performance, as regards skill, strength, endurance, or power, when subjected either to a single or to some combination of actual tests. Boys might thus be classified into groups according to their demonstrated ability in a Basketball test, in Track and Field events, or in some physical fitness test. Direct methods therefore, require only that a contestant "prove his class" by actual demonstration.

B. Indirect methods. In contrast to classification by performance tests the methods that I have chosen to describe as "indirect" make use of one or more measurements of size or maturity.

Age alone, for example, has often been used as a "classifier". Because of many important physical differences among persons of the same age, however, classification by indirect methods has usually included some allowance for weight and stature. Moreover, to compensate for differences in "maturity", school grade has also at times been introduced, since age itself apparently did not seem to take sufficient account of that factor.

Since the indirect methods of classification are employed to identify a contestant's class in terms of various attributes which are thought to influence his performance, rather than on the basis of what he himself has actually been found to do, they are actually methods of estimating performance differences. The use of these methods imply some prior knowledge gained either through experience or by a study of the relations between physical or other characteristics and various kinds of performance. Three broad types may be described briefly, namely, the several "exponent" systems as derived by Reilly,[1] and later by Neilson and Cozens,[2] the nine height-weight groups of Cozens,[3] and the classification indices of McCloy.[4]

Exponent Systems. - As early as 1917 Reilly suggested an age - grade - height - weight plan for children between 10 and 15 years of age. In his system, numbers from 4 to 9, called "exponents," were arbitrarily assigned to represent each of these four factors. The sum of the exponents was then taken as an "index" which was further

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[1]John F. Bovard and Frederick W. Cozens, Tests and Measurements in Physical Education, (2nd ed., Philadelphia: W.B. Saunders and Company, 1941), 194.

[2]Ibid., p. 196.

[3]Frederick W. Cozens, "A Study of Stature in Relation to Physical Performance," Research Quarterly I (Mar., 1930), 38-45.

[4]Charles Harold McCloy, Tests and Measurements in Health and Physical Education, (New York: F.S. Crofts and Company, 1939), 46-50.

identified by a letter class, A-E, according to class intervals of 3 units in the exponent sums.

Reilly's scheme was the forerunner of others used in California and very similar to the method that was later derived by Neilson and Van Hagen, who eliminated grade as a factor, and extended the "classes" from "E" to "H". In 1934 Neilson and Cozens[1] employed the latter exponent system as the basis for their achievement scales.

Neilson and Cozen's exponents from 1 to 17 were assigned in steps of 1, to (a) each 2 inches increase in height, beginning with 50 inches; (b) each 6 months increase in age, beginning with 10 years; and (c) each 5 pound increase in weight, beginning with 60 pounds. The exponent sums for the three items were then identified by an A to H letter class, corresponding to four integer increases from 9 and below to 39 and above.

A principal assumption in such a plan is that advantages or disadvantages, due to differences in age, weight, height, etc., are adequately counterbalanced, and that a contestant's classification, so determined, puts him on an equal footing with others in the same class group even though their physical dimensions or age may be quite different. It is assumed, that classification by exponents, redistributes contestants into "homogeneous" groups, such that

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[1]Neilson and Cozens, op. cit., pp. 4-7.

members of one letter class, are all sufficiently alike in their endowment for performance, whereas members of different groups are, on the contrary, quite dissimilar.

It need merely be remarked here that classification by exponents does not necessarily mean that subjects so grouped are homogeneous in other physical capacity or bodily make-up. Neilson and Cozens, for example, believed their exponent system to be valid because it correlated .983 with "another plan set up scientifically,"[1] - the latter being of the index type, mentioned in the following pages. As may easily be shown, however, after the Grid technique has been described, that correlation, and the conclusion drawn from it, are the results of having compared one scheme with another whose validity was no greater than that of the original.

Cozen's Height-Weight Groups. - This method of classification is apparently an outcome of results which Cozens[2] noted in connection with McCloy's formula II, i.e. #8 in the table on page 84. While Cozens believed that II was "valid," he felt that in the case of college men, height changes in a given individual were likely to be so negligible that II need not be employed and that a classification by height and weight, according to the following scheme,

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[1]Neilson and Cozens, op. cit., p. 5.

[2]Bovard and Cozens, op. cit., p. 200.

offered "certain advantages."[1] The limits for tall, medium and short were established by assigning "tall" to the upper 25 per cent, "medium" to the middle 50 per cent and "short" to the lower 25 per cent of 7389 college freshmen he measured:[2]

Tall Slender	Medium Slender	Short Slender
Tall Medium	Medium Medium	Short Medium
Tall Heavy	Medium Heavy	Short Heavy

Classification Indexes. - These are likewise indirect methods of grouping contestants, and they share with the exponent type the thought that contestants so classified are segregated into physically homogeneous groups. An "index" is the number result obtained by substituting a contestant's age, weight and height (or only two of these), into a multiple regression formula, the coefficients of which have been obtained by correlating performance in track and field events with these factors. The numerical range (about 500-955) is divided into 8 or 9 classes separated by 25-30 "point" intervals and designated by letters.

For brevity, the tabular comparison of various indices given by Bovard and Cozens[3] may be cited:

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[1] Loc. Cit.

[2] Frederick W. Cozens, Achievement Scales in Physical Education Activities for College Men, (Philadelphia: Lea and Febiger, 1936), 8.

[3] Bovard and Cozens, op. cit., p. 201.

1.	1917	Reilly (an approximation):	20A + 1.50H + 0.95W
2.	1922	California Secondary Boys:	20A + 2.00H + 1.375W
3.	1927	McCloy:	20A + 3.75H + 2.50W
4.	1932	McCloy:	20A + 6 H + W
5.	1932	Cozens & Neilson:	20A + 5.5 H + 1.1 W
6.	1932	Cozens (Jr. Pentathalon):	20A + 4.33H + W
7.	1935	Cozens, Trieb and Neilson:	20A + 4.75H + 1.60W

along with

8.	1932	McCloy II	6 H + W
9.	1932	McCloy III	10A + W

wherein A = Age in years, H = Stature in inches, and W = Weight in pounds.

McCloy, whose three different indexes (I,II,III) appear in the foregoing table as #4,8 and 9 respectively, has devoted much study to this problem. He concluded that #4, i.e., Classification Index I, was the best at all ages for the purpose of classifying boys, and thus, for dividing individuals into relatively homogeneous groups for athletic competition.

It is especially noteworthy that McCloy[1] summed up his conclusions on body build as follows: "Body build seems to be of no significance when chronological age, height and

[1]McCloy, The Measurements of Athletic Power, op. cit. p. 95.

weight are included according to their best weightings." (I.e., as in Classification Index I).

Combination Methods. - The objectives of classification have occasionally been sought by means of methods which are, in reality, a combination of the direct and indirect schemes already described. Rogers' Strength Index[1] is an example. It includes direct measurements of lung capacity, grip, leg, back and arm strength along with measurements of body weight and height.

McCloy[2] also proposed a combination method based on chinning (or dipping) and body weight as a classification device "which seems to be as adequate on the whole as the total strength test."[3]

Finally, Kistler's[4] Grouping Indices may also be mentioned under this heading of combined classification methods. He considered that Standing Broad Jump + 6.5 Burpee + 7 Shuttle Run + 0.2 Classification Index was the best combination.

These combined methods are principally mentioned to illustrate the various attempts that have been made to relate structure and function.

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[1]Frederick Rand Rogers, Physical Capacity Tests in the Administration of Physical Education, (New York: Teacher's College, Columbia University, Contributions to Education, No. 173, 1925).

[2]McCloy, "Tests and Measurements," op. cit., p. 23.

[3]Bovard and Cozens, op. cit., p. 86.

[4]Ibid., pp. 198-199.

Summarizing Remarks

From the standpoint of the purposes of the present investigation, previous work in the field of physical performance may be said to have taken two somewhat different lines of development. The one has been exploratory, and those individuals who have followed it, attempted to learn above all what it was that governed performance. Superior motor achievement seemed obviously to depend on bodily characteristics favorable to the contestant, and the early attempts sought to describe the physical patterns represented by different athletes. Refinement of this approach was achieved by applying anthropometric techniques, yet even this advance did not succeed in establishing universally acknowledged relations between performance and body characteristics. Many correlations, in fact, were so exceedingly low as to throw considerable doubt on the assumption that performance did depend on physical features. From the present vantage point it seems that the earlier investigations in this field were hampered as much as anything by the lack of practical methods for differentiating human sizes and types. Two important facts are evident, namely: (a) Most investigators who sought connections between performance and body build, practically ignored differences in size; and (b) the usual methods of evaluating body types that were employed are questionable measures of physique.

The second point of criticism that bears directly on the methods and results of this paper, concerns the problem of classification. The chief results have been reviewed in Part II. In contrast to the exploratory studies, they attempted to project information on performance and body structure to practical use. This applied, mainly, to the methods that have been described as indirect. It could obviously not apply to the direct methods of classification, for in these, a contestant could not be classified until he had actually demonstrated his ability in a given activity.

The indirect methods of classification sought to predict performance on the basis of individual body characteristics, such as height, weight, age, or other measurements. Their chief purpose was to make suitable allowance for advantages or disadvantages which individual performers might possess.

Both lines of endeavor, - the exploratory to seek relations between performance and physical attributes, and the classification proposals, have been previously applied to a problem that is again undertaken by a different method in this paper. Both lines have, at times overlapped, and it has sometimes appeared that studies of performance beginning along one course, have later been transferred to the other. Some confusion was, therefore, inevitable - yet, if the trend of developments has not always been clearly evident, it has, at least, indicated the need for further study of the classification problem if adequate provision is to be made for performance differences between pupils in physical education.

CHAPTER II

THE GRID TECHNIQUE AND ITS APPLICATION IN THIS STUDY

CHAPTER II

THE GRID TECHNIQUE AND ITS APPLICATION TO THIS STUDY

Although the Grid Technique has been used in this study mainly for the purpose of classifying subjects according to body build and body size there are a number of reasons why its broader usefulness should be mentioned. In the first place, only one other performance study based on the Grid has been reported and, as pointed out in Chapter I, that study concentrated attention on body build to the exclusion of size. Secondly, certain aspects of the Grid Technique lend themselves to further studies bearing on the relation between maturity and performance. Lastly, an understanding of its basic principles is essential for a discussion of various classification plans. In order to briefly fulfill these purposes the Grid Technique will be considered for (1) its primary use in appraising child growth, and (2) size and shape classification in this study.

The Grid's Primary Use in Appraising Child Growth

Wetzel[1,2,3] has described the Grid as a "control chart on child growth." This use is clearly evident in

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[1]Norman C. Wetzel, "Physical Fitness in Terms of Physique, Development, and Basal Metabolism," Journal of the American Medical Association, 116 (Mar. 22, 1941) 1187-1195.

[2]Norman C. Wetzel, "Growth," Medical Physics, (Chicago: Yearbook Publishers, Inc., 1944). 513-569.

[3]Norman C. Wetzel, The Treatment of Growth Failure in Children, An Application of the Grid Technique, (Cleveland: N.E.A. Service, Inc., 1948), 11-21.

GRID for Evaluating PHYSICAL FITNESS
in Terms of PHYSIQUE (Body Build), DEVELOPMENTAL LEVEL and BASAL METABOLISM
— A Guide to Individual Progress from Infancy to Maturity —

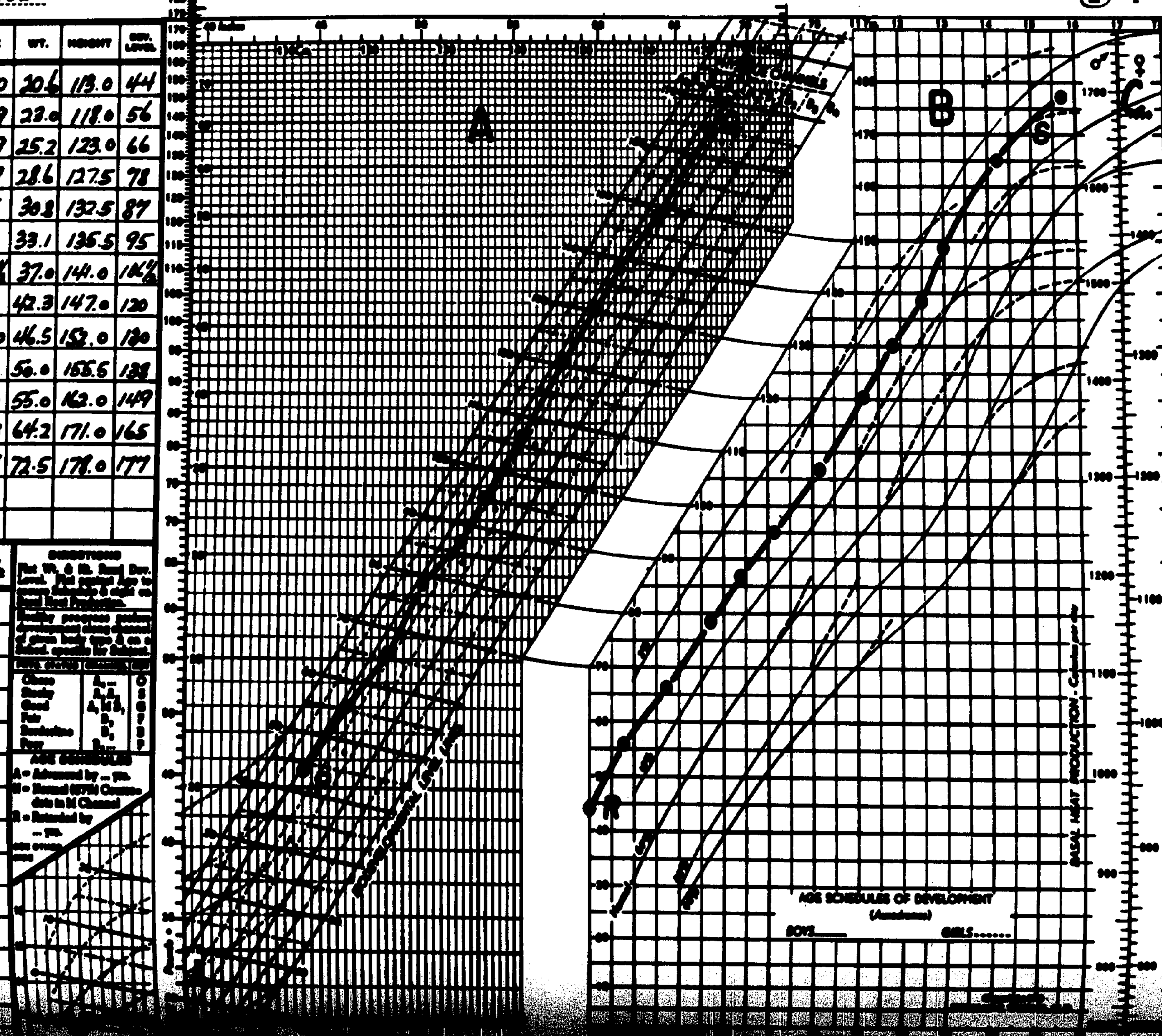
Name Willard B.

Date of Birth 8/15/32

No. B-396

(M) F

DATE	AGE	WT.	HEIGHT	DEV. LEVEL
3/37	5.0	20.6	113.0	44
12/37	5-9	22.0	118.0	56
12/38	6-9	25.2	123.0	66
11/39	7-8	28.6	127.5	78
8/40	8-5	30.8	132.5	87
4/41	9-1	33.1	135.5	95
4/42	10-1½	37.0	141.0	106½
4/43	11-1	42.3	147.0	120
1/44	11-10	46.5	152.0	130
9/44	12-6	50.0	155.5	138
3/45	13-0	55.0	162.0	149
6/46	14-3	64.2	171.0	165
10/47	15-7	72.5	178.0	177



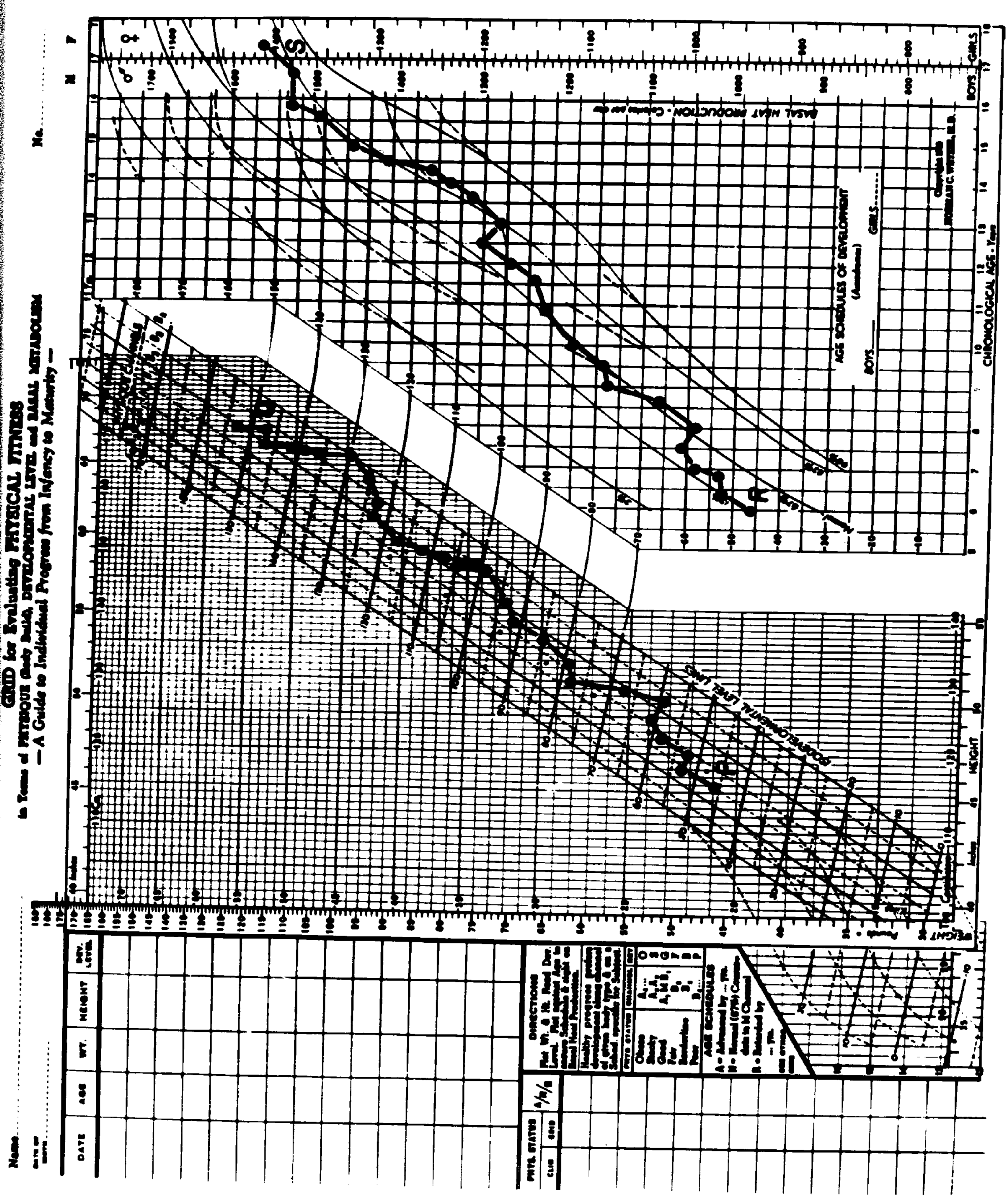


Fig. 2. Unsatisfactory Growth.

Figure 1* which shows satisfactory growth of the highest order, and by contrast in Figure 2 which shows unsatisfactory growth. These conclusions are almost self-evident without a detailed description of the Grid. An understanding of how the Grid actually conveys such information can be gained from a study of its structure.

Structure of the Grid

As indicated in Figure 1, the Grid is composed of three interconnected Panels A, B and C.

The Channel System (Panel A). - Along the borders (left, upper and lower) of this panel are weight and height scales in both metric and common units. When a person's weight is plotted against height in this field, the resulting point will fall within or close to the channel system, so long as body proportions are not extreme.

The channel system itself consists of seven separate channels symmetrically disposed about the central or M channel; those above are designated in order A_1, A_2, A_3 and represent increasing degrees of stockiness; Those below M are known as B_1, B_2, B_3 and represent increasing slenderness in body build. Extreme varieties of physique lie outside this system, viz. in A_4 and above for those in stout or obese groups, and in B_4 and below for those who are extremely thin.

Level Lines of Development. - A system of black level lines, graduated in tens according to the diagonal scale shown

*Supplied by author in personal communication.

above the upper border of A_4, crosses the channel system obliquely and extends through Panel B to align with the calories scale in Panel C. These levels are lines of constant body surface and, accordingly, are a measure of overall body size. Thus, regardless of whether subjects have the same or different body shapes, they have the same body surface - that is, they are of the same size, when their height-weight points lie on the same level line.

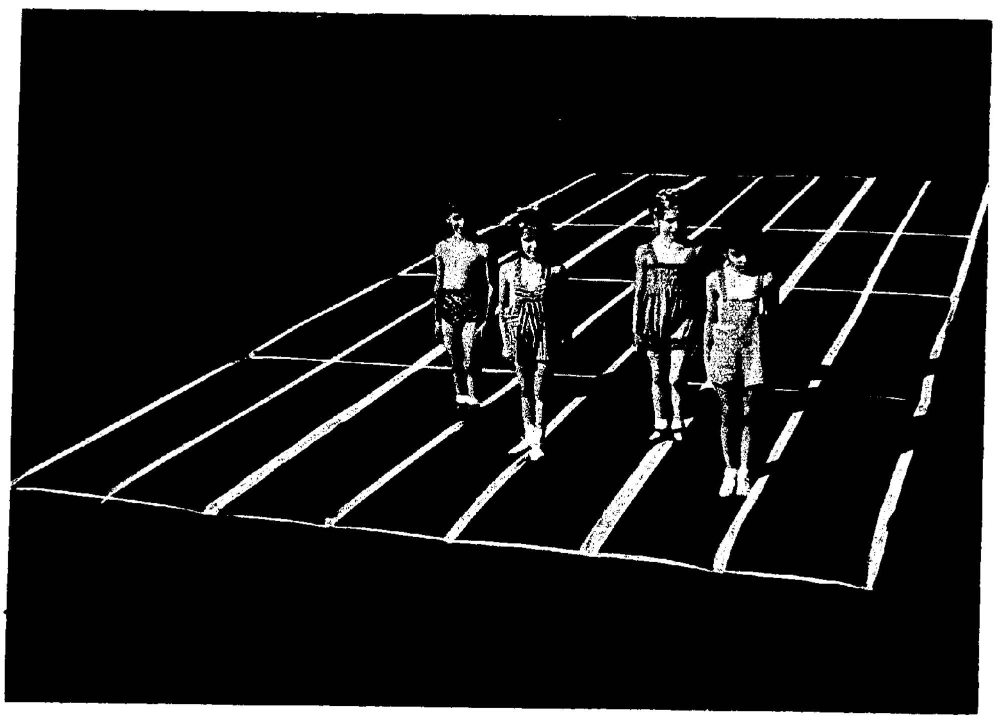


Fig. 3. Small children between levels 36 and 42.

<u>Size and Shape in terms of Channel and Level</u>. - Several illustrations of how body size and shape are separately

determined according to a subject's Grid position are given in Figs. 3,4,5 and 6.*

From Fig. 3, it is evident that the boy on the border of A_1 and M is stockier than the girls to his left, and that they increase in "linearity" in the same direction, even within such a narrow span as three channels.

Differences in size and shape are similarly indicated in Fig. 4, but these are somewhat more easily noted because of the wider channel span and the greater level (size) difference.

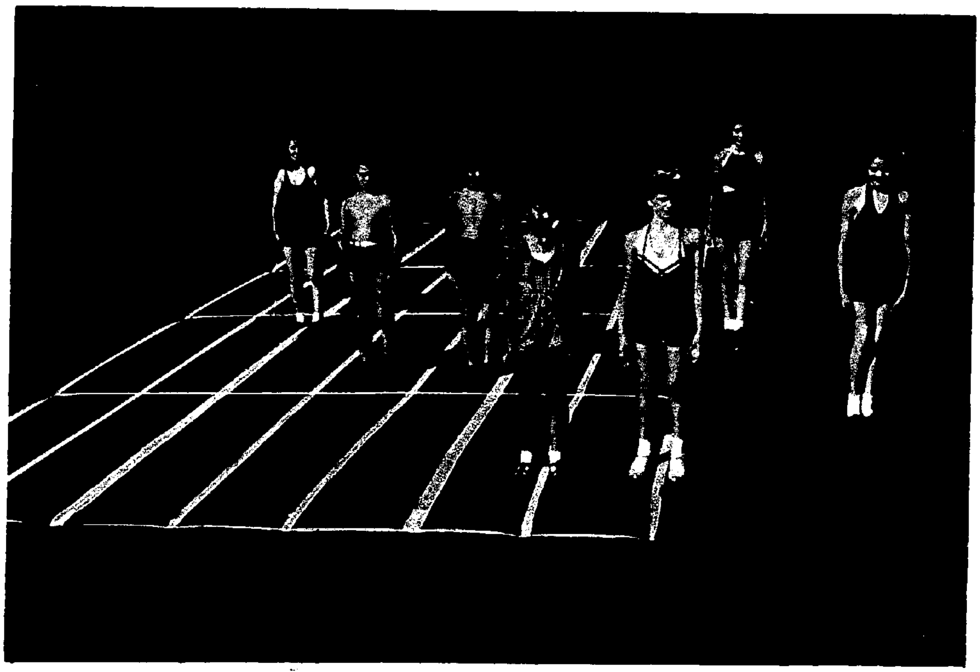


Fig. 4. Left to right, subjects in channels A_1, A_2, level 109; M - 106; B_1 - 104; B_2 B_3 - 98; B_2 - 109 (standing in B_4 to show): B_5 - 99.

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*Note: Illustrations in color, figures 3-8, inclusive, are from "Growth Measurement," A Useful Guide to Health and Disease in Childhood, A Synopsis of the Wetzel Grid Technique for Evaluating the Quality of Physical Growth and Development in Pre-School and School Children." Reprinted from What's New, (Chicago: Abbott Laboratories, November, 1946).

In Fig. 5, comparative size and shape differences are easily distinguished. The two girls in the foreground are of the same size because they are on the same level (108); but their physiques again show the characteristics

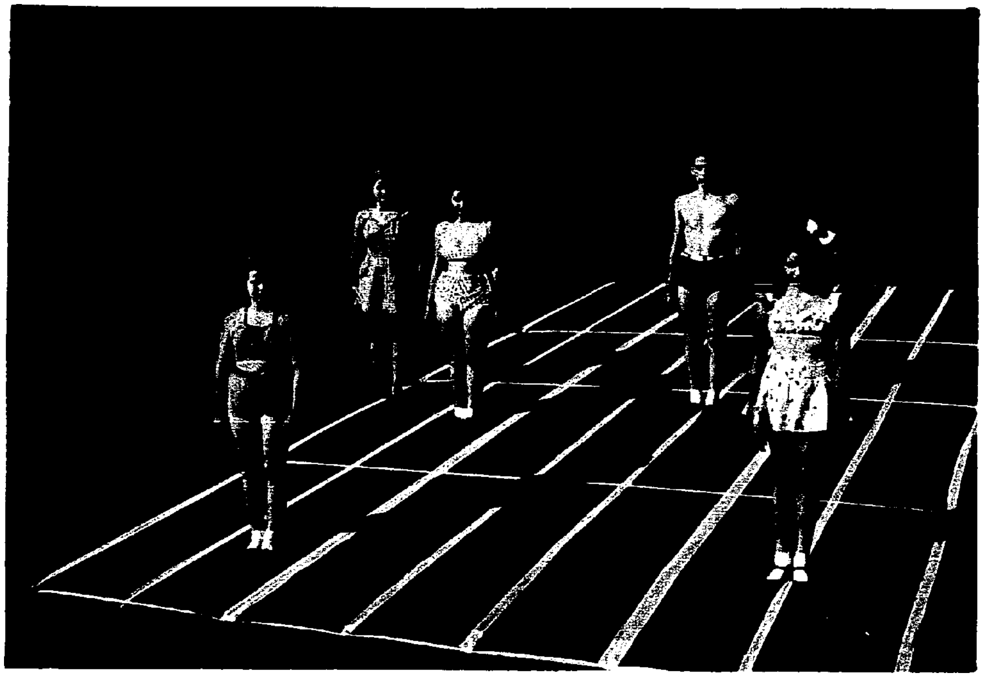

Fig. 5. Larger children between levels 108 and 157.

that distinguish A_2's (left) from B_2, B_3's (right). The strong massive features of subjects in A_3 or on the A_3A_4 border are well represented by the girl at the upper left. Easily distinguished, is the girl next to her in A_2 - at level 156 - a larger edition of the same body type shown in the A_2 foreground. The boy is a typical M-B_1 at level 157 and shows the body features characteristic of this "medial" group.

With the foregoing pictures in mind it is now not difficult to return to a consideration of Figs. 1 and 2 for the purpose of interpreting what happens during satisfactory or during certain phases of unsatisfactory growth.

A child, such as the boy whose record is in Figure 1, represents body build A_1. He has maintained that same build throughout his entire course of development up the channel system along the curve (P-Q). In health, children whose natural builds are A_3, A_2 or B_1 or even B_3 will do

Fig. 6. Children representative of channel B_2 with a level range from 36 to 109.

likewise, each increasing in size, without undergoing any significant change in body build. Pictorially, this can be illustrated, as has been done in Figure 6, by selecting children, all of whom are in some one channel, (e.g., B_2) and arranging them according to level. Uniformity of body shape is even more striking in this figure than it would have been if the first child had been serially portrayed at successive levels. From the evidence in Figures 3-6, there can be no reasonable doubt that channel classification does result in homogeneous <u>physique</u> groups - whereas level classification results in homogeneous <u>size</u> groups.

The change of channel in Figure 2, therefore, represents corresponding changes in physique as development took place, and hence growth failure, of which such physique changes are a main part. So far as growth quality is concerned, the matter of physique or change of physique is thus determined by noting the <u>direction</u> of development, which, as already mentioned, should follow that of the channel system, within the tolerable limits of variation defined by channel width.

Up channel progress during growth and development should also be maintained, during the ten to twelve year period of school life at a rate of approximately one level per month. Accordingly, speed is a second criterion of good or bad growth as the case may be, and it is determined with help of the child's own level-age curve, or auxodrome, that is plotted in Panel B, Figures 1 and 2.

Growth quality is thus appraised in the Grid Technique by periodic check on the <u>direction</u> and <u>speed</u> of physical development. These aspects of growth thus supersede the matters of size and shape in importance, although, as already explained, they are functions of them. The Grid's property of furnishing a control chart on growth is in reality an extension of its capacity to measure the physical size and body build of subjects at any observational height-weight point, regardless of age.

To summarize the use of the Grid as a device for evaluating child growth, the case record illustrated in Figs. 7 and 8 may be briefly described. The channel course 1-3 indicates how a diabetic boy changed physique from A_1 at level 35 to B_3 at 64, while the curve AC in the auxodrome panel shows the coincident "slowdown" in

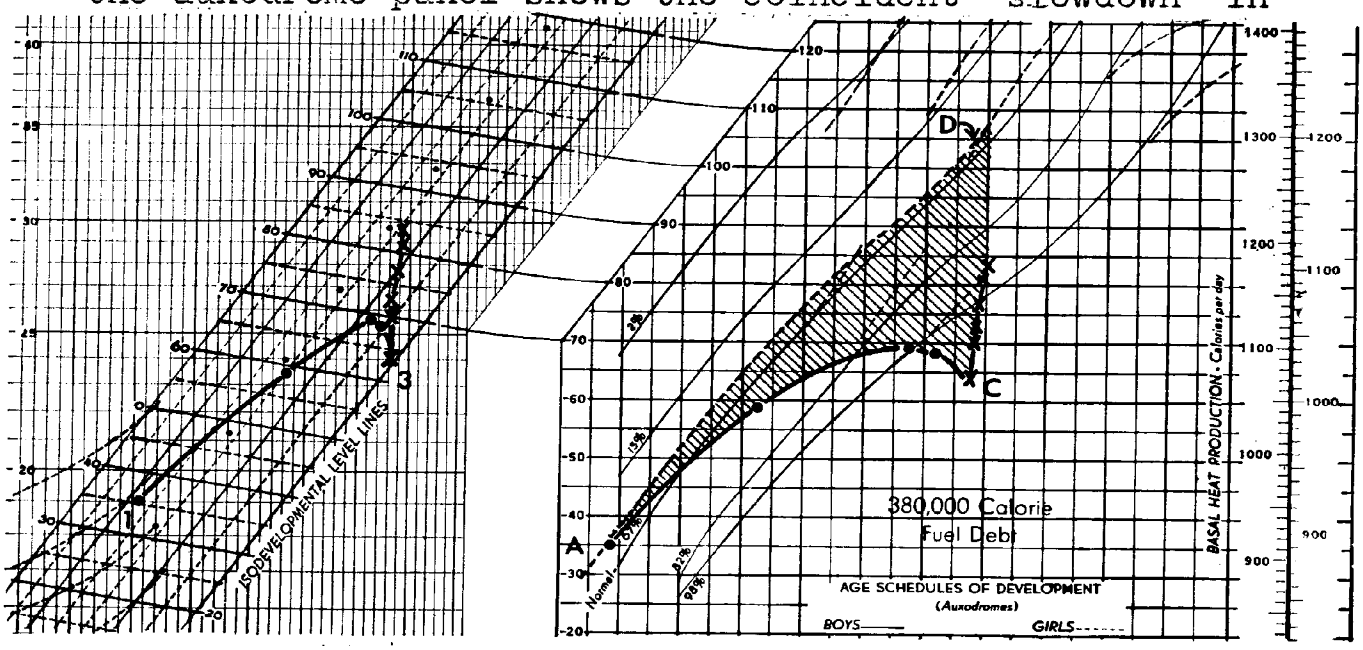

Fig. 7. Onset of growth failure with beginning recovery.

speed compared with that which should have been maintained along AD. The subsequent crosses (x) represent a "change of state" in which this boy, under treatment is regaining physique, having returned as far as B_1 in his advance to level 84 by the age of 12.

The boy's complete recovery, to channel A_1, and continued progress are shown in Fig. 8, along with the closure at E of the original lag-gap (D-C).

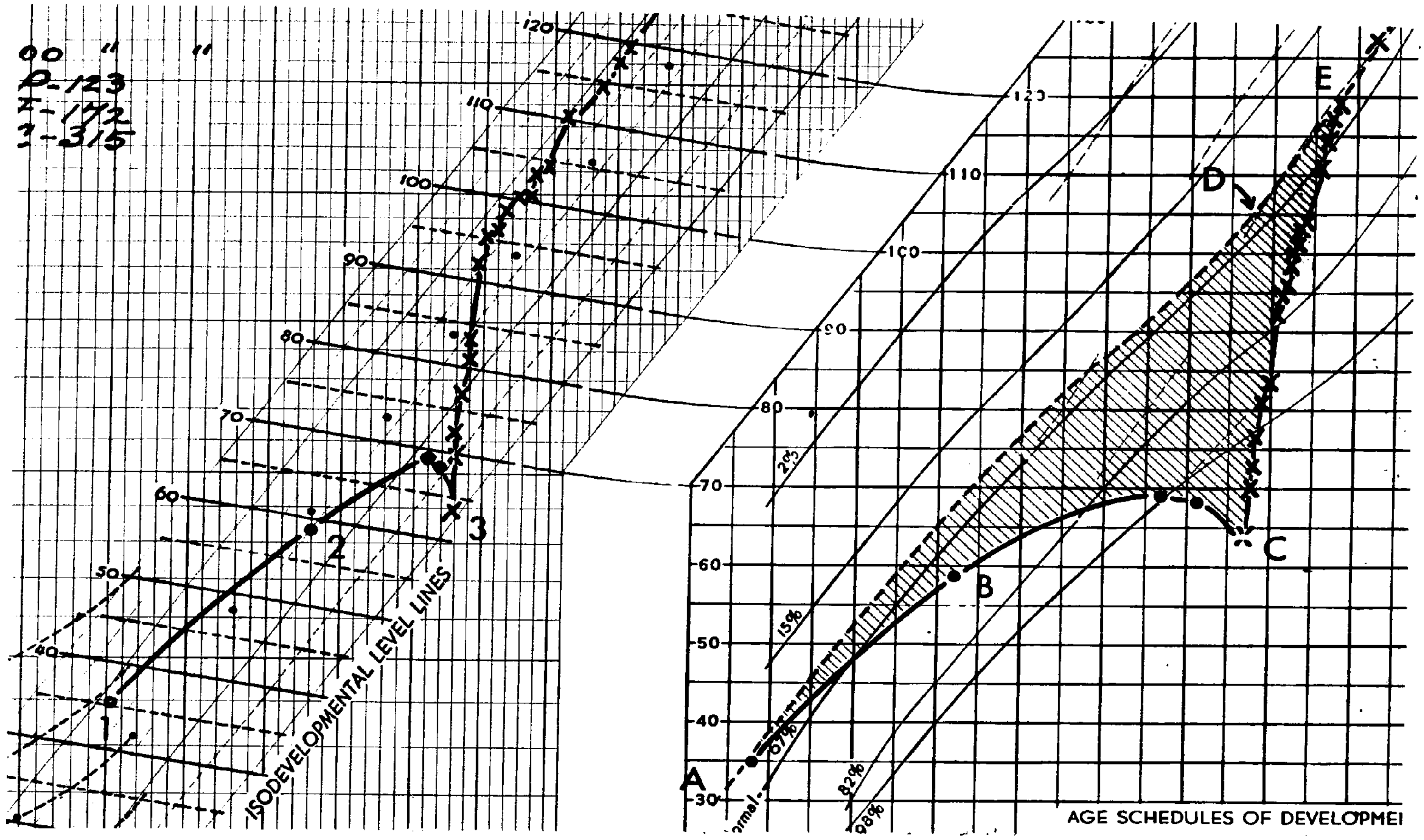

Fig. 8. Complete restoration to original physique (A_1) and schedule of development with closure of lag-gap C-D, at E.

The tendency of healthy children to travel "in their own channel" is clearly illustrated by the final course the boy pursued after making the right hand turn at level 92. Accordingly, from this point to level 132 he kept physique constant, remaining an A_1 throughout, though increasing in size from 92 to 132.

The records and examples in Figs. 3-8 thus illustrate, briefly, how the Grid employs size-shape classification at single or at successive points to appraise growth. Evidence of a similar kind was given in the form of standardized silhouettes in Wetzel's original paper,[1] and this has been supplemented with further validation, as regards growth, in a number of subsequent reports, from which these illustrations and case records have been cited. In terms of the Grid, stocky A_3's or A_2's are never found in the B_2 or B_3 channels, nor those of slender types in channels A_1 and above. Invariably, children at the same level of development differ in characteristic fashion, as regards body build, when one inspects subjects between A_4 and B_4, and it is also invariably remarkable to see how alike in shape children in the same channel are, even though they range in size from small pre-school youngsters to those in Senior High School.

USE OF THE GRID CLASSIFICATION IN THE PRESENT STUDY

The possibility of utilizing the Grid scheme of classification as a base for investigating motor and athletic performance was suggested by the earlier of the foregoing results. The application of this method especially to college men, had, of course, to be substantiated directly, even though Wetzel had already indicated its use in studying physique and size in human giants and in the extremely abnormal types of obesity to be seen in circuses.[2]

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[1]Wetzel, "Physical Fitness in Terms of Physique, Development and Basal Metabolism," op. cit., pp. 1187-1195.

[2]Wetzel, "The Treatment of Growth Failure in Children," op. cit., p. 89.

Fig. 9. Air Corps Students in Formation .

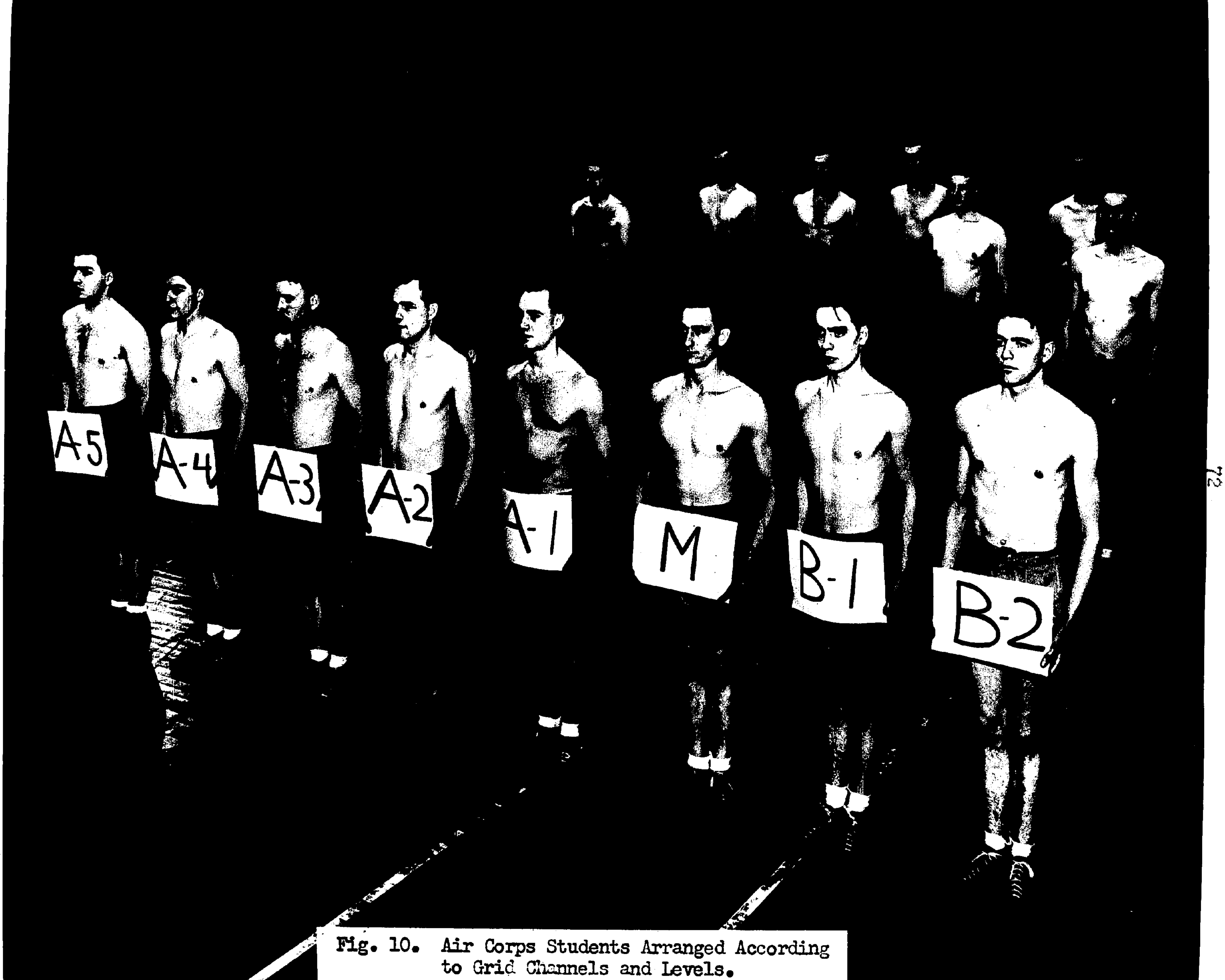

Fig. 10. Air Corps Students Arranged According to Grid Channels and Levels.

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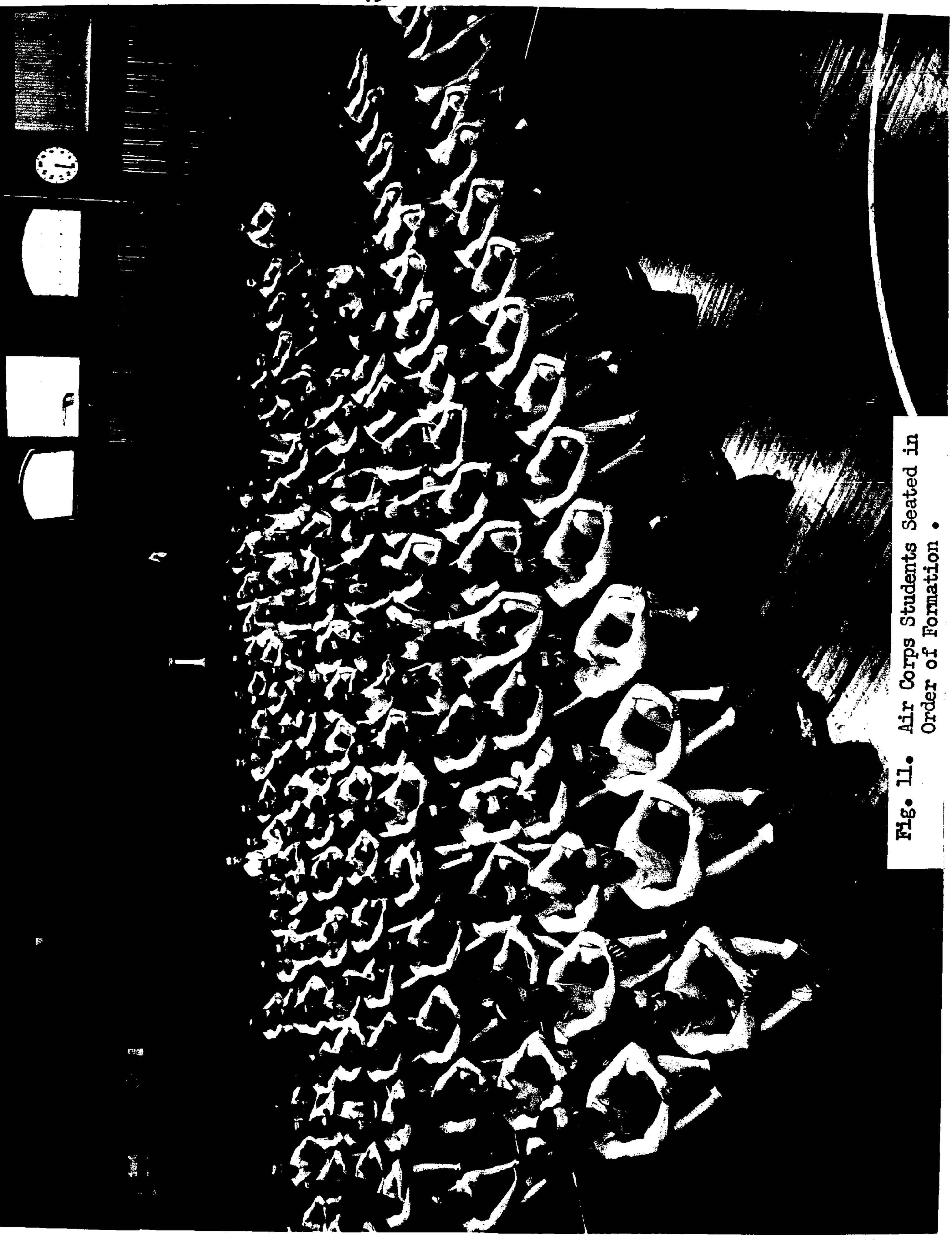

Fig. 11. Air Corps Students Seated in Order of Formation .

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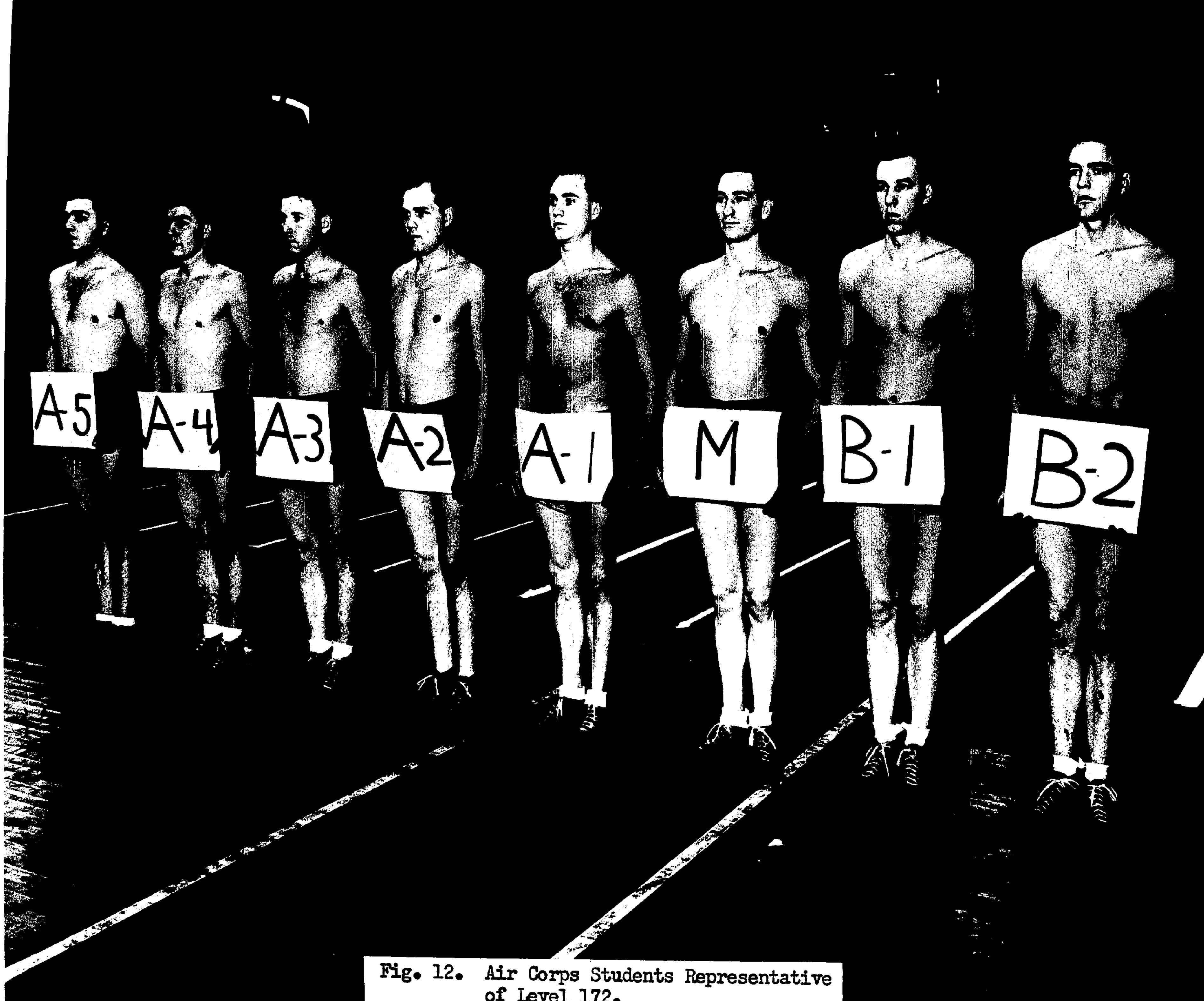

Fig. 12. Air Corps Students Representative of Level 172.

A company of "Air Cadets" numbering more than one hundred men, then in training, was chosen for this part of the study. Heights and weights in gym clothes were taken as usual; the corresponding Grid ratings by channel and level were ascertained by plotting those values on a Grid, and by simple extrapolation when necessary. The company was then photographed in (3) positions: (a) usual order, (b) space oriented according to channel and level, and (c) in sitting position, as shown in Figures 9-11. Close-up views of eight men along level 172 are shown in Figure 12. In these figures, the entirely random mixture of sizes and shapes in the usual company order of Figure 9 is seen to have resolved into the characteristic distributions previously shown in the children's pictures. Figure 10 illustrates how clearly channel designates physique among these men, and how different channels represent important differences in body build. These studies obviously confirm Wetzel's original findings that classification by channel does correspond to recognizably different physique types, whereas level values represent body size independently of physique. Of special significance is the demonstration in Figure 11 that shows how sitting heights upon which so much emphasis has been placed in medical writings, actually destroys all practical possibility of distinguishing existing differences in physiques or in size that can be so readily recognized when the subjects are space-oriented in accordance with their Grid positions of level and channel.

Thus, by direct application to men under study, the Grid also turned out to be a simple means of denoting body size and shape, and for distinguishing between these two properties of human structure.

Classification Ratings. - In the case of children, the Grid provides a 3 item rating for any given observation, such as: A_1 - 60 - 7.8/6.8; B_2 - 143 - 16.0/14.5; etc. that consists of:

(a) A channel (letter) designation which indicates and represents the subject's physique or body build;

(b) A level designation which indicates and represents the subject's body size, and,

(c) A level-age factor, expressed, for example, on a developmental ratio, which, of course, has no application after development has been completed.

Since the majority of subjects in this study were 17 years old or older, item C was unnecessary. Consequently, physique and size only were included in the ratings, e.g., B_1 - 149; A_2 - 173; etc.

Level and Channel Groupings. - While the Grid provides single integer differences in level, class-intervals of 5-10, 20 or more levels were set up for various purposes or comparisons. Men who differ by 5 levels are easily recognized on close inspection to be either comparatively smaller or larger. Unless some other purposes conflicted, the 10 level class-interval was employed.

As regards physique, no distinction was made, for example, between a "high" and "low" B. Men whose plotted height-weight points fell on a channel border, though originally rated, for example, as MB_1 - 151, were always classified with the lower of two adjacent channel groups. Owing to the comparatively smaller representation among the extreme physique groups, men in A_5 and above were classified as "A_5 and above." For the most part, the channel ratings themselves formed the class-interval of physique, though, for certain restricted comparisons, two or more channels were combined into a single class.

CHAPTER III

COMPARISON OF GRID RATINGS WITH RESULTS BY PREVIOUS CLASSIFICATION METHODS

CHAPTER III

COMPARISON OF GRID RATINGS WITH RESULTS BY PREVIOUS CLASSIFICATION METHODS

In view of the widespread familiarity of physical educators with the classification methods of McCloy and of Neilson and Cozens, a comparison between the results they furnished and the Grid ratings for a group of students was undertaken as a preliminary step toward classifying all subjects in the present study.

The "Exponent" and "Index" Methods of Classification

Both of these methods have had an intertwining history and the exact details are none too easily to be traced from published writings. Both emerged from attempts to relate performance scores with age, height and weight, and both have been modified from time to time. Each method has apparently influenced the development of the other, and while considerable pains have been taken to show individual advantages, efforts have also been made to describe the correspondence between them.

It will be recalled that the "exponent" plan of

Neilson, Cozens and their co-workers[1] was originally an outcome of Reilley's 4-point classification method (School grade, age, height, weight), in which the item of school grade was omitted. A similar method, sometimes referred to as the California Plan,[2] was extensively employed in that state from about 1922 onwards. Neilson and Cozens' method was based on a system of 8 letter groups A-H, defined by the sums of "coordinating numbers or exponents"[3] assigned to age, height and weight, the general pattern of which was:

Sum of Exponents	Class	
9 and below	A	
10 - 14	B	
15 - 19	C	
-------	---	(1)
-------	---	
35 - 38	G	
39 and above	H	

In 1934, Neilson and Cozens[4] reported a comparison of classification by (1) and that obtained from the expression:

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[1]N.P. Neilson and Frederick W. Cozens, Achievement Scales in Physical Education Activities for Boys and Girls in Elementary and Junior High Schools, (New York: A.S. Barnes and Company, 1939), 5.

[2]John F. Bovard and Frederick W. Cozens, Tests and Measurements in Physical Education, (2nd. ed.; Philadelphia: W.B. Saunders and Company, 1941), 201.

[3]Ibid., pp. 122-123.

[4]N.P. Neilson and Frederick W. Cozens, Achievement Scales in Physical Education Activities for Boys and Girls in Elementary and Junior High Schools, (New York: A.S. Barnes and Company, 1934), 162.

$$A + 3.3H + .66W \qquad (2)$$

wherein, A is in months, H in inches, and W in pounds. Since the correlation between (1) and (2) was 0.983 Neilson and Cozens concluded that the exponent plan (1) "may be used with the utmost confidence when classifying elementary and junior high school boys and girls for purposes of competition in physical education activities."[1]

Two years later, these same authors, along with Trieb, reported further studies on secondary school boys, and proposed a "best-fit index"[2] (with age in years):

$$2A + .475H + .16W \qquad (3)$$

the "exponent" values for which, instead of being assigned coordinating numbers, now consisted of the separate products, 2A, .475H, and .16W, - the sums being again classified into letter groups, with classes G and H of (1) being dropped:

Class	Exponent Value (Sum of Exponents)	
F	69 and below	
E	70 - 74	
D	75 - 78	
C	79 - 82	(4)
B	83 - 87	
A	88 and over	

[1] Loc. Cit.

[2] Frederick W. Cozens, Martin H. Trieb, and N.P. Neilson, Physical Education Achievement Scales for Boys in Secondary Schools, (New York: A.S. Barnes and Company, 1936), 12.

The various classes A-H in (1) and A-F in (4) were considered to represent "homogeneous groups" and even-step interval plans of scoring were adopted on that assumption.[1]

Meanwhile, McCloy, who had also been engaged on the problem of classification since 1922, summarized his results in 1932.[2] McCloy had employed multiple regression equations in relating performance scores with age, height and weight, in some combination. As a classifying device, he arrived at the expression,[3,4]

$$20A + 5.5H + .55W \qquad (5)$$

which, as he himself explained in 1939, "was arbitrarily changed to,

$$\text{Classification Index } I = 20A + 6H + W.\text{"} \qquad (6)$$

Values computed from (6), however, were then to be compared with one of several classification tables, depending on whether elementary, junior or senior high school, or college pupils were involved. In the case of junior high

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[1]Bovard and Cozens, *op. cit.*, p. 169.

[2]Charles Harold McCloy, *The Measurement of Athletic Power*, (New York: A.S. Barnes and Company, 1932), 63-95.

[3]*Ibid.*, p. 89.

[4]Charles Harold McCloy, *Tests and Measurements in Health and Physical Education*, (New York: F.S. Crofts and Company, 1939), 46.

school students, for example, the division proposed was (the missing F class being shown in the revised table of 1939 with a value 725-754):[1]

Classification Index I - Junior High School (1932)

Range 540-900

Class	Index Value
A	875 and over
B	845
C	815
D	785
E	755

G	695
H	665
I	664 and under,

(7)

McCloy stated that (6) as applied in (7) "is suggested for use as an aid to sectioning pupils into physically homogeneous groups for purposes of track and field athletic competition, or in other sports, and for general physical education activities."[2] This index, (6) was a device "to equalize, so far as possible, the physical differences between individuals of unlike maturity and size...."[3] Moreover, when age, height, and weight are

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[1] Ibid., p. 47.

[2] McCloy, "The Measurement of Athletic Power," op. cit., p. 101.

[3] Ibid., p. 96.

utilized, as in (6), "according to their 'best' weightings," body build appeared to McCloy to be of "no significance,"[1]

Comparison between the exponent and index methods has generally been made by applying some procedure to (2) which resulted in 20 as the coefficient of age. Accordingly, Neilson and Cozens found that (2) became

$$20A + 5.5H + 1.10W \qquad (8)$$

"when transposed in McCloy's terms"[2] age now being taken in years, and the resulting shift in index value as between (2) and (8) being left without further explanation. An earlier study by Cozens himself had resulted in a similar expression:[3]

$$20A + 4.33H + W \qquad (9)$$

so that (5), (6), (8) and (9) are quite similar, and differ chiefly in the coefficient for weight. McCloy reported that correlations, as might be expected, between his own Index I (6) and the exponent formulae (8) and (9) was 0.98,[4] and Bookwalter drew up a table showing 84.1 per cent agreement between the two systems of classification.[5] For these reasons the exponent and index methods may be

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[1]*Ibid.*, p. 95.

[2]Neilson and Cozens, "Achievement Scales," *op. cit.*, p. 162.

[3]*Ibid.*, p. 161.

[4]McCloy, "Tests and Measurements," *op. cit.*, p. 50.

[5]Karl W. Bookwalter, "The Utilization of McCloy's Athletic Index with California Achievement Scales," *Research Quarterly*, VI (Mar., 1935), 61.

treated together in the comparisons that follow.

Direct Comparisons Between Grid Ratings, Exponent and Index Values

At the very outset of this study trial classifications were made with junior and senior high school boys to determine how the exponent and index values just explained would compare with corresponding Grid ratings. Even among the first of these observations, certain startling differences began to appear, as represented, for instance in the case of the two following boys:

				McCloy - I		Neilson & Cozens		
Subjects	Age Yrs. Mo.	Ht.	Wt.	Index	Class	Exponent	Class	Grid Rating
J	13 - 3	69	138	812	D	82	C	MB_1-164
M	17 - 6	58	104	802	D	80	C	A_3-131

both of whom thus had identical index and exponent class values, although they were much too widely separated by their Grid ratings to be considered physically "homogeneous." This is clear from Figure 13 if the size-shape differences suggested in Figs. 3 to 12 are borne in mind.

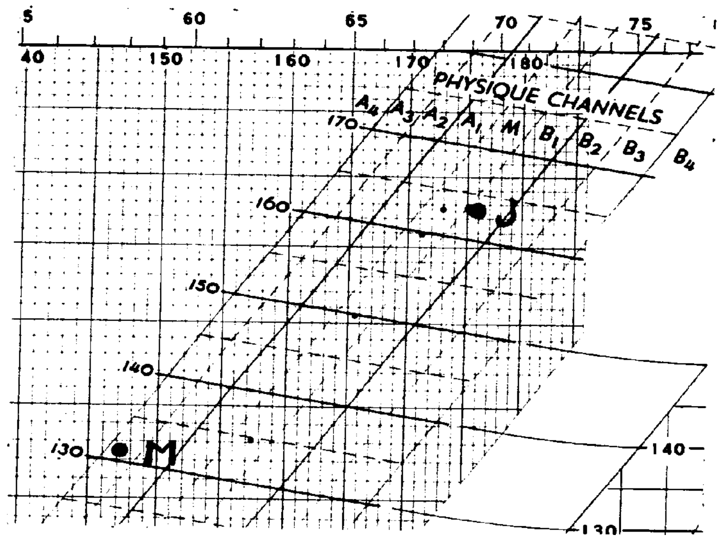

Fig. 13. Grid positions of two boys both of whom were in Exponent Class C, and an Index Class D.

A number of such experiences then led to a more systematic study of the relations between exponent and index classification on the one hand and Grid Ratings on the other.

A first step in this direction was undertaken by plotting the Grid positions of 253 boys in a junior high school, many of whom were actually attending the same gymnasium sessions. The results are shown in Fig. 14 for the separate A to F exponent classes.

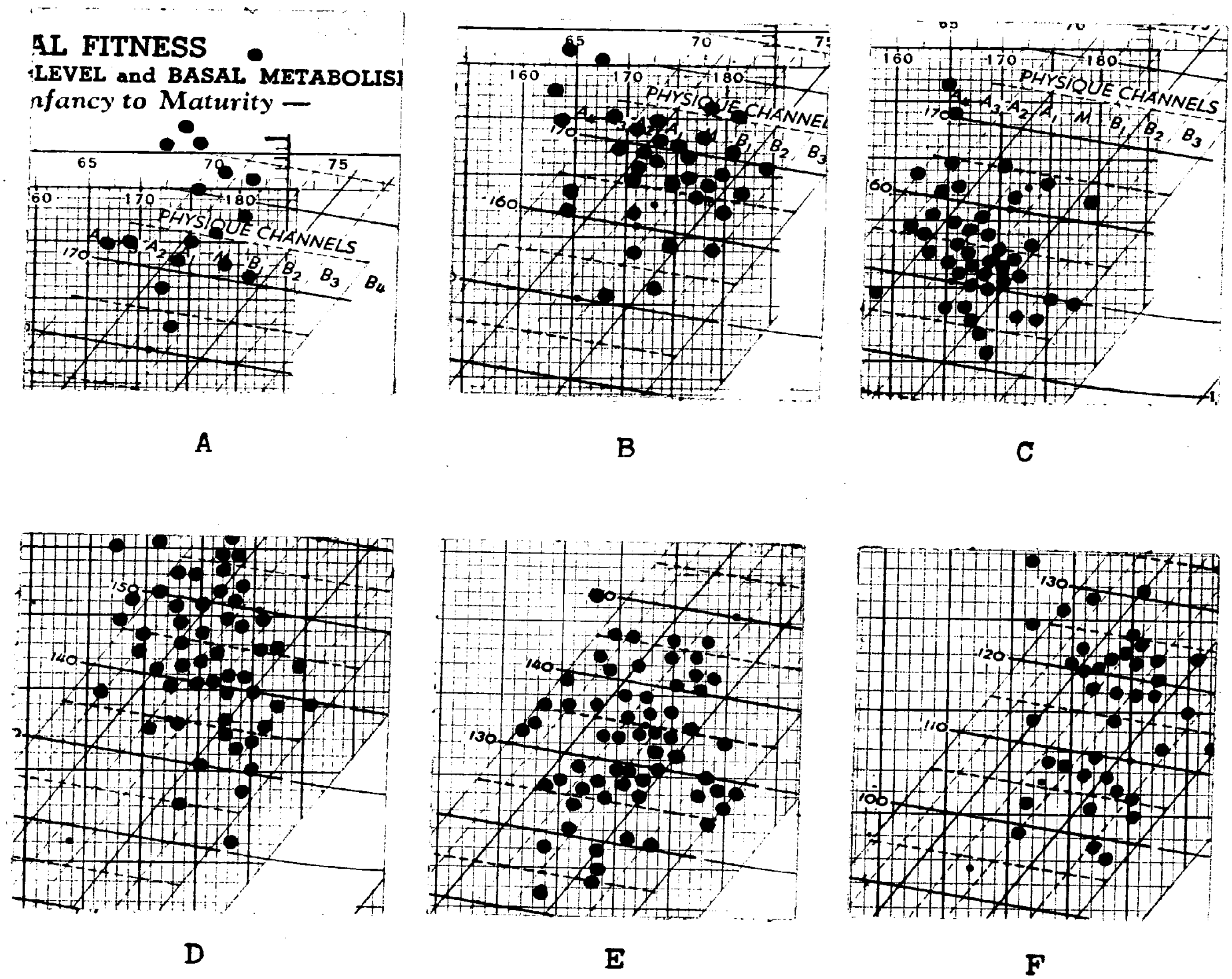

Fig. 14. Grid positions of 253 junior high school boys, showing channel and level spread in the separate A-F exponent classes.

From these it is again evident that a very considerable range of physique and level is actually implied in any given exponent class. This amounts altogether to about thirty levels or more as regards size, that is, to about $2\frac{1}{2}$ to 3 years of normal physical development, and to differences in body build corresponding to the span of the entire channel system, or even somewhat more than that. Besides, as the composite plot in Fig. 15 shows, there is considerable overlap between exponent

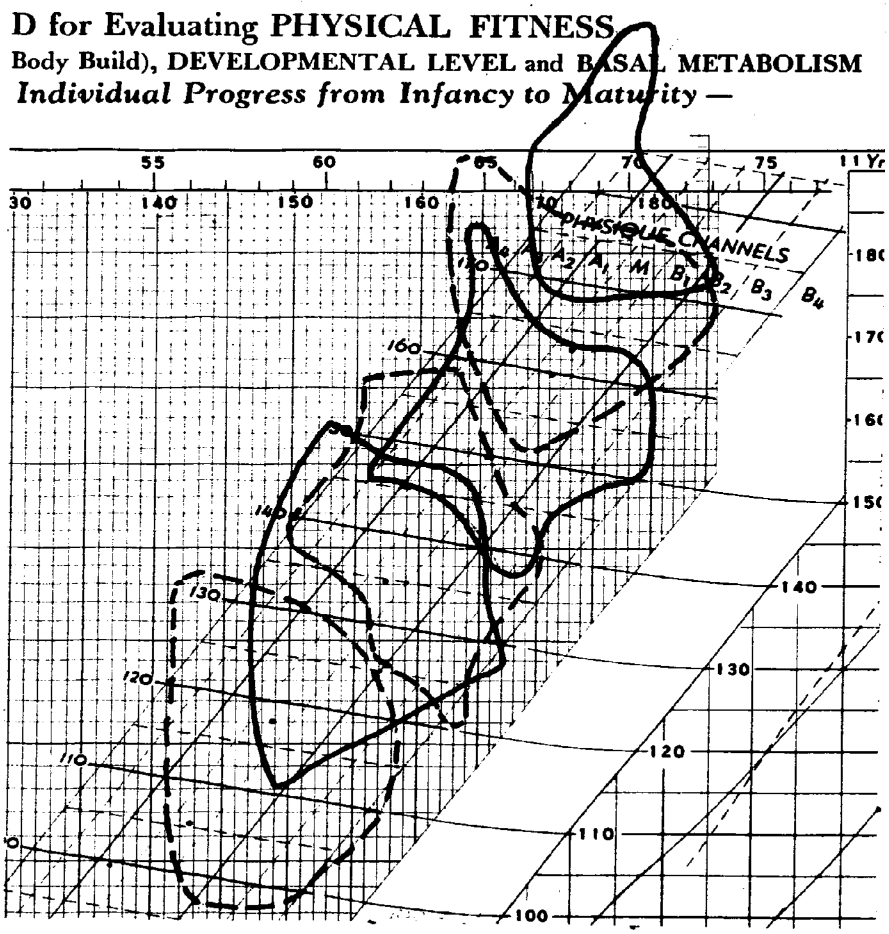

Fig. 15. Showing overlap of Exponent Classes A-F.

classes, even in the group selected at random for this study.

These results naturally led to a search for examples that would represent even more extreme differences,

TABLE 2

COMPARATIVE INDEX - EXPONENT AND GRID RATINGS OF 15 BOYS IN THE SAME GYMNASIUM CLASS

Sub-ject	Age Yrs.Mo.	Ht.	Wt.	McCloy - I Index	McCloy - I Class	Neilson, Trieb & Cozens' Exponent Sum	Neilson, Trieb & Cozens' Exponent Class	Grid Rating
1	12 - 9	65	158	808	D	82	C	A_5-174
2	13 - 2	65 1/2	153	803	D	81	C	A_4-171
3	13 - 2	65	141	791	D	80	C	A_3-164
4	13 - 11	64 1/2	132	796	D	79	C	A_2-157
5	13 - 5	65	131	791	D	80	C	A_1-157
6	14 - 11	65 1/4	118	808	D	80	C	MB_1-147
7	13 - 3	69	138	812	D	82	C	MB_1-164
8	13 - 11	63 1/2	111	769	E	76	D	MB_1-141
9	12 - 10	61 1/2	125	750	G	75	D	A_3A_4-151
10	12 - 11	63 3/4	129	773	E	75	D	A_2-155
11	13 - 9	62 1/2	113	765	E	76	D	A_1-141
12	13 - 5	65 1/2	117	777	E	77	D	B_1-146
13	13 - 11	65	103	773	E	75	D	B_2B_3-134
14	14 - 3	65	100	770	E	76	D	B_3-131
15	14 - 11	64 1/2	91	765	E	76	D	B_4-122

TABLE 3

INDEX CLASSIFICATION AND GRID RATINGS ON 15 BOYS IN EXPONENT CLASSES A AND C

Subject	Age	Ht.	Wt.	McCloy - I Index	McCloy - I Class	Cozens - Neilson Exponent	Cozens - Neilson Class	Grid Rating
16	13 - 5	58	158	776	E	80	C	A_{12}-171
17	15 - 2	58	138	781	D	80	C	A_8-158
18	18 - 0	55	111	801	D	80	C	A_7-136
19	13 - 0	63	150	788	D	80	C	A_6-168
20	11 - 6	70	147	791	D	80	C	M -170
21	17 - 3	60	97	802	D	80	C	M -126
22	14 - 5	65	122	802	D	80	C	M -150
23	16 - 6	65	100	820	C	80	C	B_3-131
24	13 - 0	72	125	817	C	80	C	B_3B_4-156
25	18 - 9	67	110	887	A	88	A	B_3-141
26	14 - 8	75	144	894	A	88	A	B_3-169
27	16 - 7	70	143	893	A	89	A	B_1-167
28	12 - 8	73	173	871	B	88	A	A_1-186
29	17 - 5	65	145	885	A	89	A	A_3-166
30	18 - 9	62	129	876	A	88	A	A_3A_4-154

such as those listed among the thirty subjects whose index, exponent and Grid Ratings are given in Tables 2 and 3.

The fifteen boys whose data are given in Table 2 were, again, all in the same gymnasium group. The first seven are in index class D and in exponent class C, although they actually range between A_5 - 174 and MB_1 - 147. Subjects 8-15 are all in exponent class D, and all but one (#9) are grouped by McCloy's index as E, whereas the Grid range extends from A_3A_4 - 151 to B_4 - 122.

Subjects listed in Table 3 were found in different gymnasium groups, #16-24 are again in exponent class C, like #1-7 of Table 2 but they represent even greater size-shape difference, e.g., A_{12} - 171 to B_4 - 156.

The actually enormous range of subjects in exponent class C, listed in Tables 2 and 3 is easily visualized from their corresponding Grid positions in Fig. 16, but that same result is not readily comprehended from inspection of the tables alone. As Fig. 16 shows, subjects whose exponent class is C, and for the most part D, according to McCloy's Index, may actually differ by as much as 40 levels as regards body size, and by as much as 16-17 channels of physique.

For further comparison, the Grid positions of six boys whose exponent value placed them in Cozens', Neilson and Trieb's Class A (Table 3) are also plotted in Fig. 16_X

the lowest at B_2B_3 - 141 and the highest of this class group at A_2 - 186. Finally three of the boys in Class F (Fig. 14), along with a fourth from another group are

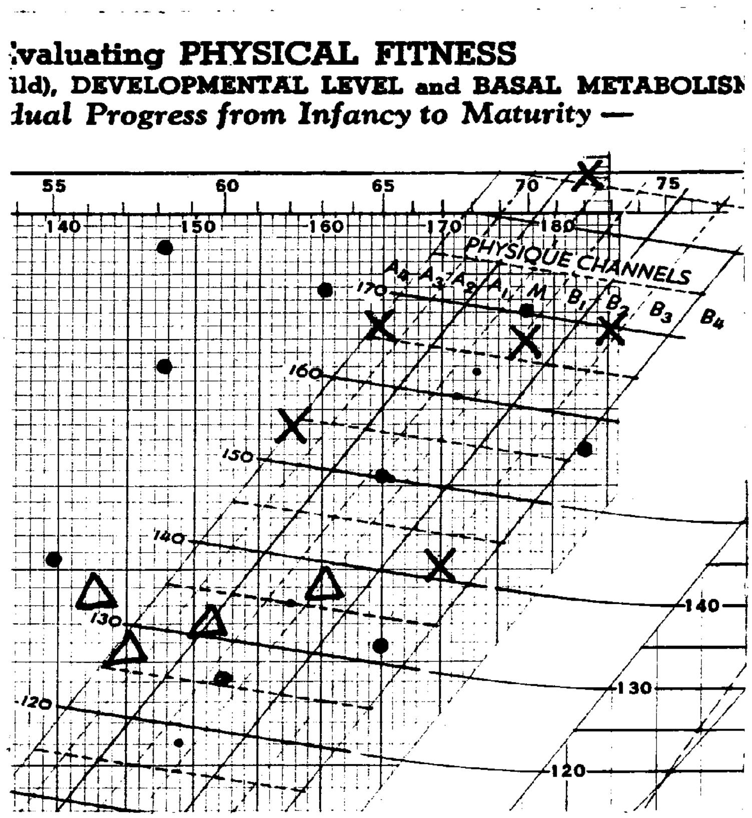

Fig. 16. Showing Grid positions for subjects of Neilson and Cozen's Exponent Classes C & F, McCloy's Index Class D, and Cozens', Neilson and Trieb's Exponent Class A.

represented by the open triangles.

The results in Fig. 16 thus bear out the suggestion in Figs. 13 to 15 that a single index or exponent class is very widely distributed over many levels and channels of the Grid. From Fig. 16 it may be seen in particular that the range of exponent class C, and the corresponding index class D is sufficiently great to overlap each of the other five classes in the A-F scale. Actually, therefore, at a given Grid point one may encounter boys who are classified by more than one of the five different exponent groups set up by Cozens, Neilson and Trieb for secondary schools, and in anyone of six index classes in McCloy's Junior High Division. Again, at widely separated points on the Grid one must also expect to find subjects who are, nevertheless, in identical exponent or index classes.

Cozens' Nine Classes for College Men*

At the outset of the present study, three good reasons existed for considering Cozens' 9-class plan for grouping college men: (1) a large number of the observations on motor performance were to be made on college students; (2) since Cozens' publication in 1936, a number of reports had already appeared, in which this method had been used; and (3) Cozens had also reported achievement scores for each of these nine classes, and for events, that were included in the present program. The latter circumstance, in particular, served to offer the most favorable opportunity for direct comparisons of performance based on the Grid and on another method of classifying the subjects under test.

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*See Chapter I

Cozens was led to his nine class scheme as a result of studies undertaken to determine the correlation between performance and the usual factors of age, height and weight. Among college men, the influence of age was negligible. Furthermore, since the influence of weight and height on performance was not sufficient to establish equations for predicting performance, Cozens adopted an arbitrary classification in

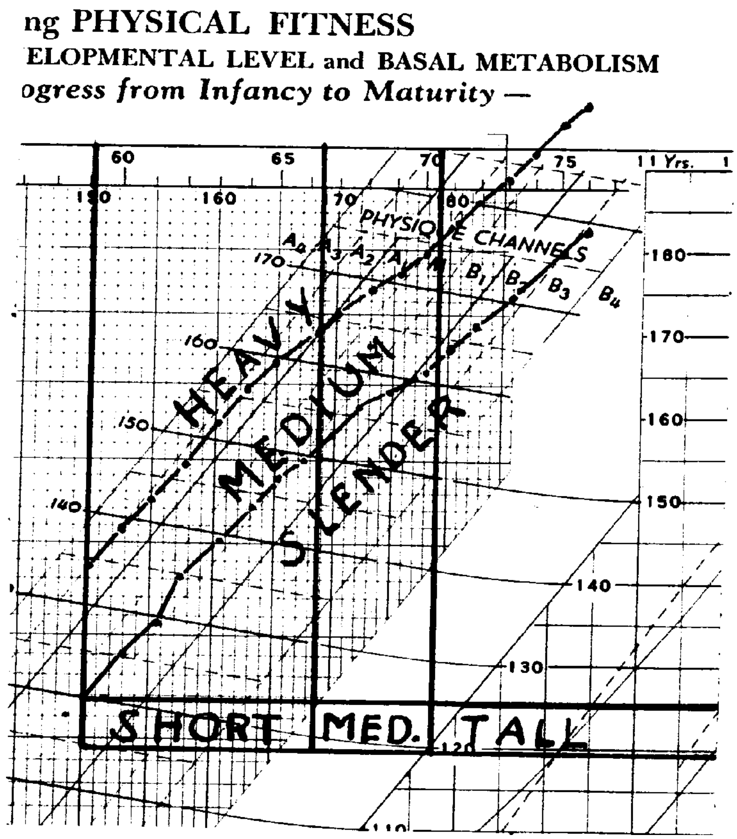

Fig. 17. Cozens' 9-classes plotted from the limiting values for height and weight he reported.

which the upper 25 per cent of 7389 students was assigned the designation "tall," the lower 25 per cent that of short, the middle 50 per cent being called medium (height). Three weight groups (heavy, medium and slender) were then combined with each of the three height classes, so that nine separate classes were formed:

Tall Slender	Medium Slender	Short Slender
Tall Medium	Medium Medium	Short Medium
Tall Heavy	Medium Heavy	Short Heavy,

Cozens added a table showing these class divisions by height and weight. When the limiting values are plotted on a Grid, as in Fig. 17, it is more immediately evident what the terms "tall-slender", "tall-heavy," etc., actually represent.

As Fig. 17 shows, Cozens' 9-class method forms an interesting Grid pattern especially because the medium weight classes tend, on the whole, to follow the central channels of the Grid. The "medium-medium" group shows the greatest "size-shape homogeneity" but even in this class, one must necessarily expect to encounter differences as great as three channels of physique and twenty-five levels of size. Still greater differences appear in the other eight classes and amount, as a rule, to about 30-45 levels and from three to five channels or more.

For the purpose of comparing performance of individuals, Cozens' scheme again fails to distinguish important differences in size and build among men of the same class group. Moreover, even though this plan distinguishes men of different classes, it does so only roughly, and in general on a basis that does not "equate" likenesses. Take, for instance, men who are "medium" in height, that is the three vertical groups from above downwards: in Fig. 17, heavy-medium, medium-medium and slender-medium. The fact that men in all of these groups carry the common designation "medium" certainly means that they are nearly alike in respect to height, but it is also apt to convey the impression that they are alike in something more than height.

Yet, as regards the decisive features of structure, which are size and build rather than the elementary items height and weight, men in the heavy-medium group have nothing in common with men in the slender-medium class because the levels and channels of the one group are quite different from those of the other. Such distinctions are more clearly conveyed by the corresponding Grid ratings: e.g., $(A_5 - A_1)$ - (165-185) as compared with $(B_2 - B_4)$ - (135-160) . These do not carry any suggestion of likeness as regards physical structure; whereas the designations, medium-heavy, medium-slender unavoidably do so. The source of difficulty lies in the fact that structural size and shape cannot be adequately differentiated by such height-weight groupings. As already shown in the case of the exponent and index methods, the ultimate effect of any rectangular height-weight classification is a "scrambling" of physique and body size. Whereas this effect is less pronounced in Cozens' 9-class method than in the index or exponent plans, a group spread of twenty to forty levels is considerably more than ought to be allowed if "homogeneous classification" is actually sought.

Concluding Remarks

In view of the general acceptance of the exponent and index plans for classifying elementary, junior, and senior high school boys, it was somewhat startling to learn that weight and height, employed as they are in those methods, do not denote size and build with the discrimination that would be expected of them. A given exponent or index class has been shown to range over as many as forty levels of development and over more than the seven regular channels of physique.

In spite of sub-division by school grade, it is not unusual to find three or four exponent or index classes among pupils of the same gymnasium section to overlap a twenty level region of the Grid. Therefore, from the standpoint of the ultimate use which is made of classification, nothing but defeat of its own purpose can be found in any method that permits stocky, powerful A_3's to be grouped with slender B_3's, especially under the implication that a common class value, however determined, signifies physical homogeneity. If individuals are to be commonly grouped by these methods, it is certainly on some basis that is quite independent of considerations of body make-up.

The Grid Technique, on the other hand, has the advantage of precise distinctions of size and shape, and the ratings it furnishes have comparable significance over the entire range of body sizes and types. The possibility of utilizing the Grid scheme of classification as a uniform reference base for investigating physical performance accordingly goes even beyond the population limits which have been chosen for this study.

CHAPTER IV

TEST SELECTION, SOURCES OF DATA AND PROCEDURES

CHAPTER IV

TEST SELECTION, SOURCES OF DATA AND PROCEDURES

Test Selection

The following twelve tests were selected for investigation:

1. The Burpee Test in 10 Seconds
2. The Burpee Test in 60 Seconds
3. Dodging Run
4. 440 Yard Dash
5. Hand Grip
6. Parallel Bar Dips
7. Pull-ups
8. Push-ups
9. Sargent Jump
10. Sit-ups
11. Squat Jumps
12. Standing Broad Jump

Conditions Governing Test Selection. - With the general purpose in mind of studying the effect of body build and body size in physical performance, it was felt, in the first place, that test choice should not be limited to events of a single performance type, that is, for example, to tests which involve strength primarily, or again, agility. On the contrary, it seemed important to include in the battery not only enough but also a sufficient variety of tests that are accepted as involving, besides strength and agility, the elements of power, endurance and speed. It was reasonable to suppose that body build and size would hardly be found to affect all of these different elements in the same way or to the same extent. A smaller battery would have lacked the variety that seemed desirable, as well as some comparative similarities. On the other hand, a more numerous battery would not have been administratively possible on as large a scale as planned.

In general, an event was selected first because it had withstood the test of time (such as the Sargent Jump), or because it had been widely used as an exercise in physical education work (push-ups being an example).[1]

Test selection was also influenced, in part, by the fact that all subjects were enrolled in physical education classes at school. Thus, the Navy fitness tests (#2,7,8,10,11) were included because they already coincided with the aims of certain schools and formed a part of their regular program.

Apart from these more general factors which helped to determine the selection of the present test-battery, there were seven particular conditions to which it was thought any test should conform:

1. - A test should avoid calling upon those specific skills of earlier play life

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[1]Karl W. Bookwalter, "What is a Physical Fitness Program for Boys," Research Quarterly, XV (Oct, 1944) 245.

which have been more highly developed in some subjects than in others. Not all boys, for example, have had an equal opportunity to develop skill in throwing a baseball; had that test been used, certain subjects would have been definitely handicapped by inexperience.

2. - For practical reasons, a test should be suited for large classes in physical education and should not require more than a reasonable amount of time.

3. - All tests should be sufficiently simple and direct to enable assistants, such as squad leaders, to conduct them with a minimum of instruction or with brief practice trials.

4. - Tests scoreable in objective, performance units, e.g., chins, etc., are to be preferred. If timing is required experienced observers must be in charge.

5. - Tests should be of the "indoor" rather than of the "outdoor" type to permit testing under uniform conditions.

6. - Tests requiring gymnasium apparatus should be restricted to standard equipment.

7. - Finally, a test should meet accepted standards of reliability and objectivity.

Preliminary work with trial groups confirmed the suitability of the battery within the general scope of these conditions.

Reliability of Various Tests. - Volunteer groups of students, representing several physical education classes were tested in six events. One week later, the tests were repeated and the two sets of scores[1] were analyzed by the product moment method of correlation,[2] with the following results:

Test	No. Cases	r_{lI}
Parallel Bar Dips	38	.951
Hand Grip	28	.949
Pull-ups	38	.937
Dodging Run	38	.886
Sargent Jump	38	.867
Burpee 10 Second Test	38	.754

These tests show a fairly high consistency between

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[1]Refer to Appendix C for tables of raw scores.

[2]Henry E. Garrett, Statistics in Psychology and Education, (2d ed., New York: Longmans, Green and Company, 1941), 265-279.

the first and second sets of data. They are sufficiently reliable to warrant their selection for the purpose of the study.

Reliability testing of the 440 Yard Run and Standing Broad Jump was waived in favor of correlations reported by Cozens,[1] who obtained coefficients of .917 and .965 respectively. According to the program then in force in the high schools repeat observations on the same students could not be obtained in the four Navy fitness tests, Push-ups, Burpee 60 Second, Sit-ups and Squat Jumps. Other investigations have shown, however, that group reliability in these tests is quite satisfactory, tending to run between .75 and .90 in most reports.[2]

Objectivity. - As a matter of interest, product-moment correlations between observations by three different class leaders were also determined in the same tests for which the reliability coefficients have just been cited.

Little difference was, therefore, evident between examiners. The element of sighting the Sargent Jump introduced noticeable differences between examiners but the problem was overcome by assigning this task to one man. The writer assumed the conduct of this event. As for the other events,

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[1]Frederick Warren Cozens, The Measurement of General Athletic Ability, (Eugene, Oregon: University of Oregon Press, Physical Education Series, I, No. 3, 1929), 144.

[2]Ruth B. Glassow and Marion R. Broer, Measuring Achievement in Physical Education, (Philadelphia: W.B. Saunders and Company, 1939), 22-30.

correlations between examiners assured reliable accuracy of the test results turned in by assistants.

Correlation of Scoring Between
Three Examiners

Test	A. & B. No. Cases	A. & B. r	A. & C. No. Cases	A. & C. r	B. & C. No. Cases	B. & C. r
Burpee 10 Second Test	23	.995	23	.992	23	1.00
Dodging Run	25	.995	--	---	--	----
Hand Grip	24	1.00	25	.941	23	.860
Parallel Bar Dips	24	.984	25	.972	25	1.00
Pull-ups	24	1.00	25	.981	25	1.00
Sargent Jump	25	.855	25	.845	26	.693

The tests, accordingly, met the general, as well as the seven special conditions previously outlined. At the same time they comprised a manageable battery which summons a variety of physical efforts associated with strength, speed, agility, and motor power. Owing to such diversity in physical demands, it seemed reasonable to expect these tests to be differently influenced by body size and shape.

Sources of Data

1. Performance Studies. - The observations of the present study were made on college students, and on high school and junior high school boys in the years 1942 - 1944.

The college data were collected in the writer's department of physical education at Western Reserve University.

Through the kind cooperation of supervisors and physical education teachers, observations on the high school and junior high school boys were made in the following Cleveland public and Shaker Heights schools:

Cleveland Public Schools

High Schools	Junior High Schools
Collinwood High School	Audobon Junior High School
James Ford Rhodes High School	Collinwood Junior High School
John Adams High School	
John Hay High School	
Glenville High School	
Lincoln High School	
West High School	
West Technical High School	
Shaker Heights High School	Shaker Heights Junior High School

As shown in Table 4 - 36,409 scores were obtained from 5,860 boys and young men in these schools.

Approximately 20 per cent of the total subjects and tests are thus contained in the junior high data; about 50 per cent in the high school set, and 30 per cent of all observations are in the college group.

TABLE 4

NUMBER OF OBSERVATIONS BY TEST AND SCHOOLS

TEST	COLLEGE	HIGH SCHOOL	JUNIOR HIGH SCHOOL	TOTALS
Burpee, 10 sec.	1220	1050	744	2914
Burpee, 60 sec.	----	2248	756	3004
Dodging Run	1296	907	628	2831
440 Yard Run	767	----	---	767
Grip Strength	1527	930	631	3088
Dips	1722	1069	616	3407
Pull-ups	1503	2520	1084	5107
Push-ups	----	2018	734	2752
Sargent Jump	1745	2153	1135	5033
Sit-ups	----	1340	285	1625
Squat Jumps	----	1992	202	2194
Stand Broad Jump	----	2560	1127	3687
Total Tests	9780	18787	7942	36409
Total Subjects	1755	2927	1178	5860

Analyzed by age and level, 76.2 per cent of the tests were done by students seventeen years old or older, who had reached level 150 or more in the Grid.

2. Athletic Survey. - In addition to the foregoing direct measurements of test performance under the supervision of the author, a survey of the relation between size and physique to athletic performance was also undertaken by means of questionnaires and published materials. This subject itself seemed worthy of modern re-investigation by means of a method such as the Grid Technique. Consequently, during the course of the main project, information was gradually collected on the physical measurements of first class athletes, participating in various team and individual sports carried on in schools, colleges and by professional clubs. These results supplement the main studies on the relation between physique, body size, and performance. They comprise a systematic set of data on 5,759 athletes in eleven popular sports, and are discussed in Chapter VI of this thesis.

Organization of Tests

Table 5 shows which tests were conducted among the three different groups, that is, among the college men, high school and junior high school boys. The same table also indicates the order in which the tests were given - except for rotation in squad work.

TABLE 5

TESTS AND TEST ORDER

Day of Test	College	High School and Junior High
1	Burpee 10 Seconds	Burpee 10 Seconds
	Sargent Jump	Sargent Jump
	Pull-ups	Pull-ups
	Hand Grip	Hand Grip
2	Dodging Run	Standing Broad Jump
	Parallel Bar Dips	Dodging Run
		Parallel Bar Dips
3	440 Yard Run	Burpee 60 Seconds
	----------	Sit-ups
4	----------	Push-ups
	----------	Squat Jumps

The regularly scheduled physical education classes were given the tests in consecutive periods. Some of the classes were meeting twice weekly, others three times per week and some, daily. In order to harmonize the schedules, a day of rest was allowed between each of the daily classes. Differences in the length of periods and size of classes required some flexibility of procedure.

Since the 440 Yard Run was considered to be too vigorous for the untrained student, this test was not given until each student had had three weeks of physical education class work or its equivalent. Instructors were directed to include a few minutes running time in every class period in order to condition the student, at least partially, for this event.

Measuring and testing apparatus was, of course, stationed conveniently in a circular pattern around the gymnasium floor in order to facilitate progression from one test to another.

Administration of Tests

Immediately upon assembly, record cards and pencils were distributed to the class members. Personal history data were entered by the students.

The techniques of performance were carefully explained while an assistant demonstrated the correct movements for each test.

The class was then formed in open order for the Burpee Test which lends itself nicely to mass performance, under one leader. Odd and even columns scored each other's performance, and recorded the best result of three trials.

Following the Burpee, squads of 8-10 students were formed, assigned to a leader, and sent in rotation to the day's testing stations. Squad leaders recorded results, under the examiner's supervision.

Precautions were taken in the Hand Grip to have the correct hold; the examiner placed the instrument, read the result, announced it to the recorder, reset the dial and repeated this process for the other hand.

Two running courses were established for the Dodging Run. Each was governed by an examiner who started and timed the runners. As each group reported for the event, the examiner acquainted the subjects with the test by leading them twice around the course. Runners were tested individually, each being started by the customary track commands and a whistle signal.

Further details in administration of the Pull-ups, Sargent Jump, Parallel Bar Dips, the 440 Yard Run, and other tests are included in the description at the end of this chapter.

Body Measurements. - At some convenient point during the test sessions, body measurements were made by squad leaders:

Measurement of Height. (Stature). This was determined with the aid of a new Narragensett Stadiometer, graduated in inches and tenths. The subjects, clothed in physical education uniforms, removed shoes, socks, shirts and wore only their light trunks.

<u>Weight</u> was read directly from the dial of a Toledo spring balance which was frequently tested for accuracy to 1/4 lb.

These numerical values were entered on the original data cards. The individual height values of all contestants were then plotted on Grids in the usual way, for the purpose of determining each testee's physique (Channel) and level of development, by extrapolation, whenever necessary, to accommodate those individuals whose data fell outside the regularly indicated channels and levels.

Statistical Procedures

<u>Records</u>. - All performance records were collected on individual score cards, which also carried entries for biographical information, body measurements, Grid ratings by channel and level, and other notes on performance.

This information was coded and transferred to International Business Machine cards for tabulation by machine processes as desired.

<u>Analysis</u>. - The results of each test were then entered on columnar sheets, by channel and level, in a form suited to the subsequent calculation of means, standard deviations, standard errors and other statistics. These are reported in Appendix A.

Performance has not been studied in relation to age because, (1) the vast majority of subjects were over seventeen years of age, that is, beyond the "active" growth stage; (2) age determines neither physique nor size (level) explicitly, and (3) because such age correlations as are occasionally reported, are only apparent, and are more properly ascribed to level.

Test Descriptions

While the twelve tests selected for this study are all widely known, and while their administration is quite conventionalized, a brief description of the manner in which each test was actually given and performed is added in the following notes. Tests are listed alphabetically.

Burpee Ten Second Test. - As a rough measure of total body agility this test is a component of batteries designed for measuring motor capacity[1] and physical fitness.[2]

It can be described as a four count exercise performed against time (ten seconds). Starting from the position of attention the individual (1) stoops, placing his hands to the floor and his knees between his elbows; (2) thrusts his legs backwards, straightening his body so as to support himself rigidly on his arms; (3) returns to the squat position from which he immediately (4) stands erect. The number of completed cycles on a full count of

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[1]McCloy, "Tests and Measurements," op. cit., pp. 19-37.

[2]Bookwalter, "What is a Physical Fitness Test for Boys," op. cit., p. 245

four, allowing for the fractional part of the final effort, constitutes the score. The best out of three trials is recorded.

The Burpee Sixty Second Test. - The Burpee test extended from ten seconds to sixty seconds is frequently referred to as "Squat Thrusts." The movements are the same; the time extension introduces the element of endurance.

The Dodging Run. - This test measures speed of foot, in combination with rapid change of direction. It is a standardized event employed in a battery designed by Cozens[1] for testing general athletic ability. The correlation with a criterion battery for athletic ability was .729, the second highest of all correlated test items.[2]

The runner, according to Cozens' technique, follows a winding course between and around five hurdles placed in lanes. Two complete trips over the same route are run against time. The starting place is to the right of the first hurdle. Running to the left of the second hurdle the subject alternates from side to side. Upon circling the fifth hurdle he starts back again rounding the fourth hurdle to his right so as to keep up the same course. In approaching the starting line the runner has the option of circling the starting hurdle in either direction, provided

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[1] Cozens, "The Measurement of General Athletic Ability," op. cit., p. 177.

[2] Ibid., p. 157.

he gets back on the original path for the second trip. In this study one time trial was allowed. Runners who became confused were given a second chance while those who made two mistakes were disqualified.

The equipment for the Dodging Run included hurdles of official size, and a stop watch, examined for accuracy, which recorded time in seconds and tenths of seconds. This event, like others conducted against time, was controlled by whistle signals, in preference to a starting gun or verbal command.

The 440 Yard Run. - This event was selected principally to measure sustained running speed. Incorporated as an endurance item in the Cozens' Athletic Ability Test it ranked high among the activities he studied, correlating .707 with the criterion of athletic ability.[1]

All runners were timed on an improvised track made by painting a black line around the outer area of the gymnasium floor. Three and three-fourths laps around the course equalled 440 yards when measured according to the standard method of surveying running tracks. Two runners were started simultaneously, one five yards behind the other. The respective finish lines were similarly located. One examiner was stationed at each finish line to time the runner assigned to him.

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[1] *Loc. Cit.*

Hand Grip. - Strength of the hands is incorporated as a part of several well known strength formulae. The test is very easily given according to Rogers' technique.[1] In brief, a hand dynamometer is grasped firmly in one hand and pressure is exerted until the maximum effort has been expended. Dial readings for right and left hands were recorded separately but summed for the subject's score.

A new Naragansett hand dynamometer graduated from zero to two hundred pounds (in 2 lb. steps) was used and checked for accuracy before each testing period.

Parallel Bar Dips. - Actually, this is a push-up test for the arms, performed on the parallel bars. It is a strenuous exercise. Mounting the bars, and starting from a cross support between them, the entire weight resting on the hands, the subject lowers his body and raises himself again by flexion and extension of the elbow joint, until the upper arm forms an angle of ninety degrees, or less, with the forearm.

One full movement, down and up, is scored as "one." The movement is continued without alteration as many times as possible.

Parallel Bar Dips were performed on the standard

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[1]Frederick Rand Rogers, Physical Capacity Tests in the Administration of Physical Education, (New York: Teachers' College, Columbia University, Contributions to Education No. 174, 1925).

ten foot adjustable gymnastic bars. The subjects were permitted to adjust bar width, although only those individuals of extreme body proportions exercised the privilege.

Pull-ups. - This event is generally recognized as a measure of strength. It is the most frequently given test in physical fitness programs.[1]

Hanging by the hands, at full length from a horizontal bar, the subject pulls himself upward until his chin is above the bar. Returning immediately to the starting position, the subject repeats the exercise and continues without rest or modification until his limit of endurance is reached. In this study the traditional grasp with the palms of the hands turned toward the face was required.

Credit was given only for completed performance, i.e., no credit was allowed unless a boy's chin was definitely raised above the bar.

A standard metal horizontal bar, eight feet high, was used and each gymnasium was equipped with one or more bars.

Push-ups. - The Push-ups are widely known as an arm exercise. Like the other strength events they are often used as an "all out" test.

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[1]Bookwalter, op. cit., p. 245.

The testee starts from the leaning rest or front support position. His shoulders are held off the floor by hands and arms, and his body is stiffened in straight line from chest to toes. The test consists of lowering and raising the body. Each push-up is scored as one point, provided that the individual first lowers the body until the chest touches the floor.

The Sargent Jump. - Considered an excellent measure of explosive muscular power, the Sargent Jump is generally believed to have predictive value for track and field abilities. Known also as the "Vertical Jump", the test consists of a direct upward jump in which the object is to propel the body vertically as high as possible. McCloy's technique was followed.[1] Three separate trials were allowed.

A sheet of wrapping paper 2 x 5 feet, was ruled with lines one half inch apart. Every other line was heavily drawn in black to give prominence to the inches. The inch lines were numbered from zero to forty eight, the figures heavily inscribed in black along both edges of the paper. This improvised scale was attached to the wall so that the zero line was lower than the top of the head of the shortest person.

Standing a foot from the wall with his side toward the scale, the testee was asked to hold himself erect while the observer sighted across his head to note the mark

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[1]McCloy, op. cit., p. 64.

corresponding to the subject's standing height.

The observer occupied a position opposite the wall chart so that the testee was in his direct line of vision. The distance from the point of observation to the chart was fifteen feet.

As the subject jumped the examiner mounted a step ladder to a place where he could sight the mark reached by the top of the jumper's head. The difference between this and the subject's observed height represented the jump value in inches. Three trials were allowed, and the best jump was recorded.

A triangular first aid bandage was tied over the head of each performer to eliminate the interference of hair-toss.

No definite form of jumping was required, although a preferred method of jumping was explained. This called for a standing position with the feet parallel, either together or comfortably apart, with body inclined slightly forward, knees flexed to about seventy degrees, and arms placed downward and backward. Thus, without any preliminary hop or step the jump was directed upward and assisted by thrusting the arms forward and over the head. At the completion of the upward thrust the arms were to be swung violently downwards to gain whatever advantage there is said to be attached to this movement.

Comment. - Newton's laws of action and reaction[1] are sometimes called upon to justify the downward arm thrust as though this would have the same or similar effect in vertical propulsion that the corresponding movement clearly has in swimming. There is considerable doubt on this point, however, when the comparative densities of water and air are kept in mind, the latter obviously not affording a fulcrum suitable for further vertical elevation, but acting rather, or tending to act as a cushion - which will collapse upon downward pressure. This effect, however, is in need of further scientific study. Nevertheless, advice was given to practice the technique as described, but relatively few subjects followed that form.

Sit-ups. - This is a test of the abdominal muscles.

The movement is started from a supine position on the floor. The hands are clasped behind the neck. The body is outstretched and the feet are placed comfortably apart. Assisted by a partner who grasps the ankles, the performer sits up and lies down again as often as he can. On each sit-up he touches one of his elbows to a knee, alternating with the right elbow to the left knee and the left elbow to the right knee.

Each complete sit-up is scored as one point.

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[1]McCloy, Tests and Measurements, *op. cit.*, p. 62.

The testee continues to the limit of his endurance.

Squat Jumps. - This is one of the most strenuous of all physical fitness tests.

The starting position is an erect stand, feet parallel and the hands clasped behind the head. Upon the command to start the subject jumps vertically in the air so that the feet rise four inches or more above the floor. As he comes down he assumes a deep squat stand, one foot ahead of the other and the buttocks resting or almost resting on the heel of one foot. The upward jump is repeated from this position - the movements being continued, the feet alternating to the front and the rear with each new squat position. The torso is held erect throughout, the exercise ending when endurance plays out. The number of jumps constitutes the score.

The Standing Broad Jump. - The Standing Broad Jump was performed on the gymnasium floor. Existing lines already on the floor were used. Toeing the mark with both feet, the individual jumped directly forward, the landing place of the nearest heel being taken as the achieved distance. An assistant marked the landing place with chalk, and two students measured the distance with a cloth tape. Three trials were allowed, and the best jump was credited as the final score.

CHAPTER V

RESULTS ON MOTOR PERFORMANCE IN THE TWELVE TEST BATTERY

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Comparative Trends of Performance with Respect to Body Build and Body Size

For convenience, all of the numerical results on motor performance in the twelve test battery are tabulated by channel and level groups in Appendix A. In these tables five items are listed: Number of cases, mean values of test performance, the standard deviations, standard errors, and the range of scores. Each test is tabulated by 10-level groups and by individual channels; the last column shows the above mentioned five statistics for each level group.

As the influence of physique and size can be more clearly seen in chart form, the tabular results in Appendix A are illustrated in this chapter by means of graphs included with the description of each test.

Trends of performance are emphasized rather than absolute values. This emphasis is a natural outcome of classifying the subjects by the Grid Technique which provides ratings for both body build and body size. In other words, classifying the subjects by this method made it possible to study trends of performance for groups of persons having either build or size in common. Performance can, therefore, be analyzed separately with respect to body build or size. It will be recalled from the comparisons in Chapter III that no such trends could be studied when subjects were classified by the index or exponent plans because in each case there was considerable overlap of different sizes and shapes within a single class. In neither of these methods of classification could one establish a continuous trend of performance from one physique type to another or from smaller to larger subjects of the same physique.

Another reason for emphasizing the study of trends of performance with respect to body build and size is that the true effects of either of these two factors can be easily overlooked if attention is paid merely to the difference between the means of neighboring build or size categories. Performance of subjects, in adjacent channels, for example, may only differ by small amounts. Yet when their mean scores are viewed as a trend across some level group, or along some channel, the effect of differences in size and build more readily can be discerned even though the scores themselves may not be statistically significant in every case.

Trend analysis has also the advantage of making use of a much greater number of observations distributed over each classification of build or size either for comparisons within the same test or between different tests. Such comparisons are then based on more of the total information available, and consequently involve a wide distribution as regards size or build differences. To concentrate attention only on comparisons between size and build classes would tend to ignore the continuous nature of size differences in growth and would also overlook the continuous transition in body type from one physique class to another.

Detailed Description of Results in Each of the Twelve Tests

The results in each of the tests will be described in the following order:

Level Effects

Physique Effects

Level Effects. - These tests represent the influence of body size and accordingly the influence of increasing body size as level increases. To utilize all the data efficiently, two performance graphs will be shown: (a) mean values for subjects in all channels, compared with (b) the mean values for subjects in channel M, at corresponding levels. The justification for combining values for all channels at any level group is given by the fact that the result should approximate values which would be expected of subjects in channel M. The combined and actual M values in this way serve as mutual controls. Two lines, therefore, appear in the following level graphs. The solid line represents the performance of subjects in all channels whereas the broken line represents the performance of physique class M.

Physique Effects. - Since preliminary study had shown the cross-channel patterns at all levels to be very much alike, considerable condensation in presenting the physique effects can be achieved by describing the results characteristic of level 170. As a partial control on these results, another section at level 170, composed of all subjects between levels 155 and 185 will also be shown. These combined results, again, are equivalent to an estimate of what the results at level 170 might be expected to show. Such lumping has the advantage of including two to three times as many observations; and for that reason the pattern tends on the whole to be somewhat smoother. Although it does mix men of different sizes, all subjects are within fifteen levels of the mean value of 170. The procedure can be justified when size (level) itself has only a small or negligible effect. This condition is satisfactorily met for the span of fifteen levels below or above 170, in all tests as shown by the data in Appendix A.

Performance in Individual Tests

1. <u>The Burpee Test in Ten Seconds (2914 Cases)</u>. - Performance in the Burpee 10 Second test is nearly independent of body size until the highest levels 190 and higher are reached (Fig. 18). Within the 10 second time interval, boys of almost all sizes are equally capable of doing this test.

Stocky subjects in A_3 and A_2, as well as the medial groups in A_1 to B_1 are the best performers. Those in A_4 and above, and those in the slender channels B_2 and B_3

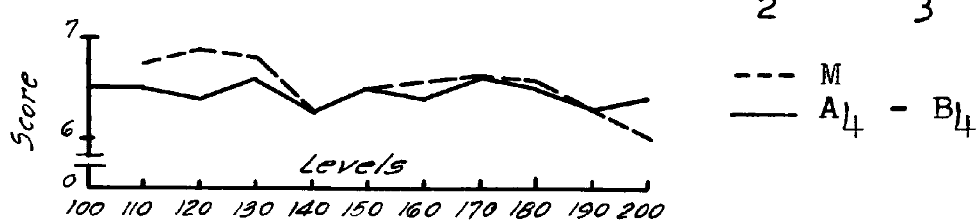

Fig. 18 Level Effects in the Burpee 10 Second Test

fell below the best performers by almost one movement. While differences of less than one are hardly of practical

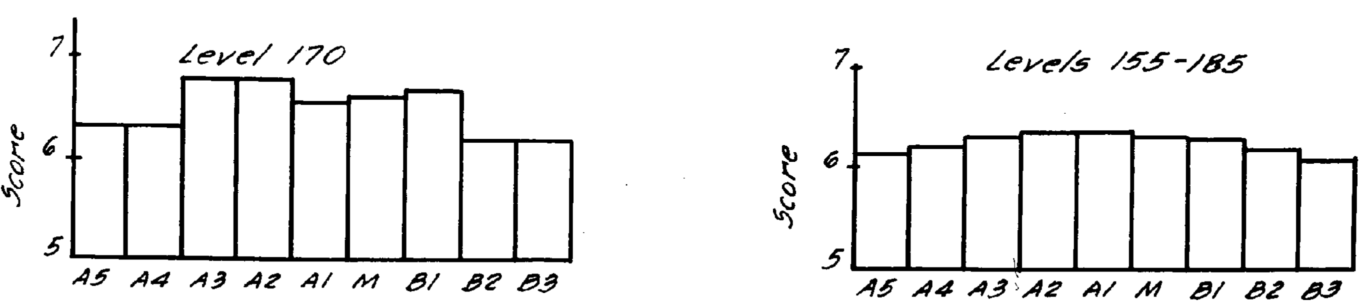

Fig. 19 Physique Effects in the Burpee 10 Second Test

importance, their occurrence in the stouter and more slender groups tends to suggest that these subjects are comparatively less competent than those in A_3 to B_1.

2. The Burpee Test in Sixty Seconds (3004 Cases). - The extension of the Burpee test from ten to sixty seconds brought out relationships quite distinct from those in

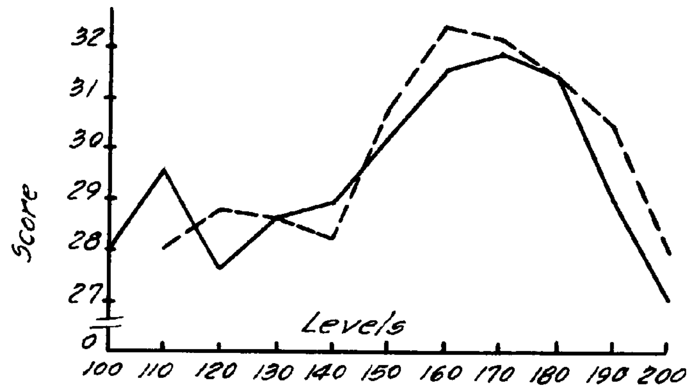

Fig. 20 Level Effects in the Burpee 60 Second Test

the shorter time trial of the 10 second event (Fig. 20). Except for level 110 with only 45 observations, the curves show a steady rise in performance to level 170 with an equally prominent drop thereafter. The trend for 713 cases in the M channel is practically identical with that obtained from 3004 subjects in all channels. Apparently

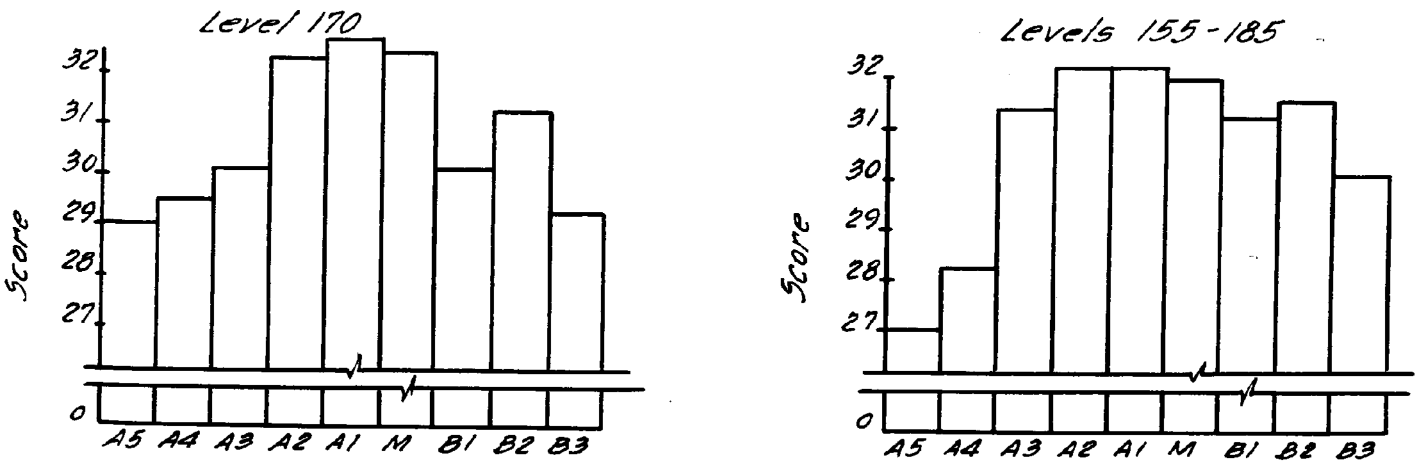

Fig. 21 Physique Effects in the Burpee 60 Second Test

time extension has called for greater endurance, and this endurance is forthcoming in greater degree as size increases up to level 170. Thereafter, still further increase of size has a counteracting effect.

As shown by the two sections of the channel system at level 170, physique differences are also more noticeable in this 60 second event. Endurance of the A_5A_4 group is least, the slender B_1 to B_3's next, and it is again greatest among the medial A_2's, A_1's and M's.

The differences between low and high scores, either by level or by channel are clearly significant, since the critical ratios are between 4.6 and 5.2 (Table 36 - Appendix B). These results indicate that body size and build are definitely limiting factors on performance in the extended Burpee test, and that some allowance for them might properly be made when conducting this test.

3. The Dodging Run (2831 Cases). - Although difference in average time is, in many cases, only a matter of tenths of a second, the trends in Figure 22 simulate those shown for

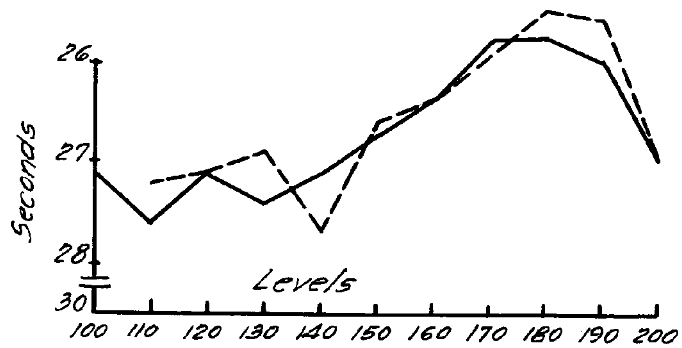

Fig. 22 Level Effects in the Dodging Run.

the Burpee test in sixty seconds. Performance improves (time diminishing) as level increases to 170 and 180, and thereafter declines showing its most definite drop after level 190.

The physique pattern appears to be intermediate to that of the two Burpee tests, although in reality, the trend is even flatter when due account is taken of relative differences in units, as explained in the following section. For

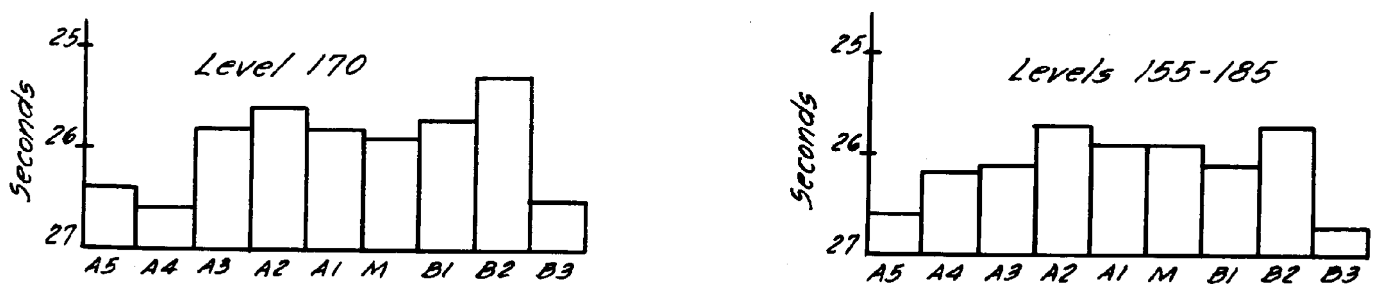

Fig. 23 Physique Effects in the Dodging Run.

the present it is necessary to point out only that the central physiques show the better performance, and that such change as the extreme physiques lead to is somewhat less than that induced by a 50 level rise in size.

4. <u>The 440 Yard Run (767 Cases)</u>. - This event was given only to college students. As a consequence the subjects

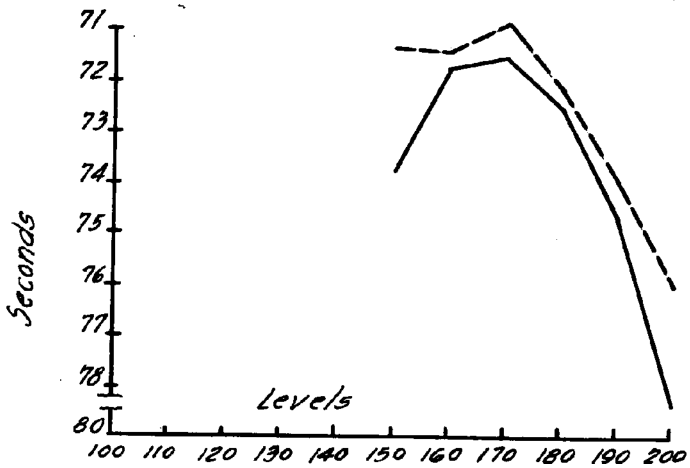

Fig. 24 Level Effects in the 440 Yard Run.

were concentrated between levels 155 and 185. However, 46 were in the 10 level group between 145 and 155, and 7 in the next lower 10 levels. Even so, the level trend in Figure 24 shows a rise of performance between levels 150

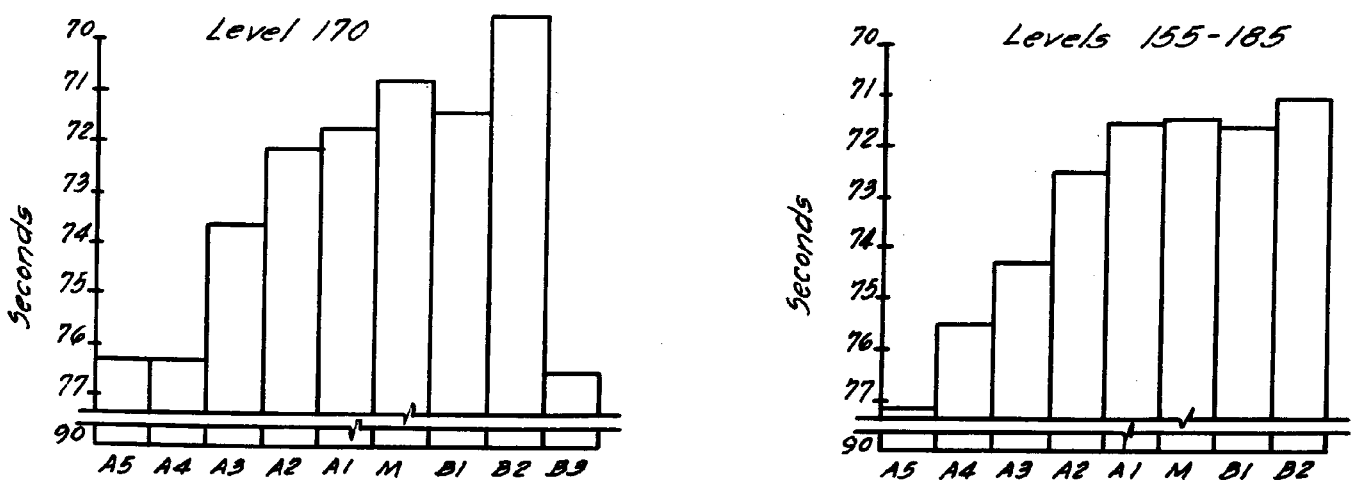

Fig. 25 Physique Effects in the 440 Yard Run.

and 170 with a very definite drop thereafter.

As regards physique, the slender types have the advantage, since slower times characterize the A types, whereas speed improves as body build approaches and involves the B types. The extremely slender B_3's, however, are altogether poor in performing the 440. Critical ratios of 2.7 and 2.8 were found for the differences between (A_4A_3) and the leaders in M and B_1.

5. <u>The Hand Grip (3088 Cases)</u>. - This test shows (Fig. 26) a steady rise of performance as level increases; and unlike any other, it shows no maximum, although the rate of increase seems to diminish at the highest levels, that is,

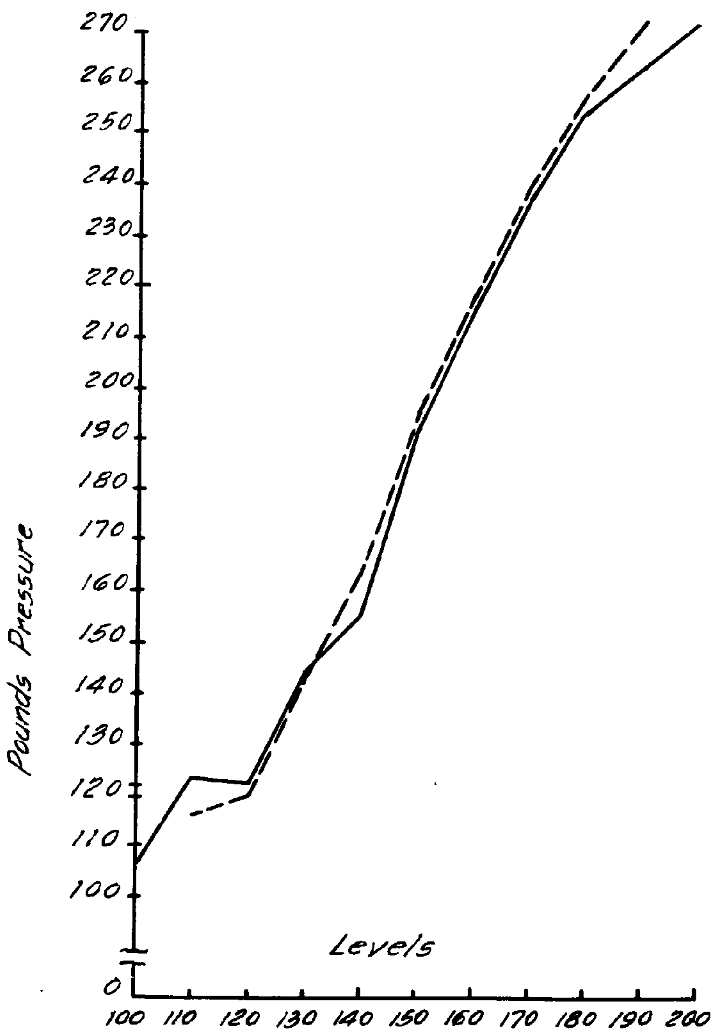

Fig. 26 Level Effects in the Hand Grip.

beyond 180. Both the M and combined set of data are remarkably alike. It should be obvious that failure to allow for body size in this test will seriously confuse results.

A 20-25 pound strength difference between the stocky A_5A_4's and the "athletic A_2A_1's" is evident from Figure 27, and it is also statistically significant, the critical ratio being 3.2. The observed value of the B_3 group at level 170 is no doubt due to a sampling error depending on the fact that this group contained only 10 of the 881 cases. This conclusion seems justified on the ground that the combined set across level 170 reflects essentially the same pattern, with the B_3 group, however, showing lower performance than the medial physiques. In general, the medium type and slender subjects thus excel in the Grip. A possible explanation would suggest that hand and finger length are herein involved.

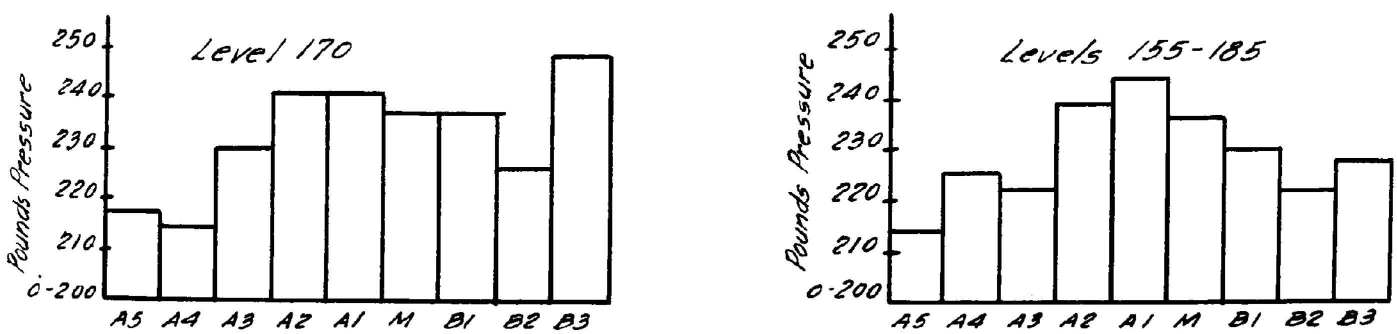

Fig. 27 Physique Effects in the Handgrip.

6. Parallel Bar Dips (3407 Cases). - Performance in this test varied from zero to thirty dips. It is worth noting that 80 per cent of the 3407 scores were between zero and

Fig. 28 Level Effects in the Parallel Bar Dips

eleven. About 6 per cent of 206 students could not execute one complete movement. It is highly possible that the somewhat greater dispersions in this test are in part the result of differences in practice or familiarity, or of some reluctance to go "all-out." As is well known, the test is sensitive to training.

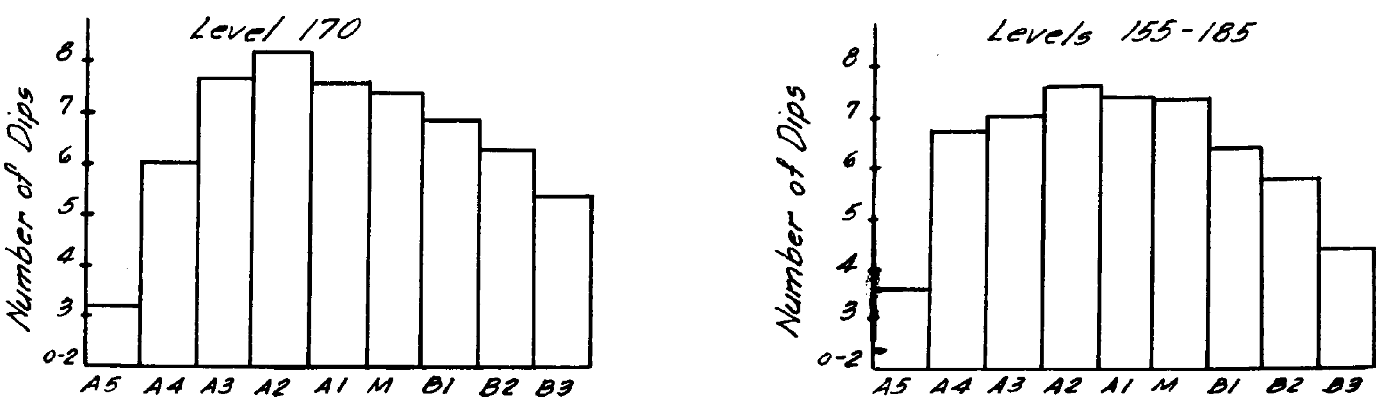

Fig. 29 Physique Effects in the Parallel Bar Dips.

The section graphs across level 170 show a definite influence of physique such as to favor the A_2's, though the central physiques are altogether better than the overly stocky or thin types. Certainly persons in A_5, A_4 and B_3 are hardly to be classed on an equal basis with those in A_3 to M.

7. <u>Pull-ups (5107 Cases)</u>. - This test was administered to all of the various junior and senior high school groups as well as to the college men included in the

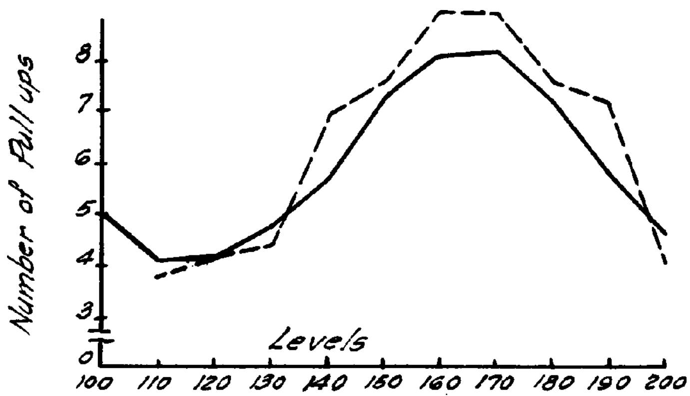

Fig. 30 Level Effects in the Pull ups.

study. As a result, the data available were more numerous than in any other test; and the trends are, at least partly for that reason, among the most stable even though the range of performance is comparatively great. About 3 per cent or 161 students were unable to perform once; 85 per cent scored 10 or less. An occasional lad exceeded 20,

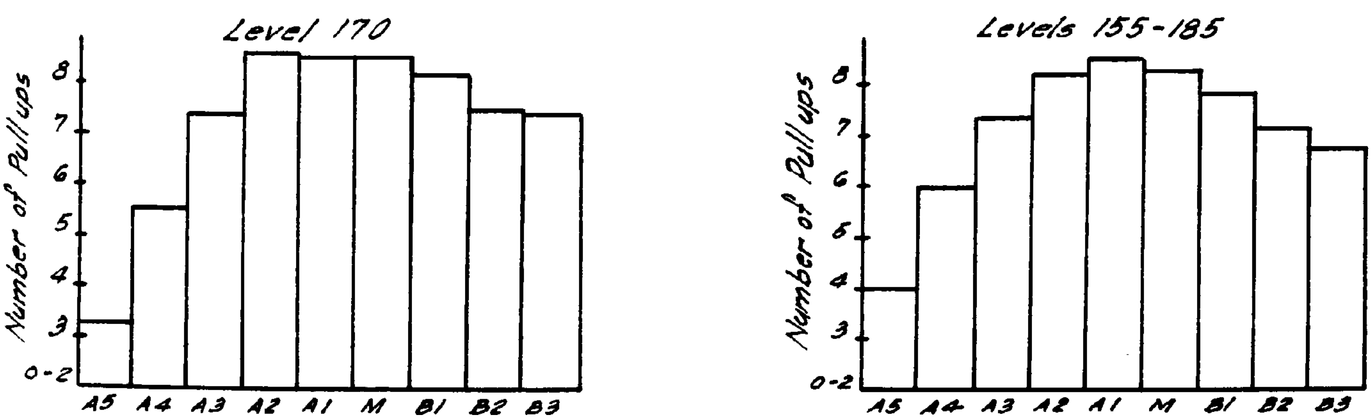

Fig. 31 Physique Effects in the Pull ups.

and some "experts" - men who had obviously had considerable training and practice, did 23 to 25 pull-ups.

As regards level, the curves in Figure 30 rise from a mean value of 4 to 8 or slightly above; this maximum is followed, as in practically every other test, especially the closely comparable dips, by a steady decline to 4 at the highest levels of size. The 1192 observations for channel M (dotted curve in Fig. 30) correspond very closely with those of the combined group (solid curve) even though only 1/5 as many records were available for that single channel. Allowance for size can hardly be overlooked in this test any more than in most of the others.

The physique effects as represented by the 170 level cross sections in Figure 31 are very uniform and indicate that subjects in A_2 to M are superior to all others; that the heavy A_5A_4's are most severely handicapped, and that the slender B's are intermediate. So grouped, the differences are clearly significant, although this example, with its 3260 cases within levels 155-184 is as good as any to illustrate the principle mentioned in the Introduction that differences between adjacent channels might not be statistically significant in spite of rather large numbers. Yet trend of performance across the physique classes is so regular as to leave little doubt that a difference of 2-3 channels exerts a very definite effect upon pull-up performance. It is of interest that where one physique type excels another by one or more pull-ups the difference is usually significant.

8. Push-ups (2752 Cases). - The push-up test was administered only to the high school students, whereas the two preceding tests, parallel bar dips and pull-ups, included college men. Nevertheless, the trend of push-ups, with respect to level (Fig. 32), again corresponds

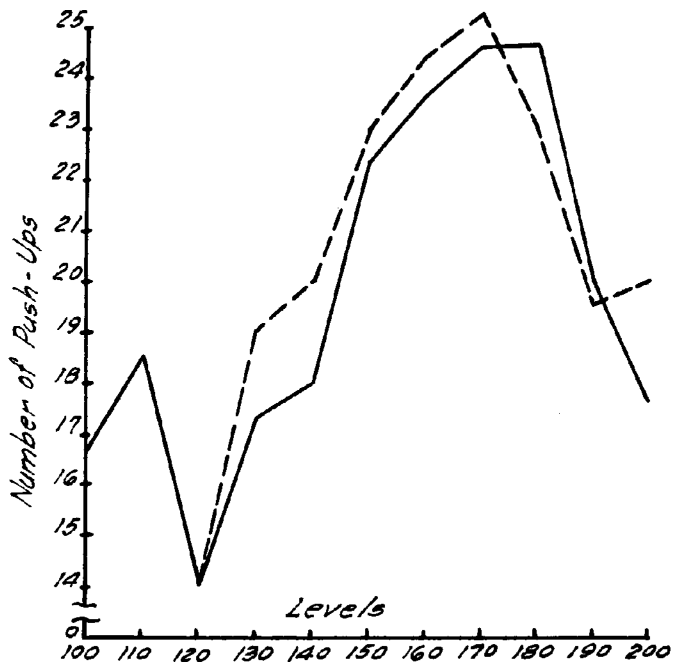

Fig. 32 Level Effects in the Push-Ups.

to the general pattern of the dips and pull-ups, by its steady rise to a maximum mean value of 24-25, which likewise occurs at level 170-175, and by its subsequent fall. In other words, size as determined by Grid level, rather than age or school grade, is a decisive factor in limiting or in favoring push-up performance.

The physique trend in Figure 33 shows the already familiar pattern with the best achievement by students in A_3 to M. In most other tests boys in A_3 are somewhat more handicapped than they are in the push-ups. The A_4's and A_5's, however, are clearly not as capable as the stocky and central types; and the B's taper off greatly in

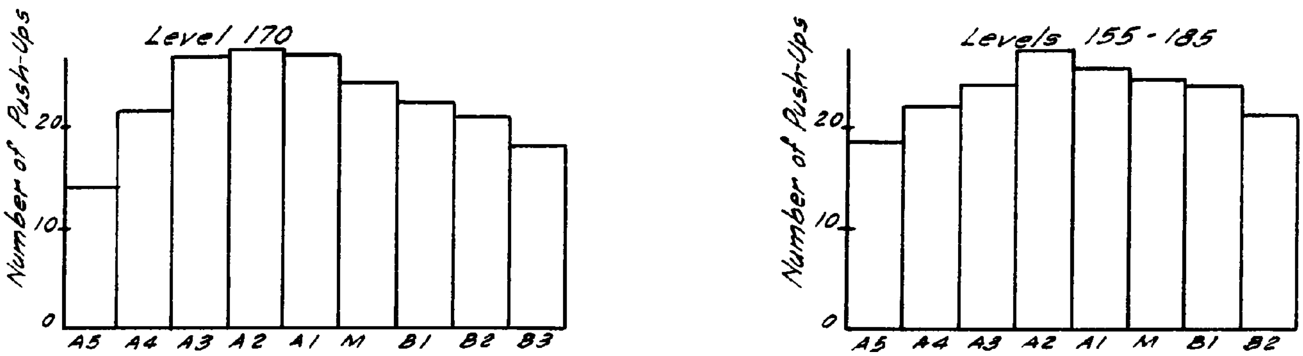

Fig. 33 Physique Effects in the Push-Ups.

performance as the outer B_4 channel is reached.

9. <u>The Sargent Jump (5033 Cases)</u>. - This test, like the pull-ups, was administered to all groups from junior high

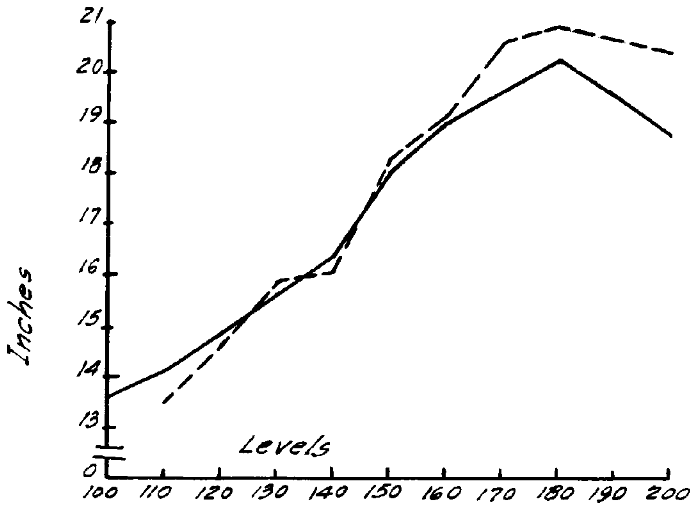

Fig. 34 Level Effects in the Sargent Jump.

school through college.

As in preceding events, proficiency increases with level to a maximum of 20.3 inches at levels 170-180. The drop following this maximum is not as abrupt or as great

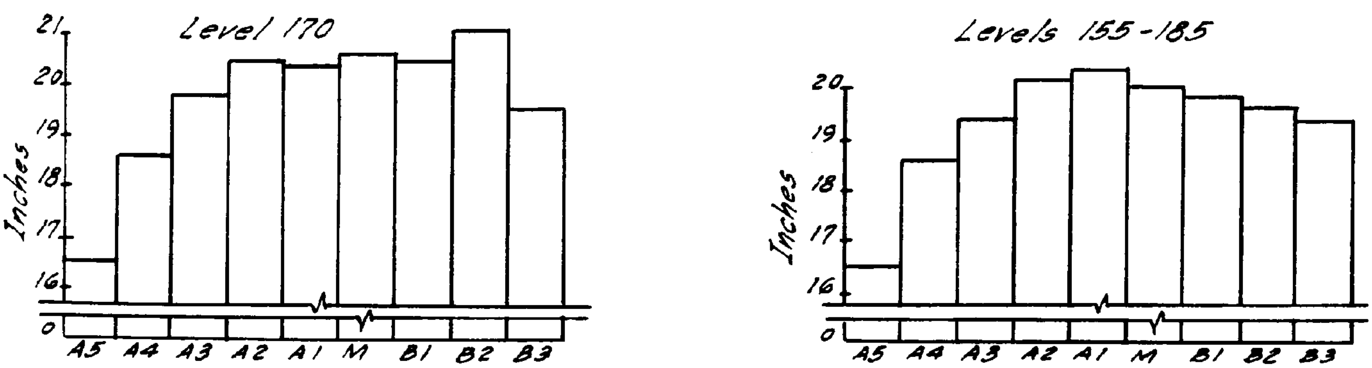

Fig. 35 Physique Effects in the Sargent Jump.

as in some of the other tests, but its existence is just as apparent.

At the 170 level cross-sections (Fig. 35) the rise in performance from A_3 to A_1 is quite sharp, whereas the tapering off toward the slender channels is more gradual. The series A and B patterns are again remarkably alike and contain respectively 1319 and 3034 observations. These results clearly contradict various statements that have been made from time to time that this jump is independent of body build.

10. Sit-ups (1625 Cases). - Although this test was not administered to college men, and only to a portion of

Fig. 36 Level Effects in the Sit-Ups.

the total Junior and Senior High School groups, observations nevertheless extended from level 100 to 200 (Fig. 36). Increasing size again enters into this exercise of abdominal muscles to about the same degree as it does in most of the other tests. Performance rises to a peak at level 170 and

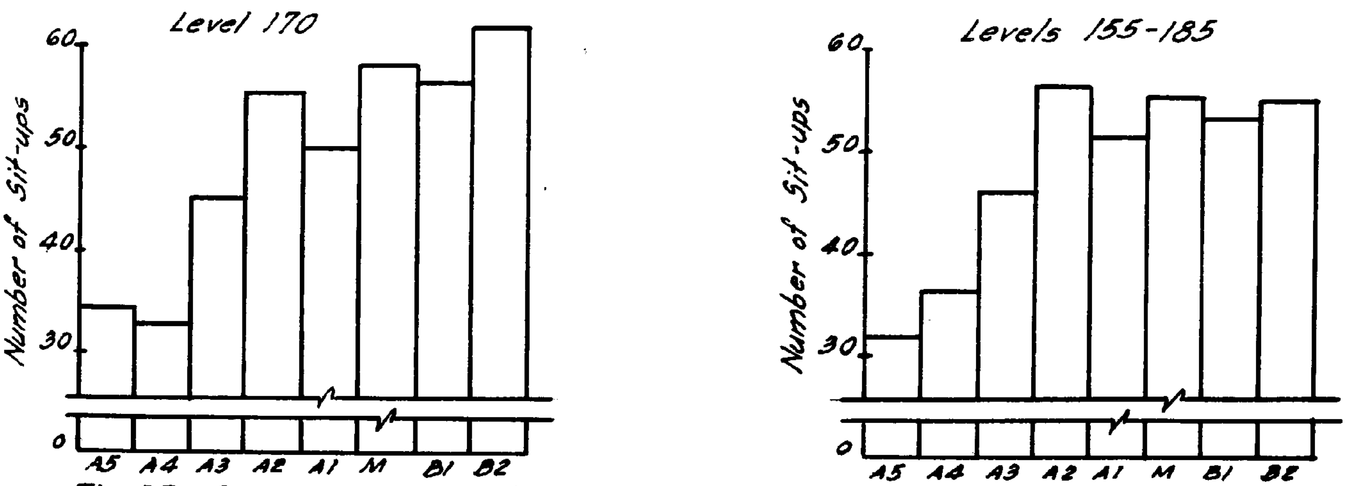

Fig. 37 Physique Effects in the Sit-ups.

thereafter shows a steady decline. Mean scores begin at about 26 sit-ups, rise to 53and taper off to about 30 as the highest levels are reached.

The physique pattern across level 170 favors the slender types, the curve rising from a low of 34 for the A_5's to a little more than 60 for B_2. Unfortunately, only nine cases in B_3 were observed between levels 155 and 185, so that no estimate of performance for this group is available. Both series A and B sections, however, are in agreement as to the rise of performance with shift of physique toward the slender channels. Expectancy for the sit-ups would thus depend very definitely upon physique with different allowances for those in A_3 and above, from those in A_2 to B_2.

11. <u>The Squat Jumps (2194 Cases)</u>. - This test was given only to High School boys, a fact that accounts for fewer observations at the lower levels (100-140).

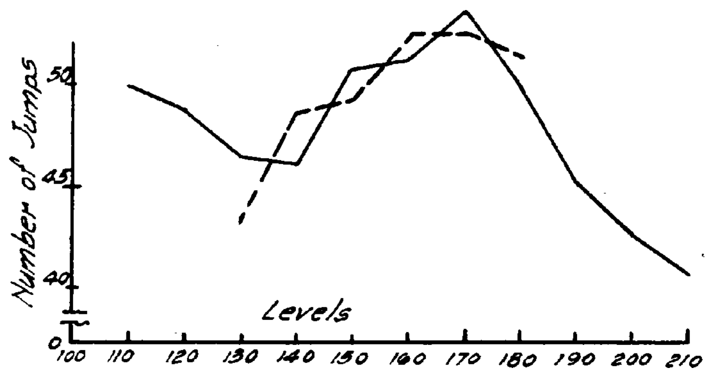

Fig. 38 Level Effects in the Squat Jump

From level 140 to 170 there is a rise in mean performance amounting to about 6-8 jumps. The subsequent drop shows performance at level 200 to be as low as 40 jumps. This test, accordingly, follows the usual size

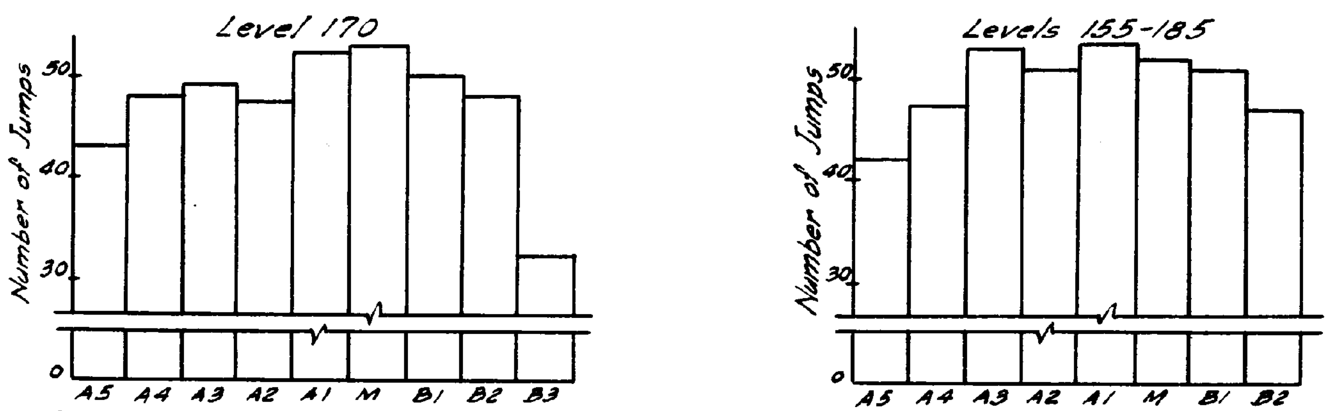

Fig. 39 Physique Effects in the Squat Jump.

pattern of rising to a maximum, and of falling thereafter as size continues to increase.

As regards physique, the heavy A_5 and A_4's as well as the slender B_2's are again at a disadvantage, since peak performance is shown by those in channels A_3 to M or B_1.

12. <u>The Standing Broad Jump (3687 Cases)</u>. - As no college men performed in this test, observations are limited to

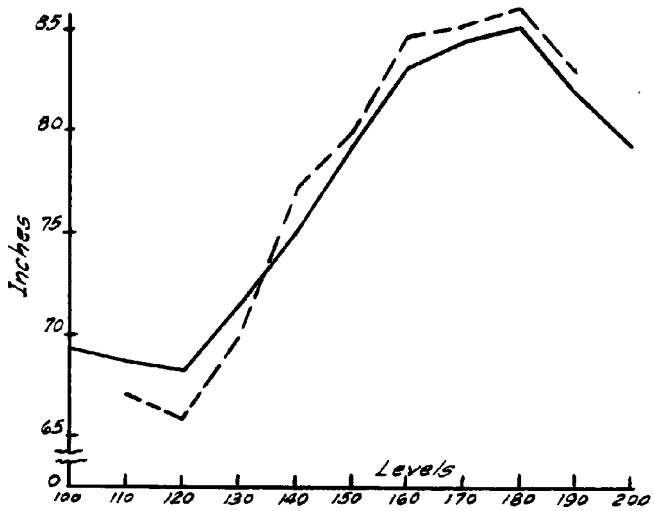

Fig. 40 Level Effects in the Standing Broad Jump.

High School and Junior High School boys.

The effect of level is clear-cut (Fig. 40), showing an increase in performance to a maximum attained at level 170 which extends even to level 180. The subsequent

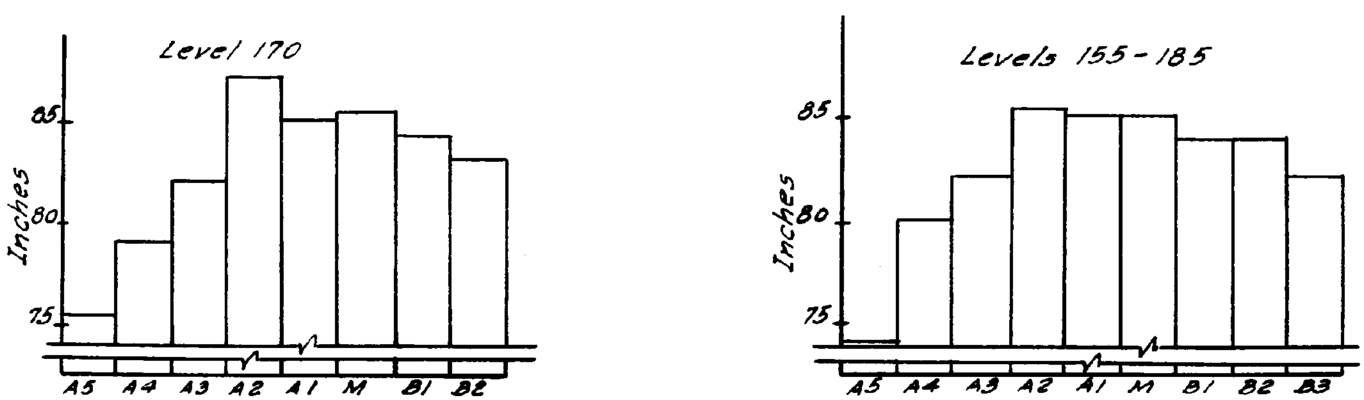

Fig. 41 Physique Effects in the Standing Broad Jump.

drop is comparatively small and affects only those at levels 190-200. A mean jump distance of about 20 inches separates the smaller boys at levels 100-110 from the peak mean of eighty-five inches.

The physique cross-section shows those in A_2 through

M to be the best, the slender B_1's to B_3 next, and the heavy A_4's and above, least capable. The A_5's are 10 inches below the best performers, and this difference is unquestionably significant with a critical ratio of 3 or more. It would appear that types A_2 to B_2 could certainly compete on equal terms; but allowances ought to be made for all others.

Remarks

The results for each of the twelve events have been expressed in terms of raw scores. Thus, in Pull-ups, chin number has been used; in the grip, pounds strength, and in the Sargent Jump, inches of leap.

The general patterns of performance, with increasing level or with change in physique, have been strikingly similar. Each test showed increasing performance thereafter for subjects of still greater body size (levels 175-225). This was invariably true of all tests except grip strength which showed continuing increase over the entire span of 100 levels.

The physique pattern, as represented by the 170 level cross section of the channel system, was likewise similar from one test to another in its rise from the A_5 low point to a maximum centering around channels A_2 - A_1 or M, and in its drop-off for the slender types in B_2, B_3 and beyond.

While the level and physique patterns of performance had these characteristic trends, and since the effects appeared to be greater in some than in others, no direct inter-test comparisons could be made as long as performance in each test was expressed in different units without some common denominator that could represent equivalent results. However, it seemed desirable to study the extent to which body size and body build influenced performance in different tests, in addition to showing merely that both of these structural traits were factors in limiting or in favoring performance in all of the tests.

Relative Performance

It seemed important, in addition to establishing the preceding results to learn whether either body build or body size had more influence in some tests than in others. A convenient method of studying this aspect of the problem would be to compute relative performance on a percentage basis. Several different reference bases were considered, namely, (a) percentage increase with respect to the "low" point, along a channel or across a level; (b) with respect to the mean value for channel or level, and (c) with respect to "peak" performance in any body size or build category.

It is obvious that the resulting trends and values of relative performance will all be comparable as long as the same reference base is employed. The three methods (a), (b) and (c) tend to represent these comparative effects about equally well, although method (a) with the "low" point base will tend to exaggerate effects considerably. All results would be greater than 100 per cent. The chief objection, however, is that the "low points" are apt to be less accurate than almost any other point on each

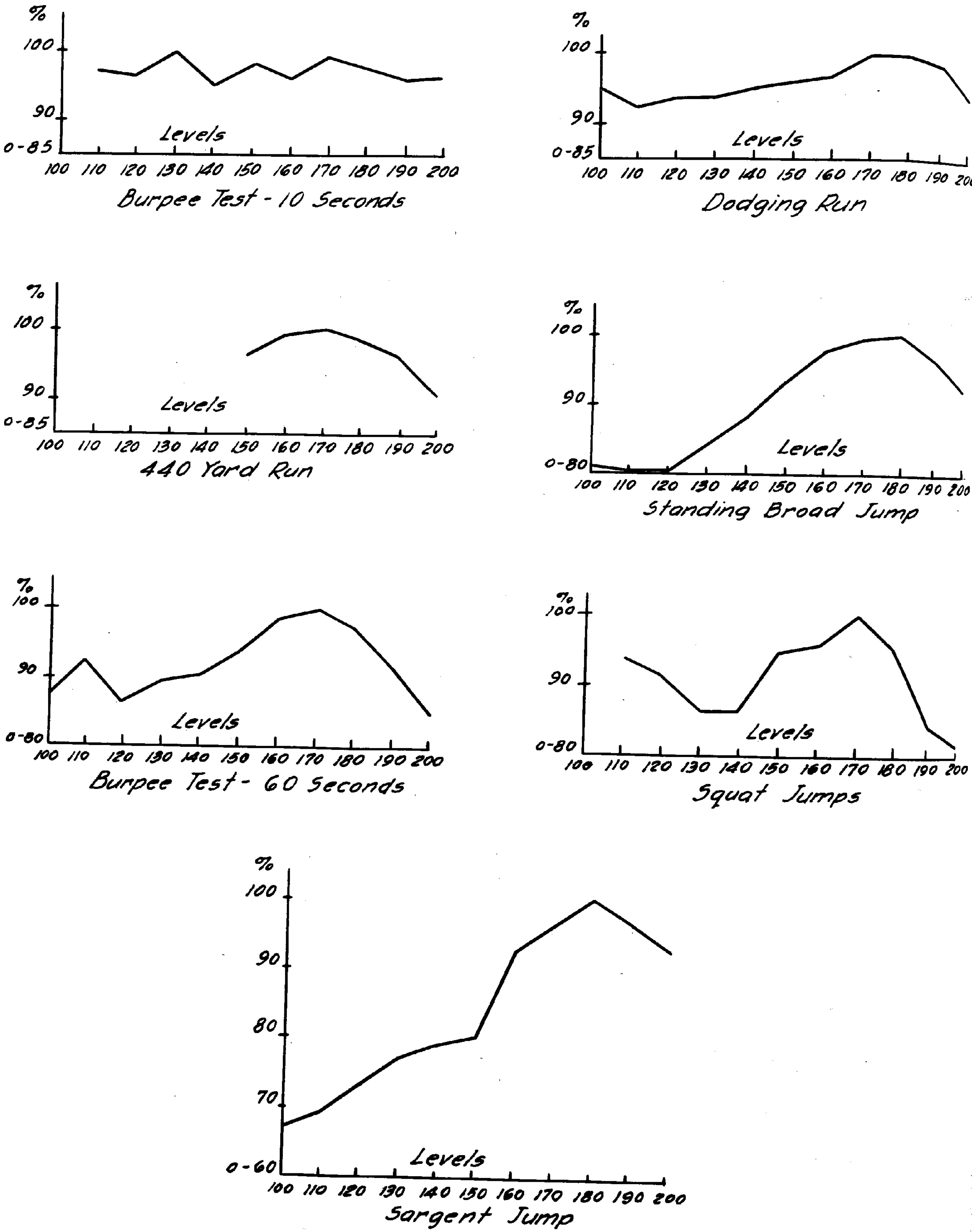

Fig. 42 Percentages of Peak Performance by Levels.

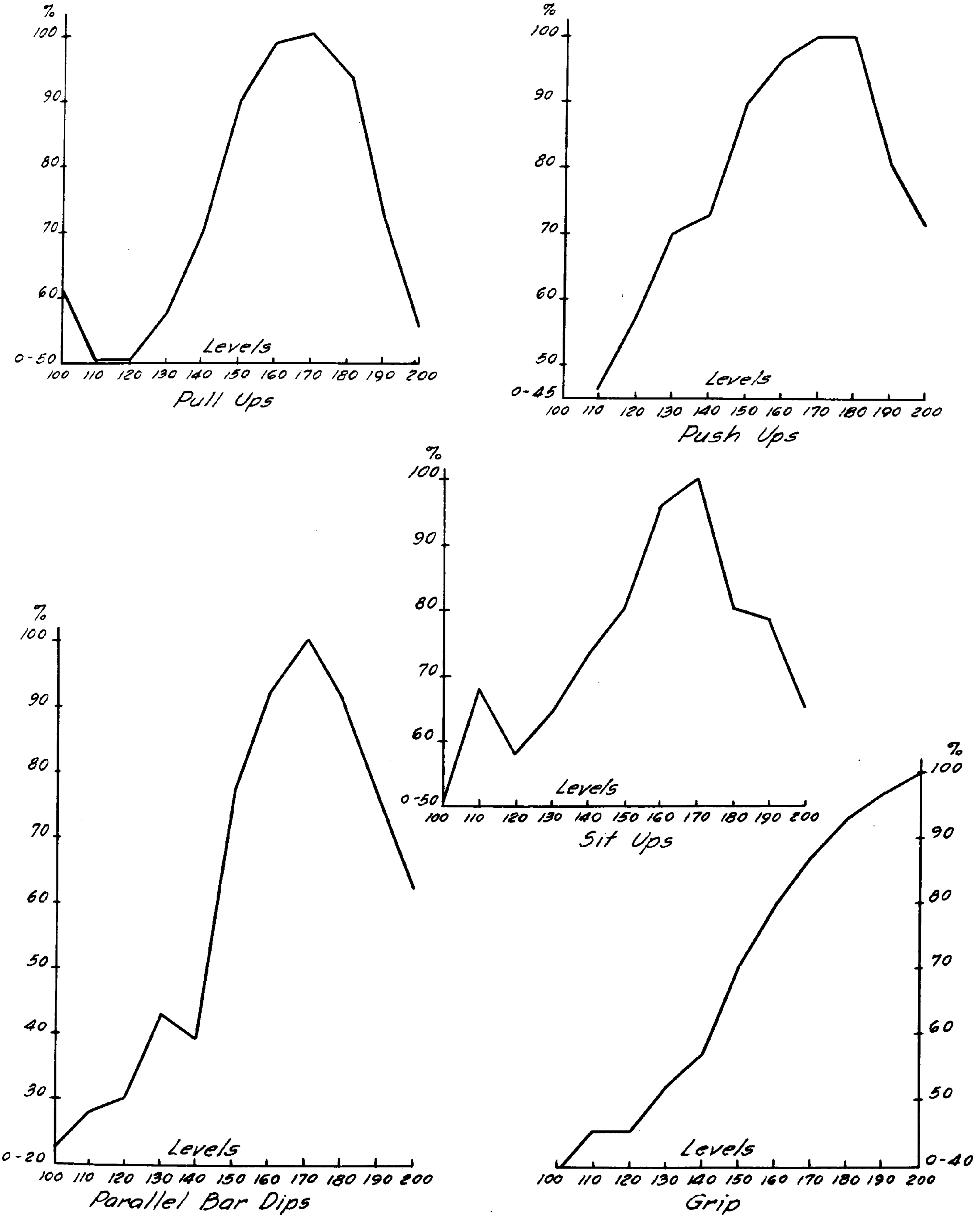

Fig. 43 Percentages of Peak Performance by Levels.

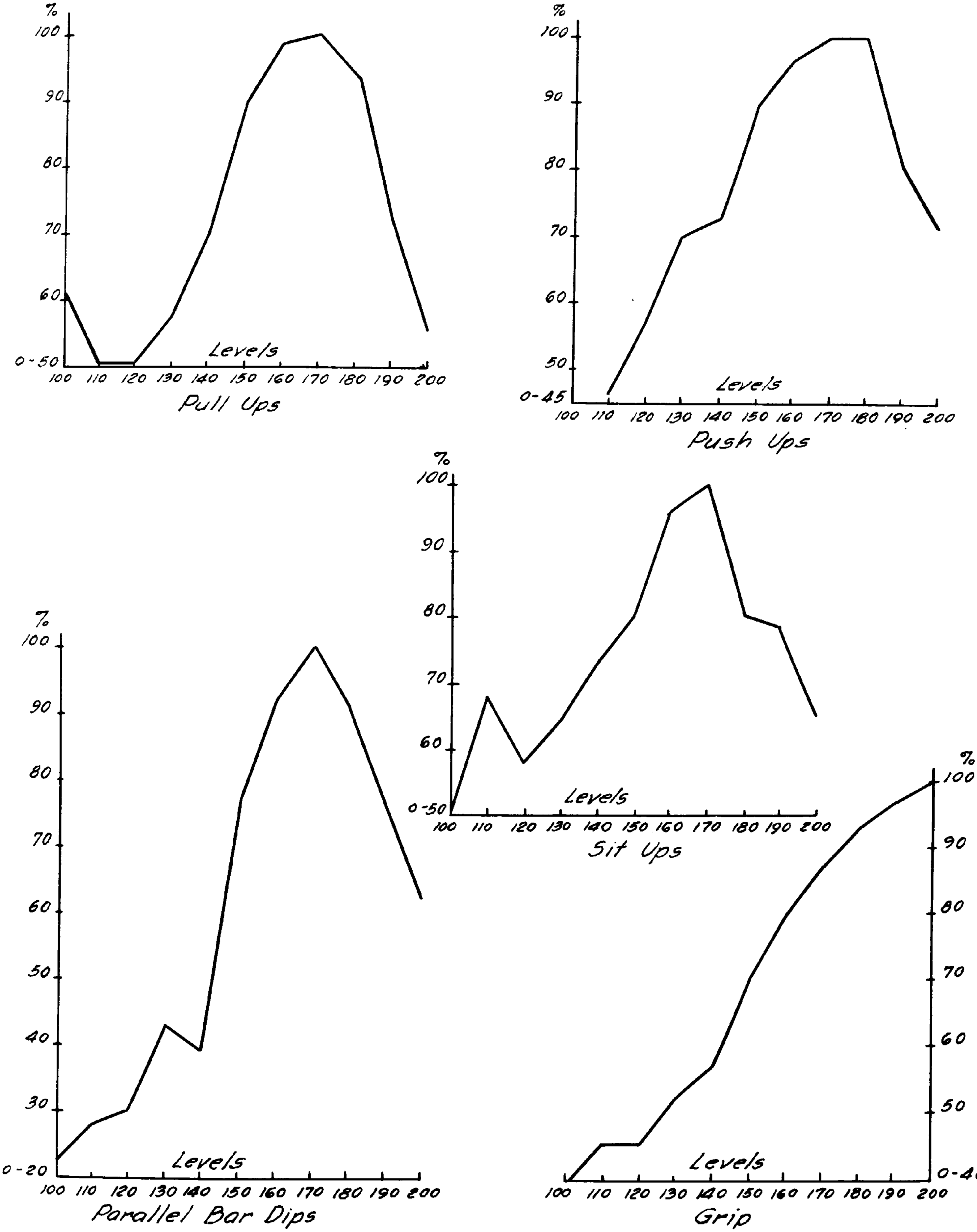

Fig. 43 Percentages of Peak Performance by Levels.

curve. Small differences cause exaggeration that might in all probability be more apparent than real. Method (b), that is, computing performance relative to the mean value along a channel or across a level line is not objectionable from the standpoint of accuracy or stability; but values greater than the mean would turn out as greater than "100 per cent" performance. Although results described as 150 per cent, etc. are quite readily understood, in economics, for example, there is some objection to speaking about "150 per cent performance," if that can be avoided. Method (c), which refers to "peak" performance seems to have the advantage in that all results are 100 per cent or less. In the present instance a definite maximum value has been shown to exist in all but one example, namely, the channel curve for grip strength.

Results of Relative Performance

Level Patterns. - When considered according to level, percentage of peak performance falls into about five distinguishable groups depending on the amount of change reckoned from "low" to "high." This is shown in Figures 42 and 43 and may be tabulated as follows:

Percentage of Peak Performance - Difference between "low" and "high."	Tests
Between 0 and 10	Burpee 10 Second Dodging Run 440 Yard Run
Between 10 and 20	Burpee 60 Second Squat Jump Standing Broad Jump
Between 20 and 30	-----------------
Between 30 and 40	Sargent Jump
Between 40 and 50	Pull-ups Sit-ups
Greater than 50	Push-ups Grip Parallel Bar Dips

From these results it is evident that the five tests in Figure 43, namely, Pull-ups, Sit-ups, Push-ups, Grip, and Parallel Bar Dips are much more affected by increasing level than the six tests illustrated in the upper part of Figure 42, that is, than the Burpee 10 Second, Dodging Run, 440 Yard Run, Burpee 60 Second, Standing Broad Jump, and Squat Jumps. The Sargent Jump takes a middle position as regards percentage of peak performance, in all these events. Compared with each other the tests show considerable difference that can be attributed to body size. The rank order of percentage point difference between low and high becomes:

TABLE 6

RANK ORDER WITH RESPECT TO LEVEL

	Test	Point Difference between "low" and "high"
1.	Burpee 10 Sec.	3
2.	440 Yard Run	4
3.	Dodging Run	7
4.	Burpee 60 Sec.	14
5.	Squat Jumps	14
6.	Standing Broad Jump	19
7.	Sargent Jump	33
8.	Pull-ups	50
9.	Sit-ups	50
10.	Push-ups	54
11.	Grip	60
12.	Parallel Bar Dips	78

The Parallel Bar Dips are, therefore, about 25 times more susceptible to differences in level than the Burpee 10 Second test; whereas the Sargent Jump is eleven times more sensitive to level than the Burpee 10, with corresponding values for the remaining tests.

Physique Patterns. - A quite similar inter-test set of relationships is seen in Figures 44 and 45 which show the percentage of peak performance across level 170. Again there are similar groups:

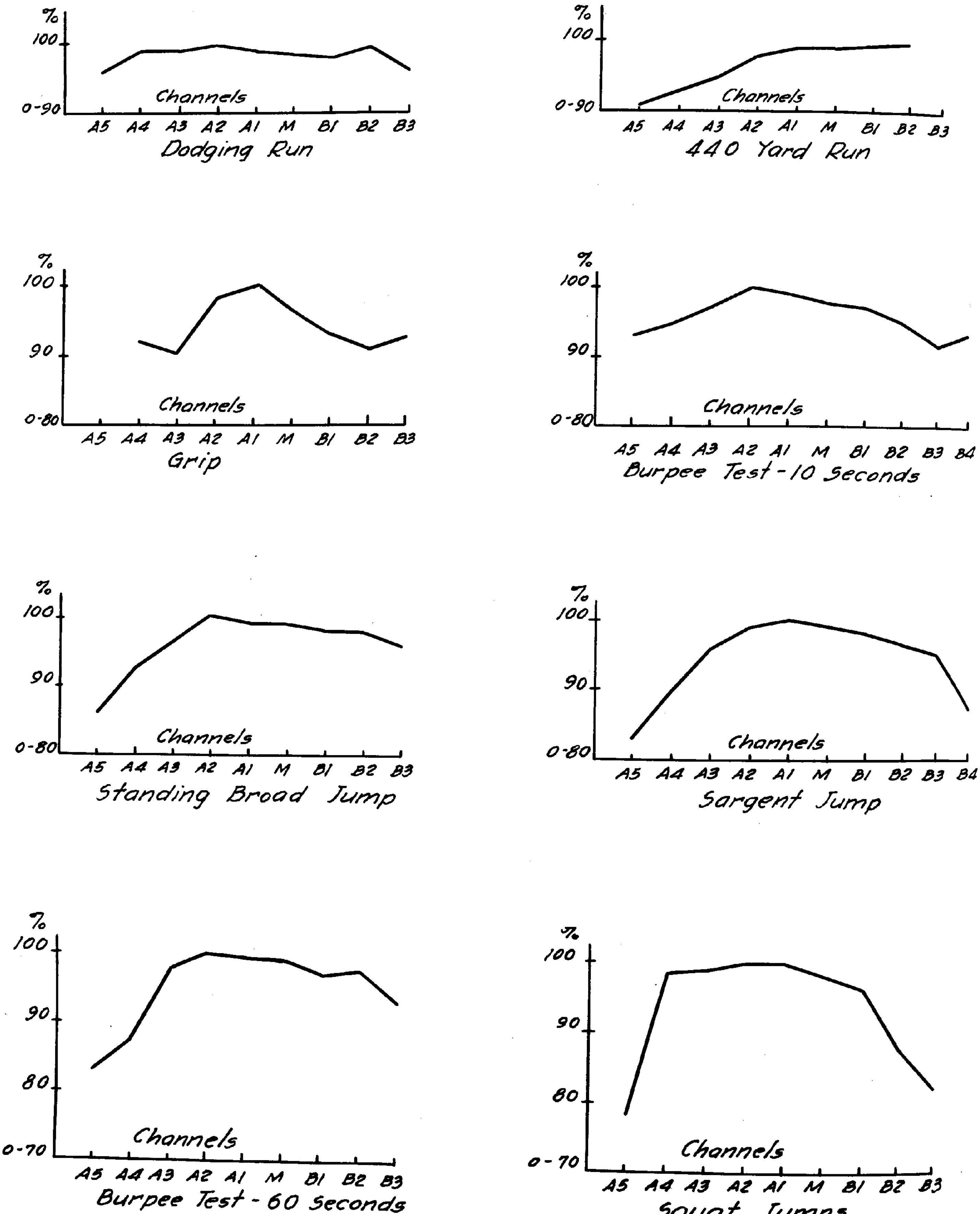

Fig. 44 Percentages of Peak Performance by Channels.

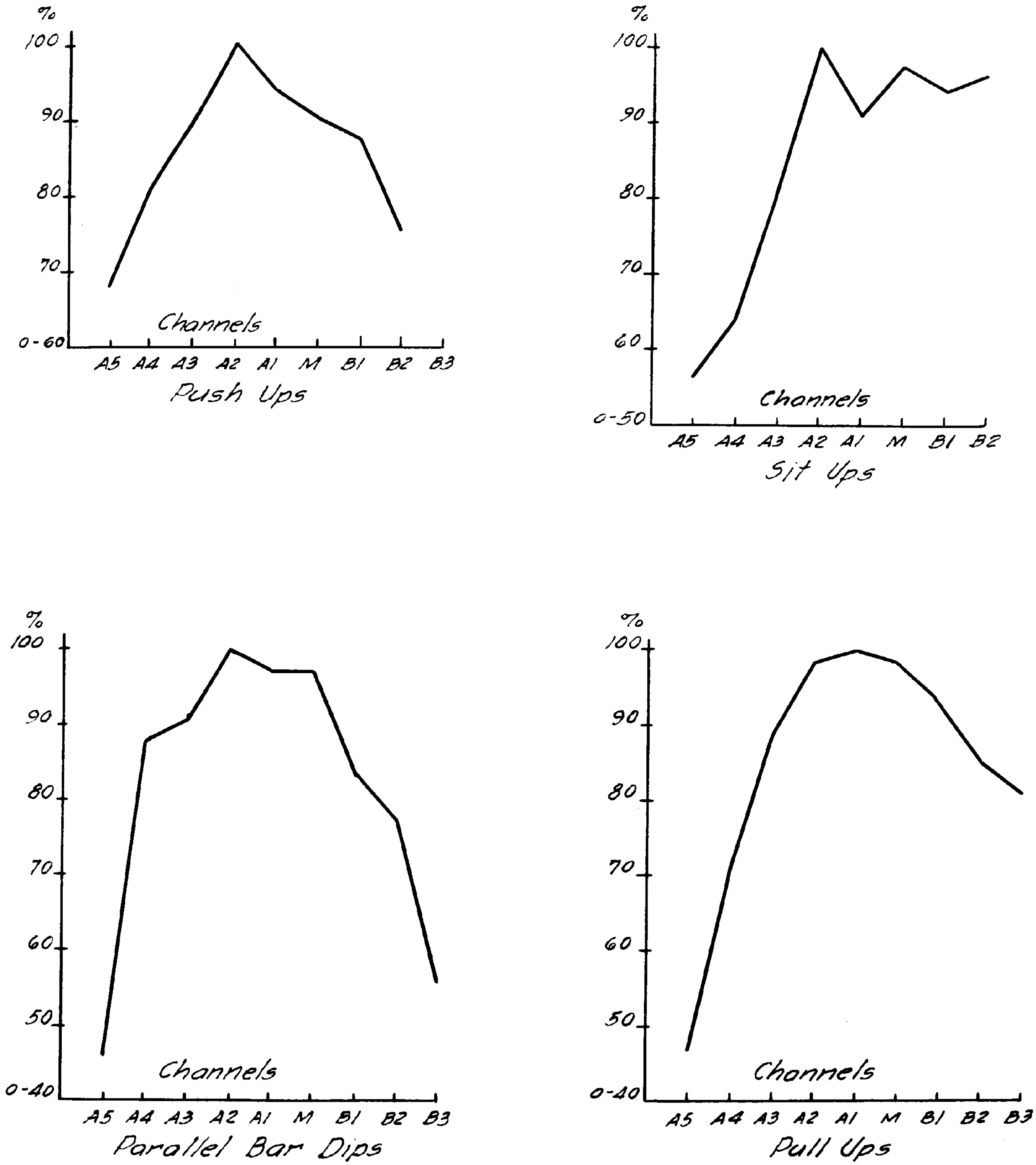

Fig. 45 Percentages of Peak Performance by Channels.

Percentage of Peak Performance - Difference between "low" and "high"	Tests
Between 0 and 10	Dodging Run Burpee 10 Second 440 Yard Run Grip
Between 10 and 20	Standing Broad Jump Burpee 60 Second Sargent Jump
Between 20 and 30	Squat Jumps
Between 30 and 40	Push-ups
Between 40 and 50	Sit-ups
Greater than 50	Parallel Bar Dips Pull-ups

The most noticeable change in position is that taken by the Grip test which is among those showing the least percentage point difference as regards physique although it is among the highest, as regards level. Rank order becomes as in Table 7, and this table permits comparisons between tests as regards physique just as Table 6 does for the level effects among different tests of the same battery. Direct comparison, however, between Tables 6 and 7 is not justified without further considerations. In other words change of rank between Tables 6 and 7 cannot be evaluated until physique and level are properly adjusted. This is described in the next section. However, the physique results shown in Table 7

TABLE 7

RANK ORDER WITH RESPECT TO PHYSIQUE

	Test	Point Difference
1.	Dodging Run	4
2.	Burpee 10 Sec.	8
3.	440 Yard Run	9
4.	Grip	10
5.	Standing Broad Jump	13
6.	Burpee 60 Sec.	17
7.	Sargent Jump	18
8.	Squat Jumps	22
9.	Push-ups	32
10.	Sit-ups	44
11.	Parallel Bar Dips	54
12.	Pull-ups	54

do seem to follow approximately the pattern established for level, although the amount of change between the low and high values is somewhat less.

Adjustment for Physique-Level Relations. - Although the corresponding curves in Figures 42 to 54 appear to be similar, it is necessary to consider the fact that the level changes in Figures 42 and 43 were observed over a span of about 100 levels; whereas the physique changes in Figures 44 and 45 correspond to a span approximately equal to that of the channel system itself. Suitable corrections must, therefore, be made before attempting to compare the physique and level results directly with each other.

As a first step, it may be noted that the point change between "low" and "peak" level values takes place over a level range that is somewhat less than the total range observed. The actual distances are shown in the second column of Table 8. Similarly, the low to high change due to physique was cumulated within a smaller channel range than that of the entire system's cross-section, as indicated for each test in column 2 of Table 9.

Thus far simple percentage point-differences between peak and low values have been used to represent the extent of inter-test relationships. It was felt that a more exact and more indicative method would be to estimate the average percentage change between actual low and peak values and then to convert them to a common 100 level basis. This was done by employing the raw scores in Figures 18 to 40 and computing the percentage difference with respect to the mean between low and high raw score values. The results in Table 8 were obtained in this way.

The values in the final column of the following table thus represant the extent of change in each test as referred to a 100 level basis. They are, accordingly, an estimate of the amount of change which characterizes low-to-high performance <u>over an equal level range</u>.

TABLE 8

RELATIVE PERFORMANCE BY LEVEL (SIZE)

Test	Percentage Change Observed	Level Range of Change	Corresponding Percent Change for 100 Levels
Burpee 10 Second	4.7	30	16
Burpee 60 Second	15.1	50	30
Dodging Run	6.8	40	17
440 Yard Run	3.4	20	22
Hand Grip	82.0	70	118
Parallel Bar Dip	116.0	50	218
Pull-ups	69.0	45	154
Push-ups	52.0	40	130
Sargent Jump	40.6	75	54
Sit-ups	68.5	70	98
Squat Jumps	18.6	40	47
Standing Broad Jump	25.1	50	50

When divided by 100 they represent the percentage change per level due to increase in body size in each of the tests.

A similar conversion to the uniform 100 level basis is shown for the physique effects in Table 9.

The procedure here is essentially the same; and conversion from channels to level-equivalents is made in accordance with the fact that the channel system itself is equivalent to 14.48 levels, with individual channels ranging from 1.7 to 2.3 levels. The conversion to a 100 level basis may then be made directly from knowledge of the span involved in the low to peak rise.

The results in the last columns of Table 8 and 9 may now be compared with each other because allowance has

TABLE 9

RELATIVE PERFORMANCE BY CHANNEL (PHYSIQUE)

Test	Percentage Change Observed	Channel Range	Equivalent Level Range	Corresponding Percentage Change per 100 Levels
Burpee 10 Sec.	6.1	$A_5 - A_1$	7	87
Burpee 60 Sec.	18.1	$A_5 - A_2$	6	300
Dodging Run	4.2	$A_5 - A_2$	6	70
440 Yard Run	5.4	$A_5 - A_2$	6	90
Hand Grip	13.1	$A_5 - A_1$	7	187
Parallel Bar Dip	73.0	$A_5 - A_2$	6	1220
Pull-ups	72.0	$A_5 - A_1$	7	1030
Push-ups	37.5	$A_5 - A_2$	6	625
Sargent Jump	17.7	$A_5 - A_1$	7	253
Sit-ups	55.5	$A_5 - A_2$	6	930
Squat Jump	24.4	$A_5 - A_1$	7	348
Standing Broad Jump	14.6	$A_5 - A_2$	6	243

been made for (a) differences in range of level or channel in which the "low to high" percentage change of performance had taken place, and for (b) the relation between physique and level distances. Uncorrected channel-level comparisons would, otherwise, have masked the predominant importance of physique. An approximate estimate of this comparatively large influence of physique is furnished by the performance ratios in Table 10 which lists the results of Tables 8 and 9 in adjacent columns, and the physique-level ratio results in the last column.

It can be seen that performance is changed in every one of the tests, somewhat more by differences of physique than by equivalent differences in size. This effect is least in the Hand Grip and greatest in the Sit-ups and

TABLE 10

COMPARATIVE EXTEND TO WHICH LEVEL AND PHYSIQUE AFFECT PERFORMANCE: (BY RANK ORDER OF RATIOS)

Test	Level Effect	Physique Effect	P/L ratios
Burpee 60 Sec.	30 %	300 %	10.0
Sit-ups	98	930	9.5
Pull-ups	154	1030	6.8
Parallel Bar Dips	218	1220	5.6
Squat Jumps	47	348	7.4
Push-ups	130	625	4.8
Sargent Jump	54	253	4.7
440 Yard Run	22	90	4.1
Standing Broad Jump	50	253	4.9
Dodging Run	17	70	4.1
Burpee 10 Sec.	16	87	5.4
Hand Grip	118	187	1.6

Burpee 60 Second tests. In most of the tests, physique differences seems to be about 4 to 6 times more effective in determining changes in performance than corresponding differences in body size. Consequently, physique predominates over body size so that performance is more sensitive to a change from one physique to another than it is to a change from one level of body size to a correspondingly greater or smaller size.

The physique-level performance ratios in the final column of Table 10 should not be interpreted to mean that physique is the only important factor to be considered. The effect of body size is not negligible, even though these ratios show that physique is the predominating factor. We should, therefore, interpret these results as follows: Performance at a given level and channel position may be expected to improve or to diminish more by a change in physique than by an equivalent change in body size.

The significance of the physique-level performance ratios can also be illustrated as follows: Suppose that an instructor wishes to choose members of a competitive "pull-ups" squad of four from the following available subjects:

A_2 - 170	M - 165
A_2 - 160	B_1 - 175
B_1 - 185	A_2 - 180
A_3 - 170	M - 155

with the intention of getting the best expected performers. Reference to Figures 43 and 45 shows that he should give preference (as a rule) to:

	Expected Performance			Expected Performance
A_2 - 170	100 %		B_1 - 175	90 %
M - 165	98		A_2 - 180	89
A_2 - 160	98	instead of to: -	A_3 - 170	86
M - 155	94		B_1 - 185	84

There might always happen to be A_3's at 170 or B_1's at 150 who could exceed the "expected" performance of those favored in the above listing. From this tabulation it is seen that an M who is 15 levels <u>below</u> the most favorable level of 170, could be expected, on the average, to do better than an A_2 (the most favored physique) who is only ten levels removed from 170, or even than a B_1 at that peak level.

The comparative influence of physique is illustrated in another way in Figure 46. Herein the level changes are shown just as they are in the earlier graph of Figure 43, but the physique results of Figure 45 are scaled in a perspective cross-section of level 170. The latter figure really represents the physique-level ratios in Table 10, and especially the comparative trends which seem to be of greater interest and importance than actual values of performance.

This study of performance brings out five results which may be summarized as follows:

(1). - The rise and fall of the performance curves between extreme physiques takes place within the equivalent of about 14-17 level lines, whereas the rise and fall due to body size is stretched out over a level range that is always about 6-7 times longer than the width of the channel system.

(2). - The tests which show the least effect of level are the same as those which show the least effect due to physique, namely, the <u>Burpee 10 Sec.</u>, <u>Dodging Run</u>,

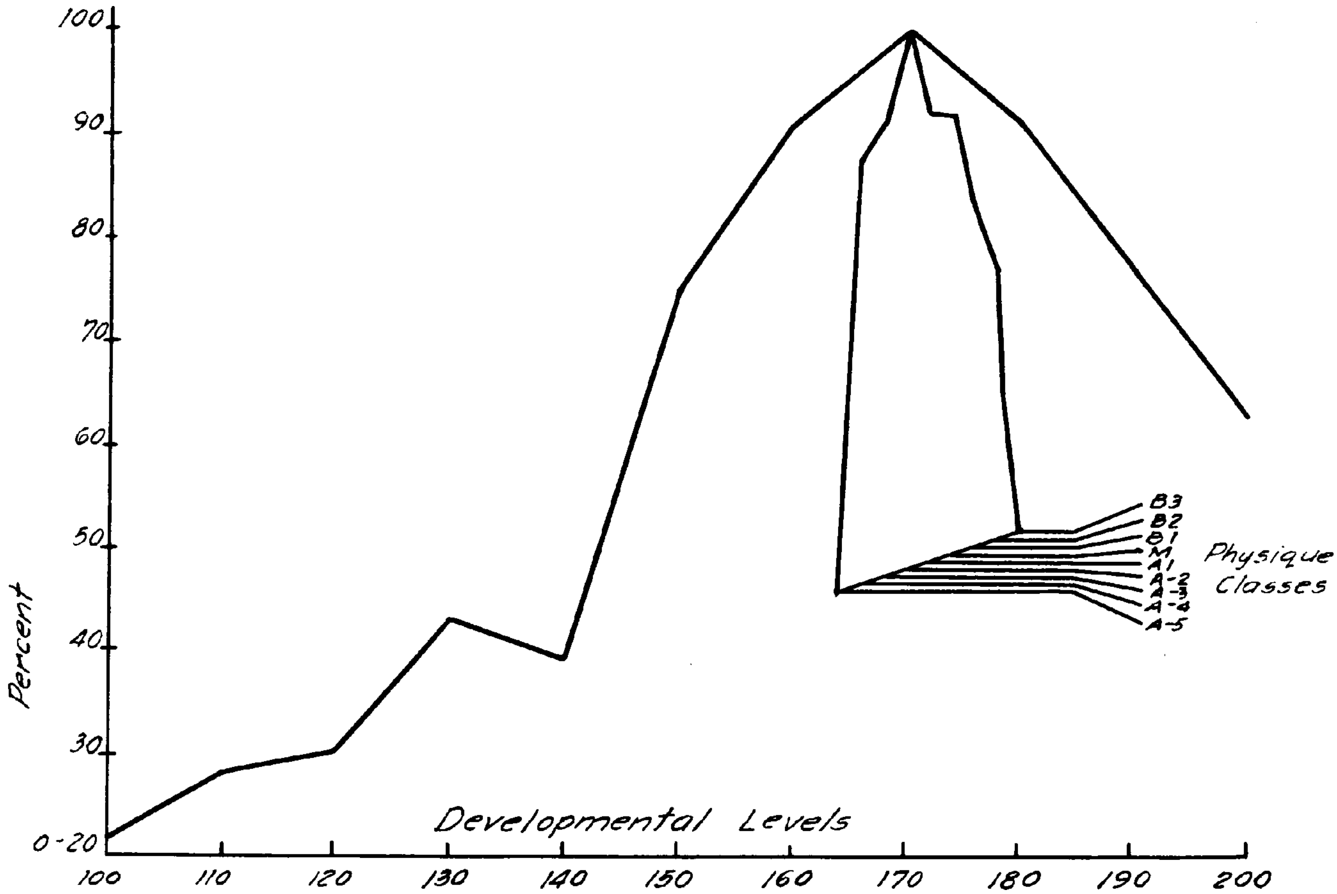

Fig. 46. Comparative Influence of Physique and Level in the Parallel Bar Dips.

and the 440 Yd. Run:

(3). - The tests which reflect the greatest changes in regard to level or physique are also the same, namely, Pull-ups and Parallel Bar Dips:

(4). - The greatest changes associated with level are about 12-13 times as large as the least changes; whereas the greatest physique effects are about 17-18 times greater than the least physique changes:

(5). - The comparative effect of physique is consistently greater than that of level in all the tests, and it ranges from 1.6 times in the Hand Grip to 10 times the level effect in the Burpee 60 Sec. test:

In addition to these five results, the study has confirmed the more general findings described under each test at the beginning of this chapter: namely, the very consistent appearance of maxima in both level and physique curves; and the fact that body size and build do have an important bearing on performance in each of the separate tests of the present battery.

A few additional relationships of interest appear when the test-battery is studied in terms of different kinds of motor performance.

Comparative Level and Physique Influence on Performance in Tests of Strength, Power, Endurance, and Agility

Physical educators often refer to different kinds of motor performance as efforts involving primarily skill, or strength, or again endurance. This has a natural appeal and considerable didactic value in helping to distinguish the significance or purposes of physical tests. With the exception of certain obvious cases, there is some difference of opinion among workers as to what the main features of tests are. All of the tests in this study involve muscle strength and physical force to some extent. It would seem reasonably clear that this is more true of some than of others. Although one might not be able to obtain complete agreement as to which single quality seems to typify each of the twelve tests, the following classification is sufficiently broad, and yet it is also sufficiently specific to employ for the present.

The twelve tests fall into four broad categories described as Strength, Power, Endurance, and Agility. Those in (I) are quite regional in their call for effort and do not involve leg strength. The power tests (Sargent Jump and Standing Broad Jump), are generally considered as tests

TABLE 11

CLASSIFICATION OF THE TEST-BATTERY ACCORDING TO THE MAIN ITEM OF A TEST

	Type Item	Tests	Remarks
I	Strength (Regional	Hand Grip Pull-ups Parallel Bar Push-ups Sit-ups	Hand-arm Hand-arm-body Abdominal-body
II	Power (Momentary) Effort	Sargent Jump Standing Broad Jump	Leg-body
III	Endurance (Prolonged) Effort	Squat Jump 440 Yard Run Burpee 60 Sec.	Leg-body
IV	Agility	Dodging Run Burpee 10 Sec.	Leg-body

of "explosive-power," with sudden leg-body movements that involve only momentary effort.

The Squat Jumps are among the most fatiguing tests and are associated with endurance. This trait also seems to typify the 440 Yard Run as well as the Burpee 60 Second test. In Class IV are the tests which depend on quickness of recovery from some displaced position and on this account demand agility.

The writer has frequently used the scheme in Table 11 in didactic work but has not, heretofore, placed any special emphasis on the particular order of the events in each group. However, when the results in Tables 8 and 9 are placed in rank order with respect to level change, it is striking that the classification just described is preserved as regards the separate main groups I to IV. This is seen in Table 12:

TABLE 12

SHOWING RANK ORDER OF RELATIVE PERFORMANCE BY GRID LEVEL WITHIN A STRENGTH, POWER, ENDURANCE, AGILITY CLASSIFICATION

Test-Type				Rank Order of Relative Performance By Body Size	Rank Order of Relative Performance By Physique
I	STRENGTH	Arm:	Parallel Bar Dips	12	12
			Pull-ups	11	11
			Push-ups	10	9
		Hand:	Grip	9	4
		Abdomen:	Sit-ups	8	10
II	POWER (Momentary Effort)		Sargent Jump	7	6
			Standing Broad Jump	6	5
III	ENDURANCE (Sustained Effort)		Squat Jumps	5	8
			Burpee 60 Second	4	7
			440 Yard Run	3	3
IV	AGILITY		Dodging Run	2	1
			Burpee 10 Second	1	2

In this table the tests which show the greatest influence of size and physique, as measured by Grid levels and channels, are assigned the highest; and those tests showing the least, are assigned the lowest values. Rank order is represented in terms of least to greatest effects, and from the bottom upwards.

It is interesting to note that the somewhat arbitrary grouping of the twelve individual tests into strength, power, endurance, and agility classes is supported by objective measurements representing the order of influence of body size and physique on motor performance. This is especially true in the case of body size.

The influence of level and physique is least in the agility tests and greatest in the arm strength events. Unfortunately, no tests of leg strength comparable to those used for the arm, were included in this battery. From the results in Table 12, however, one might expect to find such tests to give about the same results as the arm tests.

While the serial order of increasing influence due to body size is perhaps the most striking result contained in Table 12, it is also worth-while to compare the low and high tests with those in the center. The distinction between the central power and endurance tests (II and III) is primarily one of momentary as contrasted with sustained effort. But if the power-endurance tests, which take a middle position as regards both level and physique, be compared with the strength and agility tests above and below, respectively, some further relationships are brought out.

Strength and agility are contrasting characteristics; and it is, therefore, interesting that tests of different types, such as these, should fall on either side of the power-endurance group when compared on the basis of the extent to which they are influenced by body size or physique.

An interesting result is the placement of the Sargent Jump. This test has often been considered as a measure of "all around" athletic ability, and its present central position between events that are least and most affected by body size and physique would clearly seem to confirm its claim as an "all around" test. Since it falls into 7th and 6th places with respect to level and physique, and about in the center of the whole set, the Sargent Jump seems to represent a "happy-medium" between sheer strength and motor skill. In this position it also is not too greatly dependent upon, or independent of, body size and physique.

Another test that draws particular attention in Table 12 is the Hand Grip. This is near the top of the group as regards the influence of body size but it is among the lowest in its response to physique. Nevertheless, the comparative effect of physique, though low when ranked among the other tests of the battery, is also great enough to exceed the level influence by a factor of 1.6 as shown by the P/L ratio in Table 10. With this single exception, the remainder of the battery is very consistent in the rank order by which body size or physique influence motor performance. Expressed in the form of the rank order co-efficient of correlation, ρ , the values of Table 12 gave:

$$\rho = 0.81 \pm 0.07$$

and the corresponding r is 0.82. Half of the total variance is contributed by the rank order difference in the Hand Grip. A likely explanation is that this test, as compared with all the rest, involves less muscular participation, and is the most highly localized. An even more extreme example of this type would be a finger strength test. The results on the grip in Table 12 would also suggest that differences in physique are not reflected in the hand itself to the extent that they are reflected by larger portions of the body, or to the extent that the hand represents differences in body size.

Table 12 summarizes as simply as possible the general findings of this study which concern the relations between body size, physique, and motor performance in tests that call for different kinds of ability.

The tables and graphs preceding had indicated from a study of trends that all of the twelve tests were influenced by differences in body size or physique.

The next section put the results on a uniform basis so as to permit direct comparisons between each of the tests, and showed that body size and physique exert a consistent influence on performance. This influence is characterized by a rise to a maximum and thereafter by a fall with still further change of level or channel.

To represent these effects by a single item, the percentage changes of performance per 100 levels of size or physique were shown in Tables 8 and 9. Finally, the rank order of these results was given in Table 12 in conjunction with a strength-power-endurance and agility grouping of all of the twelve tests.

As summarized in the latter table, the size or physique influence on tests of the same group is practically the same. The chief exception is the Hand Grip.

On the basis of trends, or by a single measure, such as percentage change of performance per 100 levels, body size and physique, measured in terms of Grid levels and channels, exert a definite effect on performance in tests of agility, power, endurance, and strength.

These results are such as to favor certain performers and to handicap others. Competition, for example, between men at levels 170-180 and those removed only 10 levels higher or lower, would be expected to favor the former in practically all events. Within all physique classes of these same groups, the stocky A_2's and A_1's would again be favored in the long run over the even stouter A_3's and A_4's as well as over the more slender M's, B_1's and B_2's.

While these findings on the role of body size and physique are limited to the case of the twelve tests in this study, those tests are representative of many different kinds of motor performance called for in physical exercise and in different types of athletic participation. So far as they do represent the more complicated activities required in team play, they suggest that body size and physique would also show similar influences on athletic performance. An investigation of this problem is described in the next chapter.

CHAPTER VI

A SURVEY OF BODY SIZE AND PHYSIQUE AS REPRESENTED BY GRID RATINGS OF ATHLETES IN DIFFERENT SPORTS

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A SURVEY OF BODY SIZE AND PHYSIQUE AS REPRESENTED BY GRID RATINGS OF ATHLETES IN DIFFERENT SPORTS

In view of widespread interest in athletics, and conflicting opinions about the association of body structure with success in certain forms of competition, it seemed worthwhile to supplement the study on test performance with a survey of Grid ratings of a large number of college and high school athletes. A knowledge of body build and size relationships with specific athletic abilities would thus contribute further light on the general problem of motor performance, and also serve the useful purpose of the appraisal of special aptitudes thus facilitating the guidance of pupils into athletic and physical education activities.

From the standpoint of differentiating the physical characteristics of athletes, Grid ratings on participants in American sports would correspond to Kohlrausch's studies in Olympic contestants. For these reasons, such a collateral investigation seemed to be a natural extension of the fitness study reported in the preceding chapters.

Nature of the Study

Questionnaires were sent to 359 colleges and 250 high school departments of physical education, requesting information on the age, height and weight of their athletes in various sports and events. A list of individual schools and colleges which responded is given in Appendix F. In all, 238 questionnaires were returned. These furnished the data on 4810 college and high school athletes included in the source list presented in Table 13. In addition, Grid ratings on 866 professional baseball and 83 professional hockey players were obtained from published rosters and through direct communication with team managers. The total number of observations, therefore, amounted to 5759, distributed among the 11 athletic activities shown in Table 13. About half of the information applies to college men, and slightly less than half to football players.

Results of the Survey

Channel and level ratings will be described first for athletes participating in team sports, and later for those in individual track, field or other events. In each group, college and high school data are treated separately. The complete findings are given in Tables 59 to 98 of the Appendix, and are summarized in the text by means of histograms, or by an occasional table.

TABLE 13

NUMBER OF GRID RATINGS ON ATHLETES IN 11 DIFFERENT SPORTS

	College	Professional	High School
Football	2198	----	719
Basketball	371	----	129
Baseball	---	866	211
Hockey	24	83	---
Varsity Crew	31	----	---
Track & Field	147	----	239
Swimming	121	----	387
Tennis	14	----	---
Wrestling	73	----	85
Fencing	20	----	---
Boxing	41	----	---
	3040	949	1770

Total Number of High School and College Players	4810
Total Number of Professional Athletes	949

Football

College. - In Figure 47 are shown the distribution histograms for each of the team positions, as well as that for all positions. These drawings are based on the number of case records given in Table 14. This table also contains the mean channel and level values.

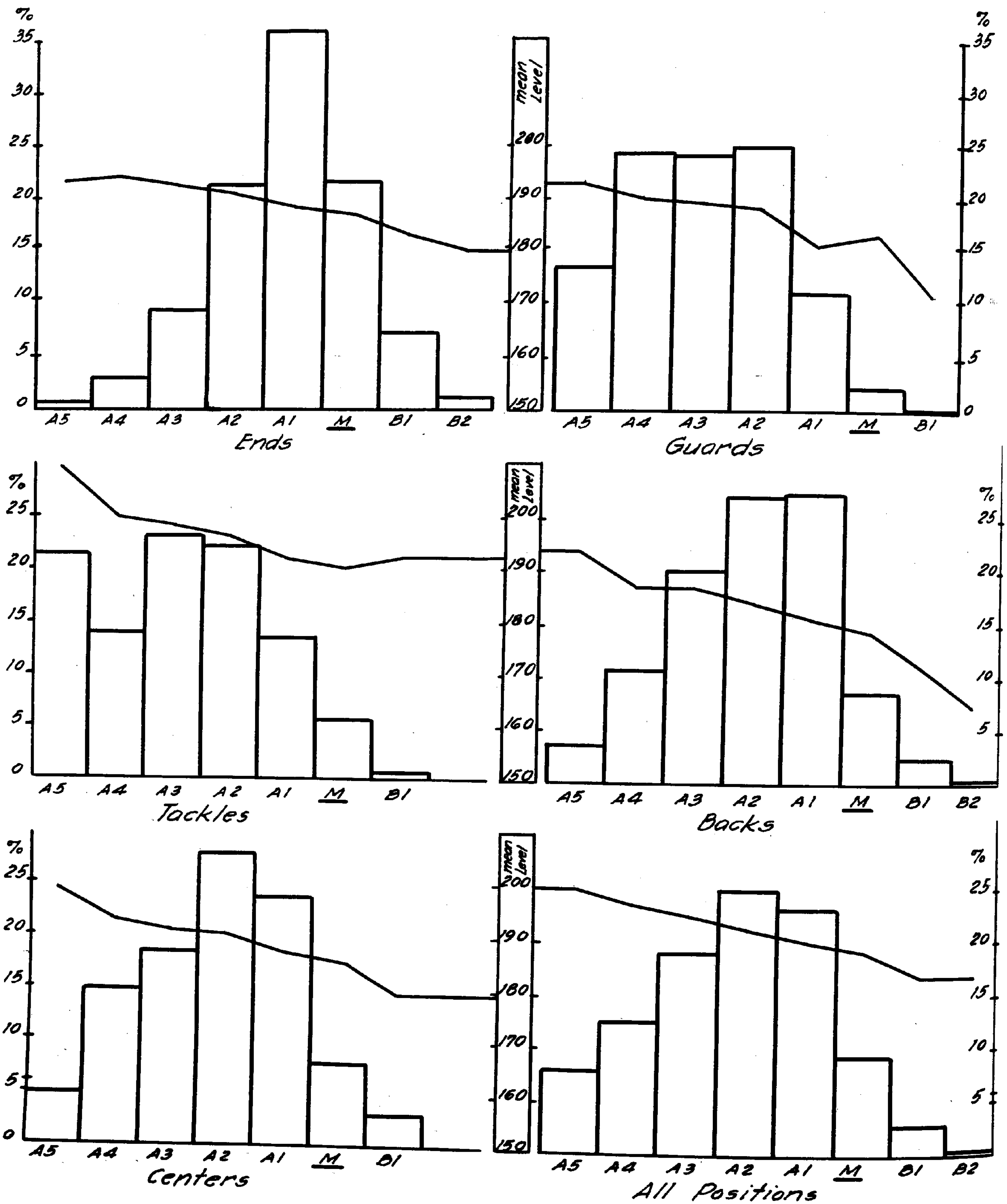


Fig. 47 The Percent Distribution of Body Types of College Football Players of Each Position. (2198 Cases)

TABLE 14

SIZE AND PHYSIQUE RATINGS IN COLLEGE FOOTBALL

Position	No. of Cases	Mean Channel and Level
Ends	423	A_1 - 188
Guards	405	A_3 - 188
Tackles	359	A_3A_2 - 196
Backs	820	A_2 - 183
Centers	191	A_2 - 190
All	2198	A_2 - 189

While it is evident from Figure 47 that college football players range from A_{5+} to B_2, the significant preference for those in A_2 and A_3 is likewise obvious. The shift toward the stocky A types is best seen if one first locates the position of channel M.

The histograms for the ends, backs, and centers are the most symmetrical; those for the guards and tackles are skewed to the left, toward the heavier and more stocky builds. If M's play college football at all they are almost certain to be ends, and large enough to have reached level 185 except for a few slightly smaller M's at level 180 who are backs.

As Figure 47 also shows, body size measured in levels varies with team position as well as with physique. In the latter respect, players of the heaviest physiques A_5 - A_4 are at higher Grid levels than those in the middle and slender channels. Physique alone, accordingly, does not determine team position even within the comparatively small average range of 20-30 levels. These facts will be more closely analyzed subsequently. It is sufficient at this point to note that in football definite preference for certain physiques and levels are revealed in this survey.

Since the returns had made available information on a group of 2198 players, it appeared worth-while to analyze the general results just mentioned in greater detail. Among other things, further analysis might indicate even more directly the extent to which team position had been influenced by physique and size. As a first step, the data were rearranged in the form shown by Table 15:

TABLE 15

PERCENTAGE DISTRIBUTION OF FOOTBALL PLAYERS

	A_5A_4	A_3A_2	A_1	M	B_1B_2
Guards	37.8	48.7	11.1	2.2	0.2
Tackles	35.3	45.1	13.4	5.6	0.6
Centers	19.4	46.1	23.6	7.8	3.1
Backs	14.1	47.1	27.2	8.6	3.0
Ends	3.4	30.7	35.8	21.6	8.5

The preponderance among the stocky groups is clearly evident. These groups (A_5A_4) and (A_3A_2), as shown, are combined in part for convenience, and because that is the usual procedure in dealing with Grid ratings.

Although the distribution in Table 15 seems to indicate an obvious association between physique and team position, the real strength of that association can be more properly determined by means of the Chi-Square Test[1] on actual numbers, as presented in Table 16, rather than on the percentages in Table 15.

TABLE 16

NUMBER OF FOOTBALL PLAYERS IN DIFFERENT CHANNEL GROUPS

	A_5A_4	A_3A_2	A_1	M	B_1B_2	Total Observed		Total Expected
Guards	153	197	45	9	1	405	2/11 =	400
Tackles	127	162	48	20	2	359		400
Centers	37	88	45	15	6	191		200
Backs	116	386	223	70	25	820		800
Ends	15	130	151	91	36	423		400
	448	963	512	205	70	2198		2200

On the basis of the fact that guards, tackles and ends each represent 2/11's, centers 1/11, and backs 4/11's of a team, the distribution observed is practically identical with that expected in actual team make-up. As shown in the bottom row of Table 16, 963 or 44 per cent of the 2198 players were in channels A_3 and A_2. Certain interesting findings are

[1]For an explanation of the Chi-Square Test see Henry E. Garrett, Statistics in Psychology and Education, (2d ed., New York: Longmans, Green and Co., 1944), 377-387.

apparent, especially at the fringes. For example, out of more than 2000 players only one B_1B_2 played guard, the preference of the slender types being clearly that of end positions. Conversely, only 15 A_5A_4's played end. One should especially note that 223 or almost half of the A_1's were backs. This would seem to indicate a strong preference of this physique for backfield positions. Yet analysis by the Chi-Square test shows that A_1's are even more strongly attracted into the end positions. This is clearly evident from Table 17 which gives the Chi-Square values of each cell.

TABLE 17

THE CHI-SQUARE VALUES FOR TABLE 16

	A_5A_4	A_3A_2	A_1	M	B_1B_2	Totals	
Guards	+ 61.0	2.0	- 25.1	- 19.2	- 11.0	118.2	
Tackles	+ 39.8	0.1	- 15.4	- 5.1	- 7.4	67.8	
Centers	+ 0.1	0.2	0.02	0.5	0.0	0.8	
Backs	- 15.5	1.9	- 5.4	0.5	0.04	23.3	
Ends	- 58.5	- 16.9	+ 27.2	+ 69.0	+ 40.6	212.2	
Totals	174.9	21.1	73.0	94.0	59.0	422.3	39.25

$P < .001, n = 16$

The (+) and (-) signs in Table 17 preceding each Chi-Square value indicate that the deviation from expectancy is respectively plus or minus. For example, guards in A_5A_4 exceeded the number expected if physique and position had no association other than chance. On the other hand, the negative sign before the 25.1 for A_1 guards indicates that fewer men were found in this group than would be expected in the absence of any physique-position association.

The value, $\chi^2 = 422.3$ very considerably exceeds 39.25 (n = 16) for which $P < .001$. As a result, team positions in football depend very definitely on physique as measured by Grid channels. In fact, the probability that the distribution of Tables 16 and 17 could occur simply by chance is even less than 1 in 10,000.

The individual cell values of χ^2 are interesting especially when the values greater than 2 are considered as attractive (+) or as repellent (-) to team position. Taking first the enclosed cell values less than 2, which indicate that expected and observed numbers were practically identical, it is particularly noteworthy that the distribution of centers among all physiques is wholly proportional to their team representation, that is, 1 in 11. In other words, regardless of how many players in M, A_1 or in other physiques are available, one out of 11 will be a center. This position, therefore, appears to be the most indifferent to physique. Considering next the A_3A_2 players, all but ends show "normal expectancy." The only remaining cases in which physique and position are purely in proportion to team representation are the M and B_1B_2 backs.

The six positive deviations from expected values run from above at the left downwards to the right, and show that as physique changes from the husky A_5A_4 groups to the slender M and B_1B_2 types, team position is changed from guards and tackles to backs and ends. Thus the sample of 2198 players, as given, shows a significant preference of physique for the various team positions.

The same conclusion can be demonstrated even more effectively by comparing the actual distribution with that which would result if one assumed that there is no association between physique and the various team positions. In such a hypothetical case each category would contain its own proportionate share of the total players. The shares would simply be represented by 2/11, 4/11, 1/11 for the various guard, tackle, end, back, and center team positions. Out of 2200 men, there would be 50 guards, tackles, and ends; 100 backs, and only 25 centers in each physique channel, and there would be twice these values for combined channels, such as A_5A_4, etc., on the purely random hypothesis. For such a distribution, the Chi-Square values in each cell work out as shown in Table 17, where the (+) and (-) signs again indicate excess and defect, respectively, of the observed as compared with the random distribution. The value of Chi-Square for the whole table, 1472.9, is, of course, clearly significant and indicates that football players are not distributed at random with regard to physique. Individual cell values indicate that with very few exceptions all positions are either definitely favored or just as

TABLE 18

CHI-SQUARE VALUES ON HYPOTHESIS THAT FOOTBALL TEAM POSITIONS MIGHT BE DISTRIBUTED AT RANDOM

	A_5A_4	A_3A_2	A_1	M	B_1B_2	Totals
Guards	+ 28.1	+ 94.1	- 0.5	- 33.6	- 98.0	254.3
Tackles	+ 7.3	+ 38.4	- 12.5	- 18.0	- 96.0	172.2
Centers	- 3.4	+ 21.8	+ 16.0	- 4.0	- 38.8	84.0
Backs	- 35.3	+173.0	+ 151.3	- 9.0	-153.0	521.6
Ends	- 72.2	+ 90.0	+ 204.0	+ 33.6	- 41.0	440.8
	146.3	417.3	384.3	98.2	426.8	1472.9

definitely excluded by various physiques. By bracketing the values which exceeded random expectancy, one sees clearly, at first, that football as a team sport, and as played, favors the more rugged and stocky physiques, and secondly that team positions are by no means haphazardly selected. The former of these findings is merely consistent with general knowledge; but the latter finding, in regard to the selectivity of team positions, has not heretofore been demonstrated. The factor of physique may, therefore, be taken to represent an important element in deciding the position for which, other things being equal, a given player may be most suited.

While A_3A_2's are therefore typical of all around football players, A_5A_4's are preferentially guards, and A_1's are favored as ends. Closer discrimination of the A_3A_2 group must depend on other factors, for example, on level or body size. Thus, by taking the results of Tables 17 and 18 into account and classifying the several football positions by level as well, it may be seen from Table 19 that team positions are very closely identified with certain preferential levels as well as channels.

TABLE 19

PHYSIQUE AND LEVEL CHARACTERISTICS OF FOOTBALL TEAM POSITIONS, BY CHANNEL AND LEVEL

	A_5A_4	A_3A_2	A_1	M
Tackles	205	197		
Guards	190	190		
Centers		190		
Ends			190	185
Backs		185	180	180

From this table it is now clear that tackles are the largest players of any physique group, and backs the smallest. Players at level 190, (the average for football) will be guards by preference if they are A_5A_4's and ends if they are A_1's. When players at level 190 are A_3A_2's, they are candidates for center, and for guard positions. Finally, the smallest of all, M - 180, is found only among the backs. Such players represent, no doubt, the rare or only occasional diminutive quarterback whose skill and leadership offset his physical disadvantages.

It is, therefore, interesting that an analysis of the data submitted for a large group of representative football teams and players can demonstrate a significant association between team positions, physique, and body size. The findings show clearly that football players as a whole are not uniformly distributed among the various physique channels, and that they tend, in other words, to congregate in certain preferred channels. Such localization, however, may even be further specified by taking level into account. Thus when level and channel are both considered players in various team positions have clearly differentiable physical characteristics.

Grid Ratings on Size and Physique of Star Football Players. - Although the results of the football survey were highly discriminating in regard to body size and physique of the 2198 players whose data have just been analyzed, they apply for the most part to average representative teams, and therefore to about average football performance. To test out the question as to whether the best performance as represented by "star" athletes and players would conform to the general scheme of selective levels and physiques, the contributing football coaches were asked to name their outstanding players. Information on a total of 166 college stars (Appendix F) was thus obtained and analyzed separately, for this purpose, and the results are compared with those previously described for the entire group of 2198 players, in Table 20. Although the data of the "stars" were also part of the larger group, the two sets of results are practically independent (1) because twelve to thirteen times as many observations represented ordinary players, but also (2) because nomination of a "star" was made on performance only and therefore independently of a player's size or physique.

TABLE 20

COMPARISON OF CHANNELS AND LEVELS REPRESENTATIVE OF FOOTBALL TEAM POSITIONS IN SURVEY OF 2198 PLAYERS WITH THOSE OF 166 STAR PLAYERS

Team Position	A_5A_4	A_3A_2	A_1	M
Tackles	205 205 ± 1.7	197 200 ± 1.5		
Guards	190 194 ± 1.2	190 192 ± 1.8		
Centers		190 191 ± 1.2		
Ends			190 189 ± 1.0	
Backs		185 188 ± 1.6	180 184 ± 1.1	180 178 ± 2.5

The mean level values of the stars are given with their standard errors; and, in each instance, these agree to within insignificant differences with the values from the larger survey chosen on the basis of the Chi-Square analysis for the physique distribution. This agreement of values for channel and level is remarkably close.

The results of these two different approaches to the question of whether team position, and therefore differences in required performance depend on physique and level obviously confirm each other. The conclusion seems all the more justified that football performance as represented by different positions is definitely associated with very specific body characteristics. Even among a group that strongly favors those of the rugged and stocky types, and consequently among a comparatively small range of physique and size, the special demands of various team positions are associated with notably different physique and body size patterns. This, of course, does not mean that outstanding performance is impossible for players whose body build and size do not match the values in Table 20, or that those who possess these characteristics are necessarily excellent players. But the results of the large survey and that of the "stars" would certainly suggest that players with those attributes possess at least the physical characteristics best suited to respective team positions.

Finally it may be noted in connection with the results on classification in Chapter III that the Grid ratings from the survey and of the stars furnish significant distinctions between players of different positions which cannot be identified, for example, by the Cozens nine-class grouping usually applied to college men. In fact, the highly differentiated values of Table 20 all fall into Cozens' tall-heavy group. While this would help to identify football players as compared with those in other sports, it does not make the finer distinctions between players of different positions that can very

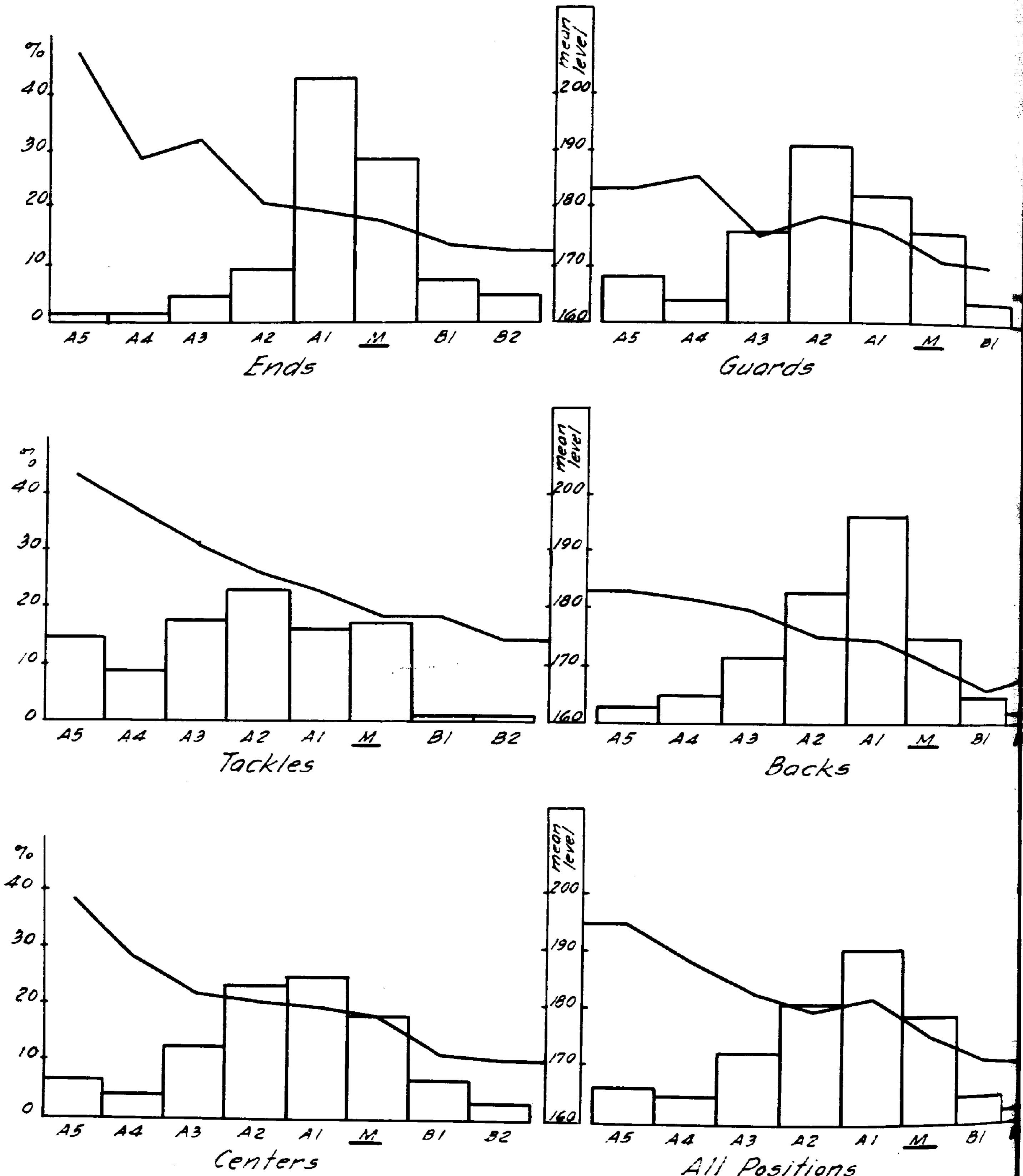


Fig. 48 The Percent Distribution of Body Types of High School Football Players of Each Position. (720 Cases)

readily be obtained from Grid ratings.

Thus, even within the physique-size range of men playing football, the special types of performance connected with team play tend to have highly specific requirements in body structure that can be expressed in terms of physique channels and level lines of body size. The analysis of these data of football players thus furnishes additional examples to show that performers, physique and level are directly related.

High School Football. - In addition to the college data, the survey also included information on high school football players. The results are given in Tables 73 and 74 of Appendix D, and are illustrated in Figure 48.

As is to be expected, these players are of slighter build and smaller size. The ends, like those in the college group are A_1's but the players of other positions are on the whole one channel less stocky than the college men. The quite minor differences in the physique distribution histograms between college and high school players can be explained partly on the basis of comparative numbers involved, partly on differences in physical development, and also by differences in the conduct of football in high school and college. Altogether high school football is less specialized and therefore would tend to admit a broader variety of players. But even in spite of such factors, the physique distribution is quite consistently similar to that for the college players. In brief, the stockier A_4A_5's and A_3A_2's were line players; the A_1's and A_2's were backfield players, while the more slender A_1's and M's were mostly ends.

A greater difference between college and high school players was evident from the level values which are directly compared in Table 21. As this table shows body size was

TABLE 21

MEAN LEVELS OF COLLEGE AND HIGH SCHOOL FOOTBALL PLAYERS

Team Position	College	High School	Difference
Tackles	200	189	11
Guards	189	177	12
Centers	190	180	10
Ends	189	179	10
Backs	184	174	10
All Positions	189	179	10

from 10 to 12 levels smaller among the high school group. This difference would correspond to about 2-3 years additional physical development for college players at the rate of about 3-5 levels per year characteristic of boys nearing their complete development.

The essential findings on high school football players are, therefore, consistent with those which have been analyzed and described in greater detail for college players. In both groups physique and level play a dominant part in determining first whether a subject plays football at all, and second, which team position he shall play. In both groups, performance as represented by different team positions expresses a similar preference for specific physiques and body sizes.

Basketball

The associations between body size, physique, and performance are reinforced by a study of the data furnished on college and high school basketball players. This sport is sufficiently different from football in its requirements so that, if body structure is as important and as selective as it has been shown to be in the case of football, there should be no difficulty in locating equally important and selective preferences in basketball.

In this instance, considerably fewer data were available. They comprise information on 371 college players of 25 teams, and 129 high school players of 13 teams, which has been similarly tabulated in Appendix Tables D,E,F. The chief results are illustrated in Figures 49 and 50.

In spite of much smaller numbers, both the physique distributions by team position and the accompanying curves for mean levels show that basketball is likewise associated with characteristic channel and level values.

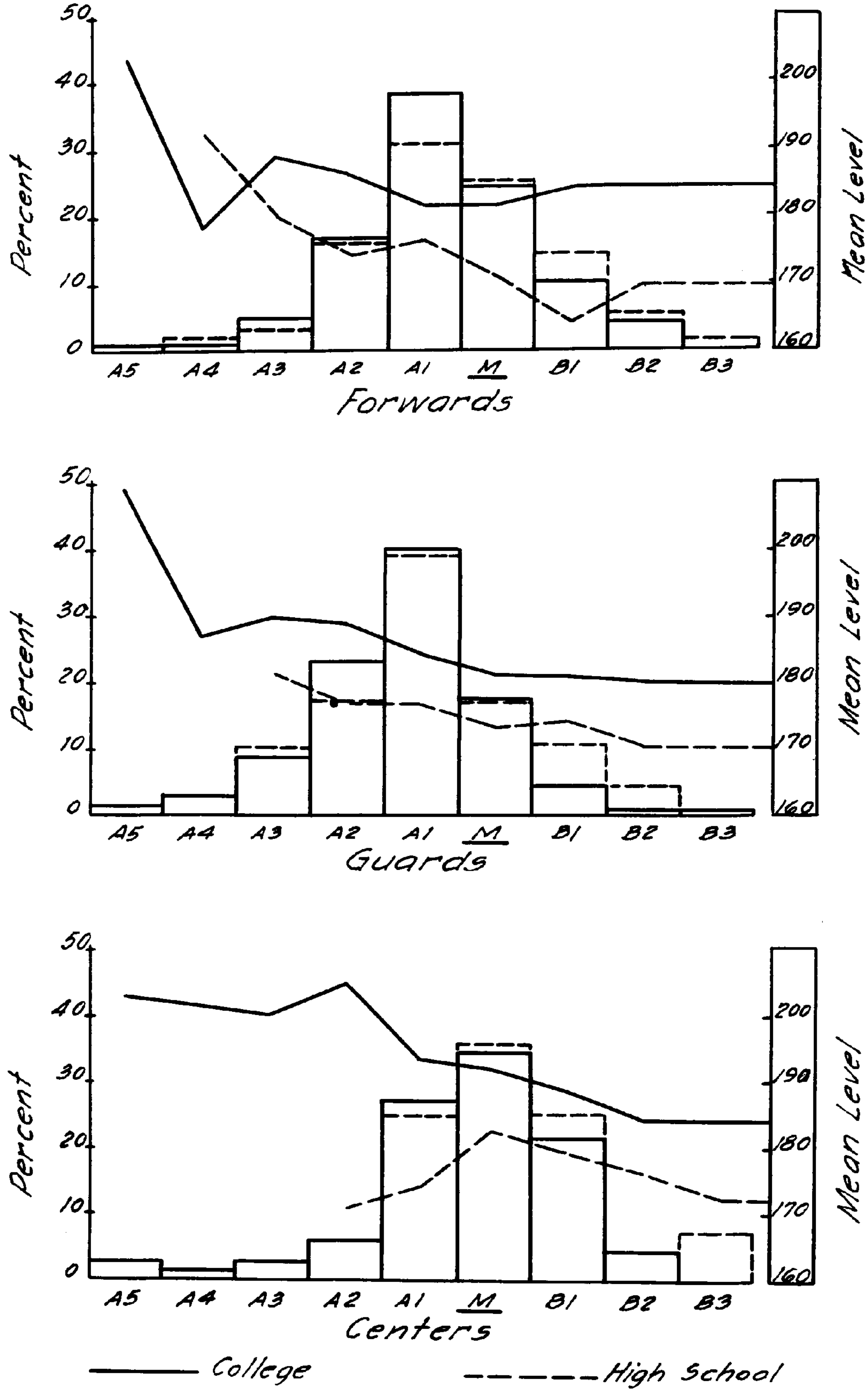


Fig. 49 The Percent Distribution of Body Types of Basketball Players for Each Position. (370 College Players - 145 High School Players.)

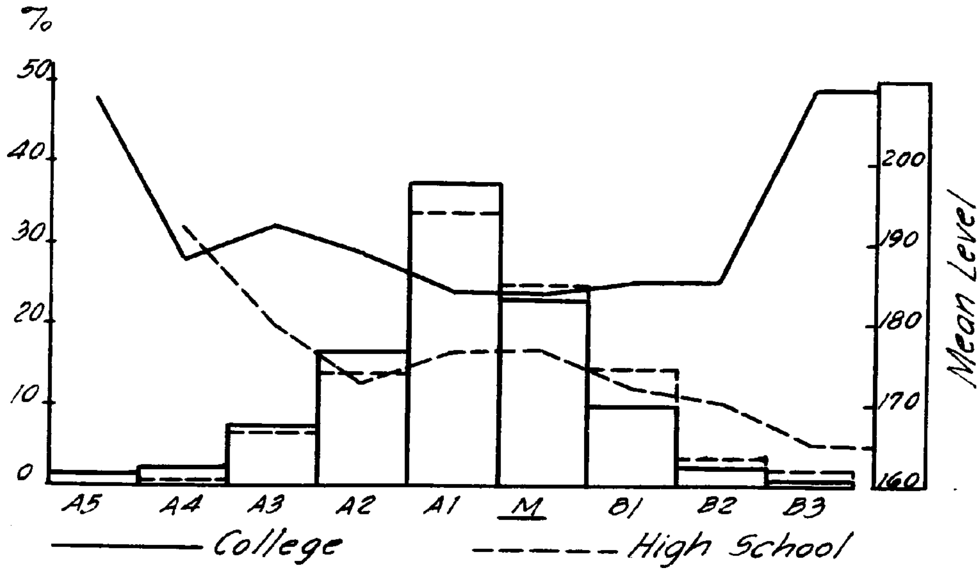


Fig. 50 The Percent Distribution of Body Types of Basketball Players of All Positions. (370 College Players - 145 High School Players.)

Again, physique of the two groups is practically identical, whereas the difference between college and high school players is, once more, about 10 levels of body size.

Forwards and guards in both groups were represented mainly by A_1's and thereafter by the A_2's and M on either side of A_1. The centers, on the other hand, clustered around M, with A_1 and B_1 almost equally represented. Thus, in contrast to football, basketball players show a definite physique shift to more medial types centered around A_1. The high school teams have a slightly higher percentage of B_1's than the college teams, but this is not great enough to alter the pattern typical of basketball. On the whole, stocky players are very definitely in the minority and they are mostly guards. These comparisons are illustrated in Figure 50.

As in football, both level and channel must be considered in distinguishing team positions. The mean values are:

	College	High School
Forwards	A_1 - 187	A_1 - 176
Guards	A_1 - 184	A_1 - 177
Centers	M - 192	M - 182

and these are typical of men nominated by their coaches as outstanding players. Little doubt can exist that body type and size are as important in determining performance

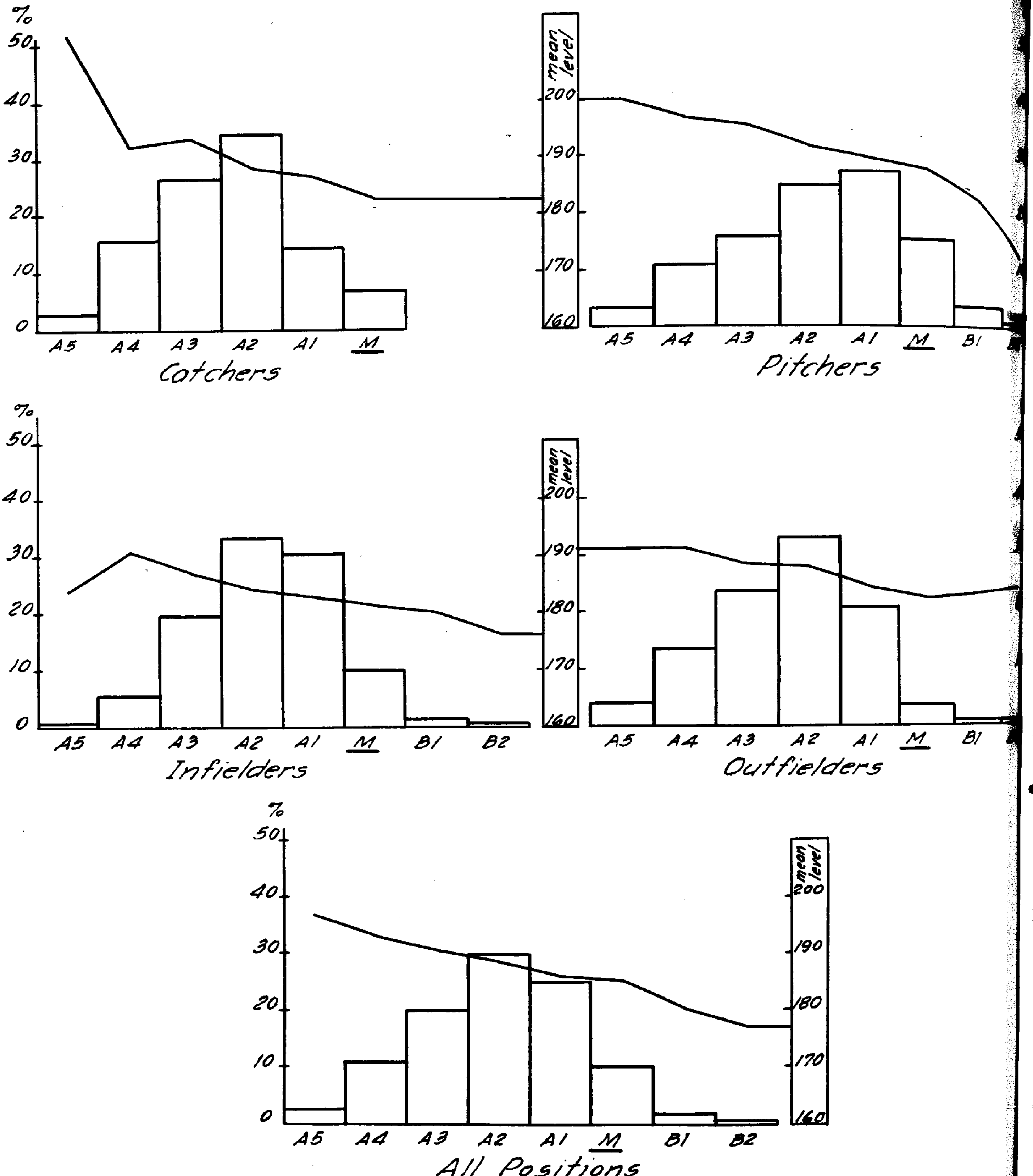


Fig. 51 The Percent Distribution of Body Types of Professional Baseball Players. (866 Cases.)

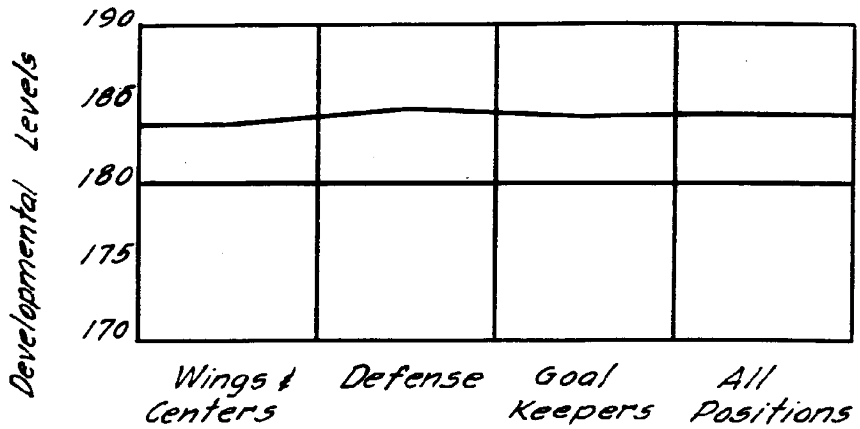
in basketball as they are in football, or that the types prevailing in one of these sports present a sharp contrast with those characteristic of the other.

Baseball

Owing to the general popularity of baseball it might be supposed that little or no relationship would be found between physique, level and performance. This would almost certainly be the case in "playing baseball" included anyone who could or had played the game, and without actual investigation, it might even be true of the best performers. It, therefore, seemed especially worth-while to analyze information on this game.

Data were collected from the rosters of thirty-three major and minor league baseball teams, supplemented by reports from the secretaries of those organizations. As a result, 866 such players were classified by channel and level, the findings being given in Tables 59, 60 and 81 of the Appendix. In addition, fifteen coaches supplied information on 211 high school players. No college data were examined. The main results apply to the professional players and are illustrated in Figure 51. The following summary shows the chief differences by team position:

Catchers	A_2A_3 - 190
Pitchers	A_1A_2 - 190
Infielders	A_1A_2 - 184
Outfielders	A_2 - 188



The Developmental Levels of Professional Hockey Players

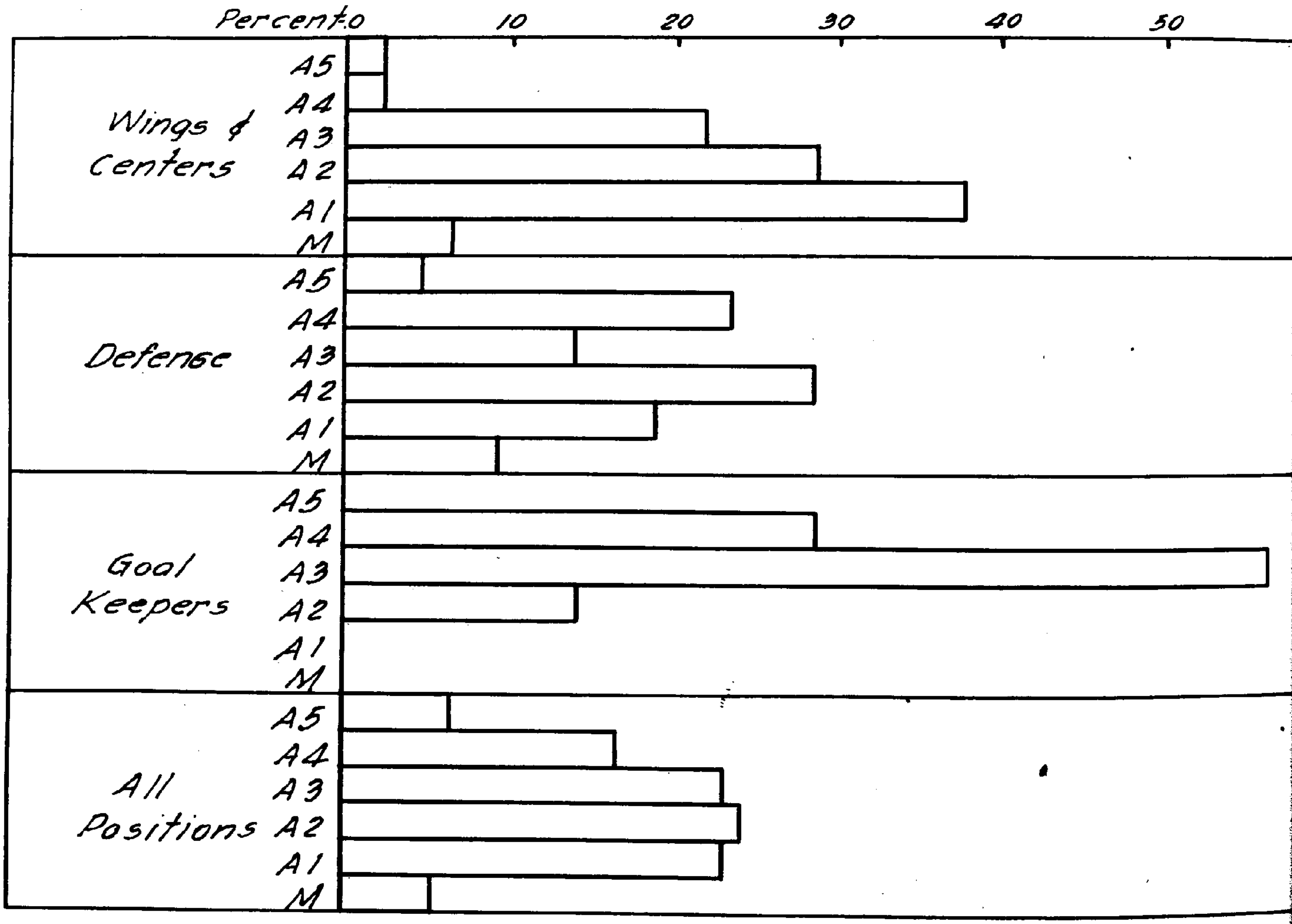


Fig. 52 The Physique Types of Professional Hockey Players. (170 Cases)

The average professional baseball player thus has a build in between that of the football and basketball players, and level is about the same in all. There are practically no players in B_1 or below. Catchers tend most of all toward A_3. The histogram for the pitchers is interesting in that it shows the widest distribution span from A_5 to B_2, a finding which is undoubtedly explained by the fact that pitchers outnumber all other players.

Thus, as represented by the best players, baseball also shows highly discriminating preferences for body build and size.

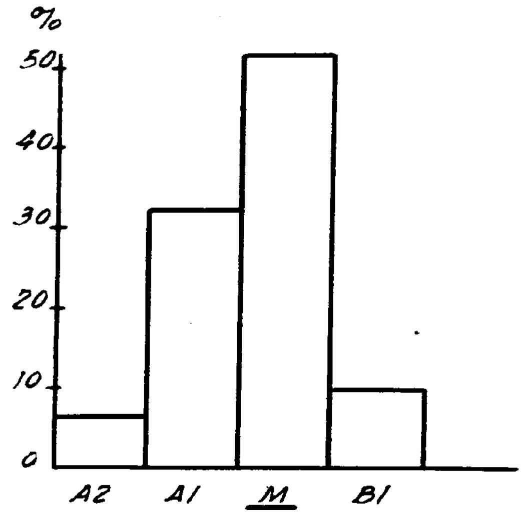
Hockey

Data on one hundred and seven professional hockey players gave the results in Table 75 of Appendix D which are illustrated in Fig. 52.

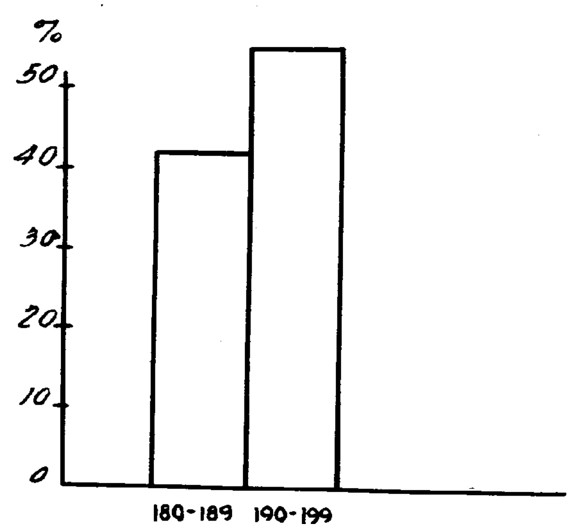
As a group, hockey players are definitely stocky types and compare most nearly with those in football. Strikingly, all players were grouped in M, or above, with no representatives in B_1 or below. The dominant team positions values proved to be:

Goal Keepers	A_3A_4 - 184
Defense	A_2A_3 - 184
Wings & Centers	A_2 - 183

which clearly shows that hockey is selective for men of rather constant size and physique.



The Physique Classes of Crew Athletes.
(35 Cases)



The Developmental Levels of Crew Athletes.

Fig. 53 The Physique Types of Crew Athletes

Varsity Crew

Though only thirty-one observations were available for this team sport, the data show a very definite restriction to men in A_1M at level 190. This, apparently, means that oarsmen must be large enough to provide the necessary strength, endurance and power, yet not so broad, as in A_3 or A_4, to offset strength that is associated with high level. The findings are given in Table 67 of Appendix D and in Figure 53.

Individual Sports

Track and Field Events

As individual competition in track and field events provides a great diversity of physical performance, it may therefore be expected to show considerable variation in body characteristics favorable to participation, as for example in weight, running, and jumping events.

The survey comprises 658 observations, owing to multiple participation usual among track athletes, on 147 college men and 239 high school boys. The full results are given in Tables 77 and 78 of Appendix D and are illustrated together in Figures 54 and 55. The favored channels and levels in thirteen events are listed in the following table. This table shows a progressive change of channel and level in an order corresponding roughly to that represented by passing from weight to running to jumping and finally to endurance events. It is obvious

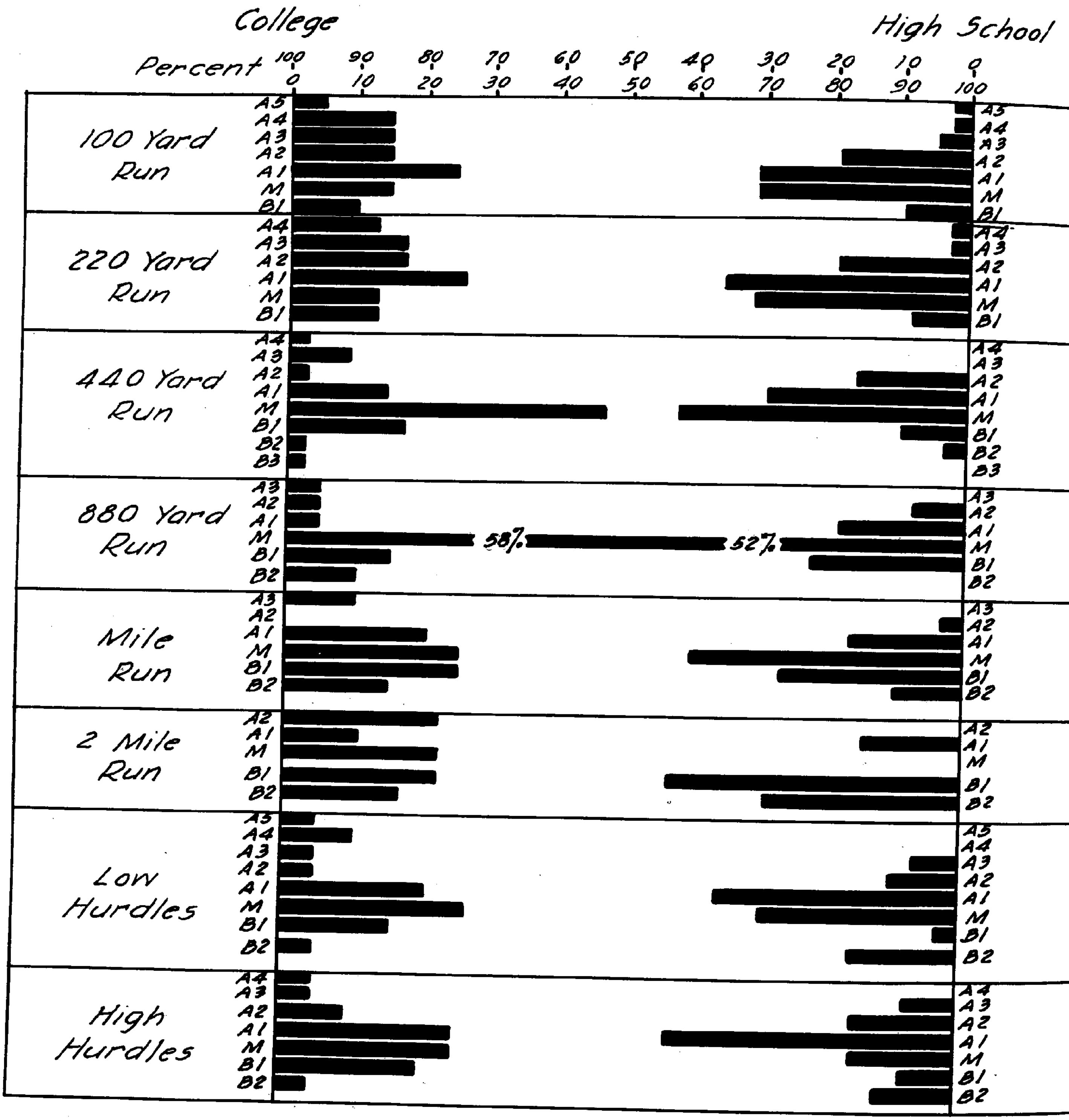
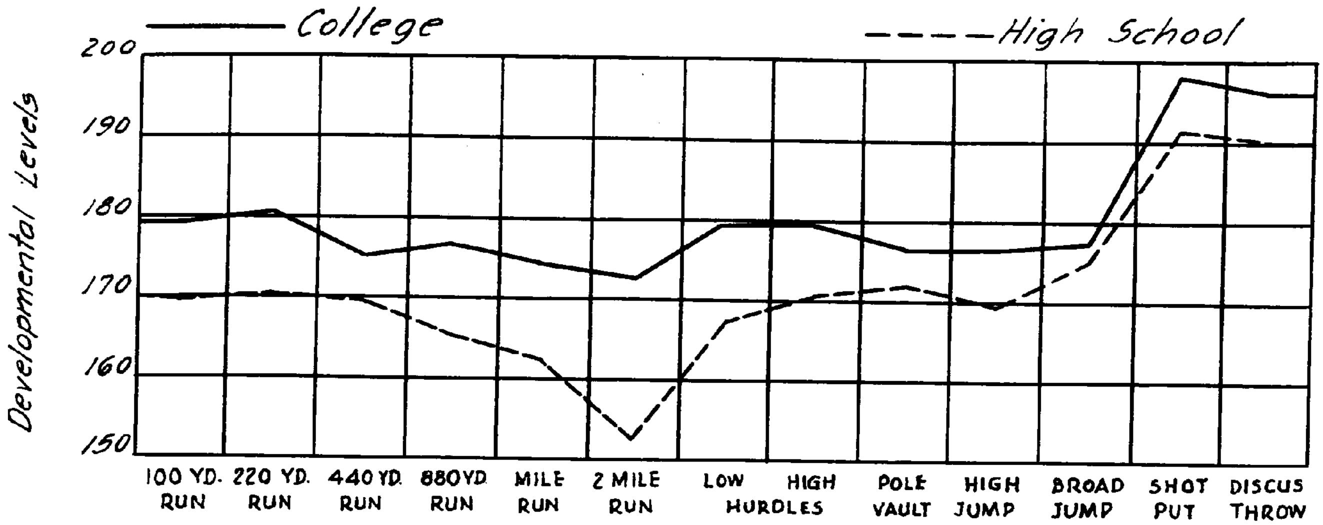


Fig. 54 The Physique Types of Track Athletes.



The Developmental Levels of Track Athletes.

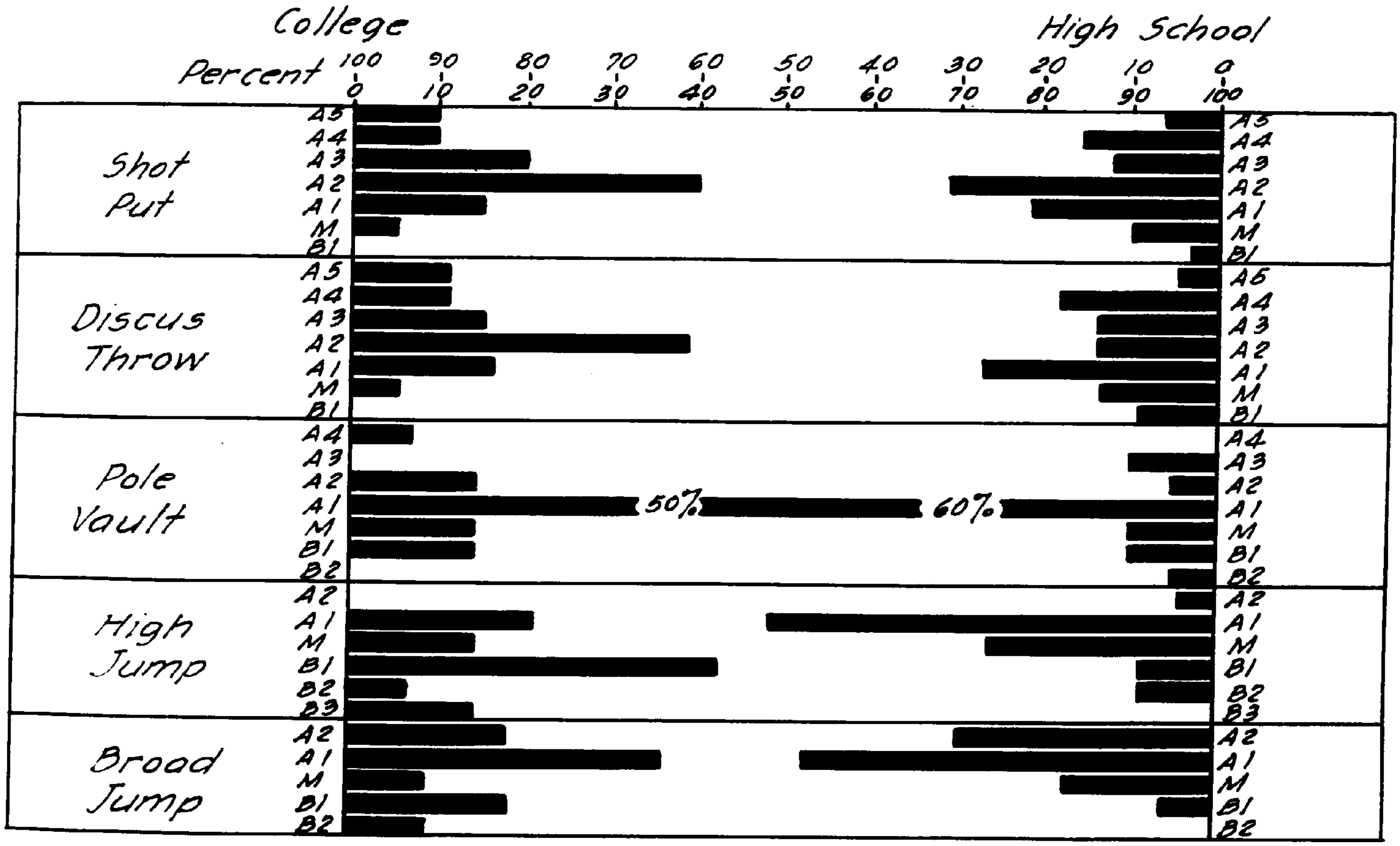


Fig. 55 The Physique Types of Track Athletes

TABLE 22

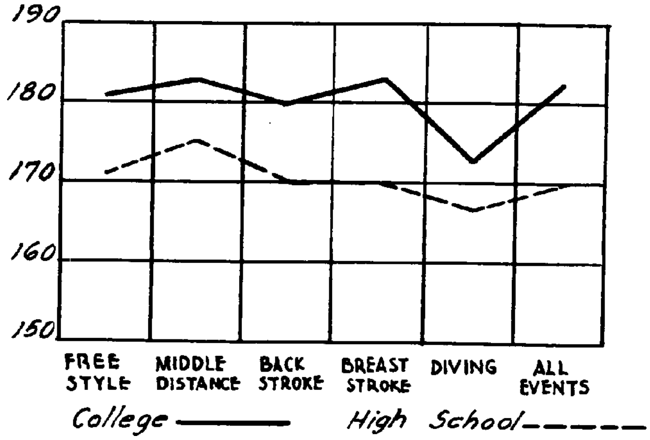
FAVORED CHANNELS AND LEVELS IN TRACK AND FIELD EVENTS

Event	College	High School
Shot Put	A_2 - 198	A_2 - 191
Discus	A_2 - 196	A_2 - 190
Javelin	A_1 - 186	--------
100 Yard Dash	A_1A_2 - 180	A_1 - 170
200 Yard Run	A_1 - 180	A_1 - 170
Hurdles (Low & High)	A_1M - 180	A_1M - 169
Broad Jump	A_1M - 177	A_1 - 175
Pole Vault	A_1 - 177	A_1 - 172
880 Yard Run	M - 177	M - 166
High Jump	B_1 - 177	M - 170
440 Yard Run	M - 175	M - 170
Mile Run	M - 174	M - 163
2 Mile Run	M - 173	B_1B_2 - 153

that the distinctions in physique and size correspond to intrinsic differences between events.

Swimming

Data on 527 swimmers, of whom 129 were college men and 398 were high school boys, are summarized in Table 76, Appendix D and Figure 56. Both groups show a wide channel spread from A_5 to B_3, with A_2 to M predominant, and with the college men about 10-12 levels larger than the high school swimmers.



The Developmental Levels of Swimmers

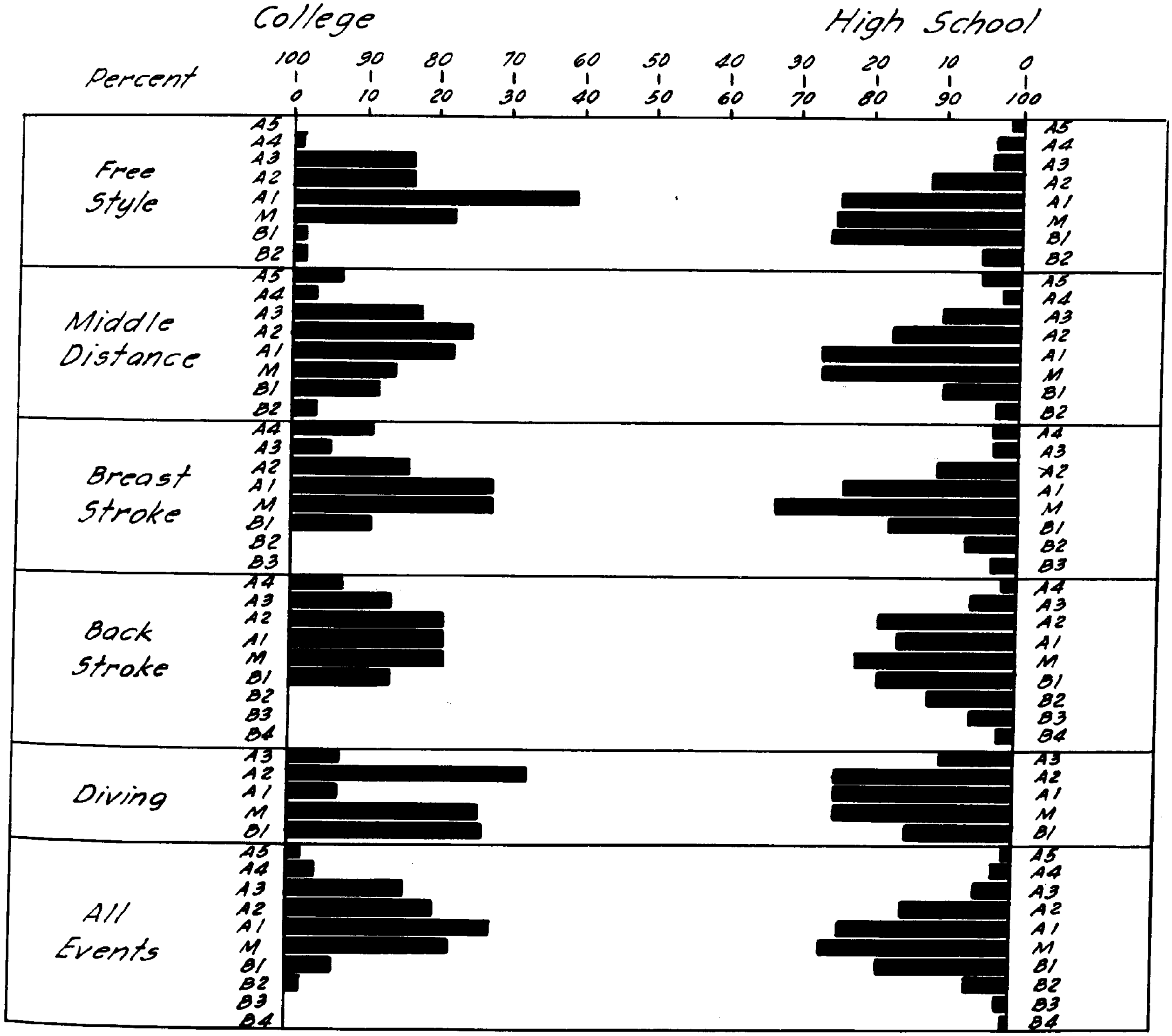


Fig. 56 The Physique Types of Swimmers. (149 College Swimmers, 391 High School Swimmers.)

Tennis

Only fourteen players could be classified, and nine of these were either A_1's or M's with a mean level of 180.

Combative Sports

Observations on two hundred and nineteen wrestlers, boxers and fencers are given in Appendix Tables 66, 68 and 80. In general, very few B's were found, and each of these sports showed the majority to be between M and A_2, with level varying according to weight class.

CHAPTER VII

ABSTRACT SUMMARY AND CONCLUSIONS

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The first objective of this study has been to measure and analyze different kinds of motor performance as represented in twelve well known "physical fitness tests" that were administered to 5860 high school boys and college men who had been classified according to the Grid Technique.

The main body of data was obtained from seven of the tests which were administered to students at Collinwood High School in Cleveland, Shaker Heights Junior and Senior High Schools, and at Western Reserve University. All of these tests were personally conducted by the author. This information was supplemented by scores in five tests conducted in the Cleveland Public Schools in collaboration with the physical directors of seven high schools and one junior high school. The latter data extended the sampling range of body size and at the same time provided observations on tests included in the Navy fitness batteries which were then being emphasized.

A closely related study, and logical corollary to the main objective of this investigation is the appraisal of athletic ability in relation to physique and body size. Everyone familiar with competitive sports is aware of a natural selection of participants. Any knowledge of specific relationships between body size, build, and athletic proficiency would seem to have value in team selection and it ought to be helpful in guidance. Physical educators are often called upon for this purpose, but scientific and practical methods for helping them to detect special fitness for sports are few and of questionable accuracy. On the assumption that differences in body structure imply differences in athletic ability, other things being equal, the problem is one of attempting to recognize those individuals who possess physical advantages peculiar to various sports.

Grid ratings were, therefore, made of 5759 athletes who participated in eleven principal sports as members of interscholastic, intercollegiate, and professional teams. In this portion of the study, the attempt has been made, not only to detect the significance of body build and size in various sports, but also within certain sports, to note the influence which different body characteristics have in determining individual team positions.

Regarding the historical background of the subject, the work of previous investigators was directed along two different lines of approach. Of course the very earliest attempts to define physical proficiency in relation to body characteristics must be credited to the Ancient Greeks, whose works of art show a very clear understanding of the physical differences between various athletes. In modern times, scientific efforts were aimed at measuring physical traits in order to determine how these influence or distinguish performers. In contrast to these anthropometric studies, a second type of approach was directed more towards methods of classifying performers in terms of body measurements especially for the purpose of predicting performance so as to provide handicaps or advantages in competition.

Nevertheless, no general agreement has prevailed on the most suitable basis for evaluating achievement or on the most practical approach to pupil classification, either for the purposes of competition, adoption of standards or for that of guidance. In spite of many reports on tests and experiments, physical educators still differ widely in their opinions concerning the factors which are most influential in determining performance. As a result, the tendency has been to devise more and more tests of proficiency, and to employ these without regard for differences in physical traits. Moreover, tests are frequently employed inconsistently, subject to local option, and in many instances without proper qualification. In short, the present situation is one of confusion as to the most suitable and practical methods of determining or allowing for innate physical capacities.

Although the only use which is made of the Grid

Technique in this study is to classify the subjects under test by physique and body size, the significance of this method is more readily established through a brief resume showing how the Grid is applied as a control chart on child growth. Preliminary studies with classification by the author on junior and senior high school pupils and college students confirmed Wetzel's original findings that classification by channel and level does distinguish varieties of physique, and specific differences in body size.

In view of considerable interest in the exponent and index methods of classification, comparisons were made with Grid ratings on 253 junior high school boys. It has been found that height and weight and age as employed in either the index or exponent methods does not provide "physically homogeneous" groupings as regards body size and shape. A given exponent or index class, for example, ranges over as many as 30-40 levels of development and even much more than the seven regular Grid channels of physique. Similar findings apply to broader schemes of classification that distinguish physical make-up by such descriptive terms as tall, medium, slender, etc.

Having resolved some of the problems of classification the study was undertaken with the following strength, power, endurance, and agility tests:

Burpee 10 Sec.	Hand Grip	Sargent Jump
Burpee 60 Sec.	Parallel Bar Dips	Sit-ups
Dodging Run	Pull-ups	Squat Jumps
440 Yard Run	Push-ups	Standing Broad Jump

Altogether a total of 36,409 individual observations were made on 5860 college men and boys in junior and senior high school. Approximately 20 per cent of the data were derived from the junior high school groups, 30 per cent from the college men, and 50 per cent from senior high school boys.

Results

For each of the twelve tests, five items are tabulated by channel and level groups in the 23 tables of Appendix A: Means, Standard Deviations, Standard Errors, Range, and Number of Cases. These values are given for each 10-level increase in size, and according to each of the physique channels.

The results are described and analyzed from two points of view: (1) Mean score trends, and (2) Relative performance trends in terms of percentage changes, since the former does not permit direct comparison of the body size (level) and physique effects in different tests. For each test, the numerical data are illustrated in the form of appropriate graphs in the text.

All of the tests except the Hand Grip conformed to a common pattern for physique-level relationships with performance. In the case of level this consisted of (a) an increase in performance as body size increased to level 170; (b) a definite maximum in this level neighborhood, and (c) thereafter, a drop in performance in spite of continued level increase. As regards physique, the pattern showed maximum performance generally for those in channels A_2 or A_1 and a persistent decline in performance for those more and more removed from these physique classes. The Hand Grip showed no maximum with respect to level, but it did conform to the physique pattern. For practical purposes, tests differed among themselves only in the extent to which their maximum effects were more or less pronounced. As a rule tests more responsive to level were also more affected by change in physique.

The order of effects on performance ranged from least in the agility events as represented by the Burpee 10 Second Test and Dodging Run, to greatest in the strength tests such as Pull-ups, Parallel Bar Dips and Push-ups. Momentary effort (power) represented by the Sargent and Standing Broad Jumps ranked above sustained efforts (endurance) in the Squat Jumps, Burpee 60 Second, and 440 Yard Run, and all of these were between the strength and agility events when ranked by level response.

Maximum performance in terms of mean scores is reached at level 180 in the power tests, i.e., the Sargent and Standing Broad Jumps, and elsewhere at level 170. While the Hand Grip shows no maximum with respect to level, it is nevertheless interesting that its rise beyond level 170 is not as steep as it is below this very critical level.

These findings show that no further advantage is to be gained with increase in level beyond 170-180, and that performers tend, in fact, to be less proficient as they represent still higher limits of normal human size.

At all levels the advantage of physique generally lies with subjects of channels A_2A_1, the only apparent exceptions being in the 440 Yard Run, the Sit-ups and Squat Jumps in which the M's and B_1's are capable of maximum achievement.

Comparative size and physique effects have been computed by converting all results to equivalent 100 level values. On this basis, the percentage change in performance by level ranges from 16 and 17 in the Burpee 10 Second event and in the Dodging Run, to 218 for the Parallel Bar Dips, whereas the same tests show a 70-87 and 1220 percentage change associated with physique. Accordingly, physique is seen to have a greater influence than level, but this superiority, when expressed in the form of a P/L ratio, is greatest in the Burpee Sixty Second test and Sit-ups and least in the Hand Grip. Specifically, physique has 9 to 10 times greater influence on performance in the

Burpee 60 Second and Sit-up events, but only 1.6 greater effect than level in the Hand Grip.

In terms of the definite distinctions between body size and physique the findings of this study show that size and build exert notable influences on performance in all of the twelve events in the test battery. But while this general result is not entirely unexpected, there exists no previous experience for anticipating the fact that eleven of these tests, the grip being the sole exception, reveal a definite maximum of performance for all physiques at and about the level span 170 to 180, as well as maxima of achievement for subjects in the stocky-medial channels A_2A_1 at all levels.

Unlike previous efforts which have been almost solely concerned with the effects of physique, the present results emphasize the inter-play of both body build as well as body size in determining physical achievement. The element of size is frequently omitted from considerations of performance, or is at times merely taken for granted in performance appraisals. In some instances, it is indefinitely mixed up with physique. On the basis of the present results, such procedures can only lead to confusion because the findings just reported clearly show that both body build and size, as designated by Grid channels and levels, modify physical performance sufficiently to require separate allowance for their effects.

Interpretations of individual capacity and appraisal of individual performance would, therefore, seem to imply evaluation both in terms of physique and body size.

While body size and physique are in all probability the two most important physical components of structure which have been found to influence performance in boys nearing maturity and in young men, it will be worth-while to investigate the classification of subjects at lower levels according to their developmental advancement. This procedure may be accomplished with the help of the age schedule provided in the Grid Technique. No use of this property, however, has been made in the present study since the great majority of boys had already reached the upper developmental levels.

The findings of this study have a direct bearing on the problem of test construction. If batteries of events are to be selected as measures of functional efficiency, as for example, in physical fitness tests, in tests of motor or athletic ability, the separate events should all be harmonized in terms of the objective criteria represented by the two important factors of body build and size. Otherwise, to make no allowance in tests, where size and body type have great influence, would be unfair to those candidates who are in relatively unfavorable channel or level positions.

Test construction would also depend on the establishment of suitable physique and level norms of performance.

So far as this study is concerned, the mean scores herein reported represent a preliminary step in that direction. However, that problem is beyond the original intention of this investigation which is limited, more specifically to the purpose of determining the influence of body size and physique on performance.

Supplementary to the direct set of observations on performance in the test battery, a survey of body size and physique as represented by Grid ratings of 5759 athletes participating in eleven different sports has also been included in this study. Since athletic performance as called for by different sports, or even by different team positions in the same sport, is more highly complicated than the rather limited type of activity in any of the motor tests of the present battery, it appeared only natural to see whether athletic performance would reveal similar relationships to those found in the tests.

The Athletic survey produced some convincing evidence that team participation as well as individual sport performance are strongly associated with body build and size. Striking examples of this connection were found in football, basketball, track and field, crew and in hockey. A Chi-Square analysis of 2198 football players proved (1) that these players as a group are different in size and physique from the general population and (2) that players of different team positions have significantly different channel and level ratings. Furthermore, ratings on 166 "star" players were statistically identical with those which the Chi-Square analysis had indicated as being preferential for respective positions. Many athletes in the remaining sports also possess similarly distinctive body characteristics.

While earlier measures of sports ability, physical capacity or motor quotients have served certain purposes, it must be admitted that they have not suggested the significant trends of performance which classification and analysis by the Grid Technique has revealed. Moreover, subjectivity is entirely eliminated by means of the Grid classification method. Physique and body size are readily determined and, even more importantly, they are accurately distinguished. Such gains in accuracy of pupil classification should benefit both student and teacher, by indicating a sounder basis for the prescription of exercise, by aiding in the development of performance standards, and by providing guidance for selection of athletes or direction of others into activities for which they are best fitted by heredity.

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APPENDIX

APPENDIX A

TEST SCORES

AND

STATISTICAL CONSTANTS

TABLE 23

THE BURPEE TEST IN TEN SECONDS

	CHANNELS										
	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 95 - 104											
N	1		2		1	1	3	2	1		11
M											6.5
SD											.98
E											.31
R											5-8¼
Levels 105 - 114											
N						6	9	13	5	1	34
M						6.75	5.92	6.71	6.50		6.50
SD						.74	.85	.89	.71		.92
E						.33	.30	.26	.35		.16
R						5-8	4½-7	5¼-8	5-7		4½-8
Levels 115 - 124											
N	2			1	3	12	26	15	5	2	66
M	5.38			6.00	7.16	6.85	6.93	6.12	6.6	7.25	6.40
SD					.39	.58	.96	.61	.46	.75	.91
E	.13				.27	.02	.20	.17	.23	.75	.11
R	5-5½				6½-8	5-8	4-8½	5-7	5¼-7	6½-8	4-8½
Levels 125 - 134											
N	3		2	9	14	39	32	26	10	2	137
M	6.5		7.5	6.69	6.91	6.75	6.51	6.50	6.13	5.75	6.62
SD	1.0			.22	.36	1.0	.97	1.0	.50	.75	.95
E	.76		0	.28	.26	.15	.16	.22	.26	.75	.08
R	5-7½		0	5½-7	5½-8	4-8	5-8	3-8	5-7½	5-6½	3-8

TABLE 23--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 135 - 144											
N	5	3	4	5	24	18	43	28	12	5	147
M	5.55	6.08	6.38	6.5	6.17	6.32	6.42	6.08	6.58	5.80	6.26
SD	1.21	.181	1.54	.84	1.05	.79	.85	1.05	.82	1.1	.97
E	.61	.28	.89	.42	.22	.19	.13	.20	.25	.53	.08
R	4¼-5	5½-6¼	4-6½	5-8	4½-8	4½-8	4¼-9	4-7½	4-8	4-7¼	4-9
Levels 145 - 154											
N	3	2	14	19	44	69	92	49	23	3	318
M	6.50	6.13	6.59	6.54	6.68	6.53	6.41	6.36	6.19	7.42	6.48
SD	1.59	.13	1.04	.90	.88	1.1	1.03	.96	.98	.51	.99
E	1.12	.13	.29	.21	.13	.13	.11	.14	.21	.36	.06
R	5-8½	6-6¼	5-8½	4½-8	4-8¾	2½-9	4¼-9	4¼-9	2-8½	6-8	2-9½
Levels 155 - 164											
N	9	10	38	59	100	167	121	81	14	3	602
M	6.22	6.48	6.55	6.75	6.81	6.60	6.48	6.45	6.30	5.83	6.42
SD	1.43	1.00	1.14	1.01	.59	1.03	.98	.94	.99	1.0	1.02
E	.51	.34	.19	.13	.06	.08	.09	.10	.28	.71	.04
R	4-9	4-8½	4-9¼	3-8½	5-9¼	3½-9	4-9½	3¼-9	5-8	5-7	3-9½
Levels 165 - 174											
N	11	27	52	108	189	203	146	36	7	1	780
M	6.29	6.31	6.80	6.84	6.57	6.58	6.67	6.21	6.19	6.75	6.61
SD	.65	.97	.76	.97	1.02	.91	.83	.83	.55	..	.93
E	.21	.19	.11	.09	.07	.06	.07	.14	.22	..	.03
R	5¼-7	4½-8	5¼-9	4-9½	4-9½	4-9	4½-9	4-7½	4½-6½	..	4-9½

TABLE 23--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 175 - 184											
N	28	27	51	100	128	117	52	22	2	1	528
M	5.79	6.46	6.34	6.60	6.63	6.58	6.44	6.48	6.0	5.0	6.51
SD	1.23	.88	.85	.97	.84	.93	.99	.78	..	..	.96
E	.24	.17	.12	.10	.07	.09	.99	.17	..	..	.04
R	3-8½	4-8	4-8	3½-8	4-8½	3½-8½	4-9	6-9¼	..	..	3½-9¼
Levels 185 - 194											
N	26	41	40	43	32	17	5	1	..	..	205
M	6.18	6.19	6.27	6.51	6.27	6.34	6.4	5			6.34
SD	1.08	.83	.96	.89	.93	.93	.51				.98
E	.21	.13	.15	.14	.16	.23	.26				.07
R	4½-9	4-8	5-9	4½-8½	4½-9½	5-8½	5½-7				4-9½
Levels 195 - 204											
N	21	12	10	6	1	4	1				55
M	6.37	6.13	6.75	6.63	7.00	6.00	6.00				6.42
SD	1.27	.72	1.05	.64	..	.5	..				.99
E	.28	.22	.21	.29	..	.50	..				.13
R	4½-9	5¼-7	4¼-8	6-7½	..	5½-6	..				4½-9
Levels 205 - 215											
N	19	3	2								24
M											6.15
SD											.76
E											.16
R											4½-8

TABLE 23--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
					Levels 216 - 234						
N	7										7
M											5.86
SD											.59
E											1.24
R											5-6¼
					Total Number						
	135	125	215	350	536	653	530	273	79	18	2914

TABLE 24

THE BURPEE TEST IN SIXTY SECONDS

	CHANNELS										
	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
					Levels 95 - 104						
N						2	7	5	1		15
M						34	29	29	27		28.08
SD						1	2.4	2.2	0		5.01
E						.17	.45	.42	..		1.33
R						33-35	20-35	18-32	..		18-35
					Levels 105 - 114						
N		1			2	5	11	19	7		45
M		28.5			32.5	34.1	28.3	29.3	28.5		29.6
SD						4.3	4.9	3.2	2.3		4.58
E						2.15	1.56	.75	.87		.68
R						28-40	18-38	18-34	24-32		18-40
					Levels 115 - 124						
N		1		3	10	12	19	19	5	4	73
M				25.2	26.9	28.8	28.5	27.7	24.9	26	27.7
SD				3.4	4.5	5.1	5.6	4.6	4.1	5.7	4.94
E				2.4	1.48	1.53	1.31	1.08	2.01	4.03	.58
R				20-29	18-33	20-37	16-47	16-37	18-31	18-33	16-41
					Levels 125 - 134						
N	1	1	2	7	17	29	51	29	13	6	156
M	24	27	31.5	33.4	30.0	28.7	27.8	28.7	27.5	26.5	28.6
SD	..	..	..	7.0	5.4	7.5	4.7	3.7	4.5	3.6	5.46
E	..	..	..	2.85	1.36	1.42	.65	.71	1.31	1.63	4.37
R	..	..	..	23-43	20-40	8-46	20-43	23-37	17-34	23-34	8-46

TABLE 24--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
					Levels 135 - 144						
N	5	2	4	11	35	49	55	35	22	4	222
M	24.6	25.5	24.8	30.8	31.9	28.3	29.4	28.0	28.2	25.5	28.9
SD	3.98	1.5	2.5	4.5	2.4	3.1	3.0	3.1	4.2	3.4	3.23
E	1.99	1.5	1.44	1.46	.41	.45	.44	.53	.91	1.93	.217
R	17-31	23-28	20-28	20-46	20-37	17-40	17-40	14-40	14-40	20-3	14-46
					Levels 145 - 154						
N	3	8	14	23	65	120	116	67	32	4	452
M	29.	24.4	21.71	29.7	29.9	20.8	30.4	29.7	29.4	32.3	30.1
SD	7.1	3.15	8.0	6.2	6.2	5.5	5.6	4.6	4.5	6.83	5.64
E	5.05	1.19	2.22	1.32	.78	.50	.52	.55	.80	3.95	.266
R	20-28	20-31	14-46	11-40	11-43	14-43	17-49	17-43	20-37	23-40	11-49
					Levels 155 - 164						
N	9	11	38	60	141	206	162	81	19	5	732
M	29.0	29.5	30.5	32.3	32.7	32.4	30.1	31.3	29.3	26.6	31.5
SD	6.93	5.2	5.0	5.9	5.7	5.9	5.4	5.5	5.5	2.9	5.79
E	2.45	1.66	.97	.77	.49	.41	.43	.61	1.3	1.45	.21
R	19-39	22-42	13-42	13-48	22-72	13-60	16-48	13-42	19-42	22-33	13-72
					Levels 165 - 174						
N	17	16	40	94	197	195	145	30	10	2	746
M	24.4	28.3	32.7	32.5	31.8	32.2	32.1	32.5	29.6	38.0	31.9
SD	7.4	6.0	7.0	6.5	5.4	5.6	5.9	6.0	4.2	..	6.09
E	1.88	1.53	1.12	.68	.39	.40	.49	1.10	.57	..	.22
R	16-45	19-39	13-48	13-57	13-45	16-57	13-43	22-54	25-39	..	13-57

TABLE 24--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
					Levels 175 - 184						
N	28	22	43	70	89	79	33	11		3	378
M	27.8	27.4	31.0	32.1	32.2	31.5	32.2	31.9		31.0	31.3
SD	6.2	3.8	5.7	4.8	5.9	6.3	6.3	5.3		6.9	5.94
E	1.19	1.27	.86	.57	.63	.71	1.10	1.68		6.9	.31
R	19-42	13-39	22-42	19-42	19-45	13-66	22-60	22-42		19-42	13-66
					Levels 185 - 194						
N	22	27	21	23	25	12	2	1	1	1	135
M	26.6	28.7	30.1	29.8	30.0	30.5	30.5	26.5	26.5	26.5	29.1
SD	4.7	6.4	2.9	5.1	5.2	5.9	..	..	..	..	5.26
E	1.03	1.26	.64	1.09	1.05	1.79	..	..	..	..	.45
R	16-37	16-41	24-35	22-41	18-37	22-41	..	..	..	..	16-41
					Levels 195 - 204						
N	18	13	9	3	1	4	2				50
M	26.2	27.9	28.1	27.8	30.5	28.0	29.5				27.1
SD	5.3	6.4	4.9	2.9	..	2.2	1.0				5.64
E	1.29	1.86	1.65	2.09	..	1.28	1.0				.80
R	10-37	24-41	16-35	22-33	..	24-31	28-30				10-41
					Total Number						
	103	102	171	294	582	713	603	297	110	29	3004

TABLE 25

DODGING RUN

	CHANNELS										
	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 95 - 104											
N	1		2	1	1	1	2	2	1		11
M											27.1
SD											2.16
E											.21
R											21.5-32
Levels 105 - 114											
N						6	8	13	4	1	32
M						27.2	27.5	28	28	28	27.6
SD						.81	2.64	1.7	1.5	..	1.99
E						.37	1.0	.49	.87	..	.35
R						25-28.9	22-31.9	25-31.9	25-29.9	...	22-31.9
Levels 115 - 124											
N	2			1	3	9	25	15	4	2	61
M	27.5			31.5	26.2	27.1	26.2	28.2	25	27	27.1
SD	2.0			..	4.71	2.0	2.09	2.29	.73	2.5	2.51
E	2.0			..	3.32	.71	.43	.61	.42	2.5	.32
R	25-29.9			..	25-26.9	24-30.9	21-30.9	24-32.9	24-25.9	24-29.9	21-32.9
Levels 125 - 134											
N	3		2	8	13	39	30	25	10	1	131
M	27.5		25.5	30.3	27.7	26.9	26.8	27.7	27.7	26.5	27.4
SD	..		1	1.71	3.04	2.24	2.29	3.14	3.12	..	3.02
E	..		1	.65	.88	.36	.42	.64	1.04	..	.26
R	..		24.5-26.5	24-40.9	22-34.9	22-31.9	22-32.9	23-35.9	24-35.9	..	22-40.9

TABLE 25--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
					Levels 135 - 144						
N	4	3	3	5	20	17	44	26	13	4	139
M	28.5	27.5	29.2	27.5	26.9	27.7	26.4	28.5	26.0	27.7	27.1
SD	3.08	1.0	2.5	1.26	1.63	2.04	1.68	1.76	1.60	.43	1.94
E	1.78	.71	1.76	.63	.37	.51	.25	.35	.46	.25	.16
R	23-21.9	26-28.9	26-32.9	25-29.9	23-29.9	24-31.9	23-31.9	23-32.9	23-28.9	27-28.9	23-32.9
					Levels 145 - 154						
N	7	6	23	37	83	65	89	45	21	2	378
M	26.9	27.5	26.6	26.6	26.8	26.6	26.4	26.8	28.6	26.5	26.7
SD	1.59	1.36	2.67	2.30	2.99	1.76	2.13	2.11	1.79	1.0	2.31
E	.65	.61	.57	.38	.33	.22	.23	.32	.40	1.0	.12
R	24-29.9	25-30.9	23-35.9	22-33.9	22-41.9	22-30.9	22-33.9	23-34.9	25-32.9	25-27.9	22-41.9
					Levels 155 - 164						
N	1	4	24	31	56	150	123	76	10	3	478
M	27.5	25.7	26.3	26.1	26.6	26.4	26.7	25.7	26.1	27.5	26.4
SD	..	2.54	1.91	1.99	2.35	1.69	2.73	1.93	1.82	1.0	2.19
E	..	1.46	.40	.36	.31	.14	.25	.22	.61	1.0	.10
R	..	23-29.9	22-32.9	22-30.9	22-32.9	21-30.9	22-37.9	22-33.9	23-28.9	26-28.9	21-37.9
					Levels 165 - 174						
N	10	22	51	128	176	201	138	34	7		767
M	26.4	26.6	25.8	25.6	25.8	25.9	25.7	25.3	26.5		25.8
SD	2.17	2.06	1.55	2.12	1.74	2.03	2.18	2.67	1.07		2.02
E	.73	.45	.22	.19	.13	.14	.19	.46	.44		.07
R	23-29.9	22-31.9	23-29.9	20-35.9	22-33.9	21-33.9	21-35.9	20-35.9	24-27.9		20-35.9

TABLE 25--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 175 - 184											
N	24	30	62	102	141	105	45	14	1	1	525
M	26.9	25.4	26.2	25.9	25.7	25.5	25.9	26.4	26.5	32.5	25.8
SD	3.01	2.5	2.12	1.91	1.99	1.55	2.07	2.69	..	..	2.0
E	.63	.32	.27	.19	.16	.15	.31	.75	..	..	.09
R	23-20.9	23-30.9	22-32.9	22-35.9	22-32.9	22-30.9	22-30.9	23-33.9			22-40.9
Levels 185 - 194											
N	29	39	37	51	40	26	4	1	1		228
M	28.1	26.4	25.8	25.9	25.7	25.6	26.2	26.5	26.5		26.0
SD	1.08	1.96	2.10	2.03	1.86	1.46	1.47	..	..		2.84
E	.24	.31	.35	.29	.20	.29	.85	..	..		.19
R	23-40.9	22-31.9	22-29.9	23-35.9	22-30.9	22-28.9	24-27.9	..	..		22-40.9
Levels 195 - 204											
N	21	15	12	7	1	2					58
M	27.6	26.9	25.5	26.4	24.5	27.0					26.9
SD	2.95	2.03	1.78	1.25		.5					2.44
E	.66	.54	.54	.51		.5					.32
R	23-35.9	22-29.9	23-29.9	24-28.9		26-27.9					22-35.9
Levels 205 - 224											
N	18	3	2								23
M											27.2
SD											3.3
E											.70
R											24-31.5

TABLE 25--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Total Number											
	120	122	218	371	534	615	508	251	72	14	2831

TABLE 26

440 YARD RUN

	CHANNELS									
	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	All Types
Levels 145 - 154										
N			1	2	4	12	19	7	1	46
M			70.5	75.9	75.9	71.3	72.3	71.8	70.9	73.9
SD			..	5.00	6.63	4.52	5.84	4.76	..	4.84
E			..	5.00	3.82	1.36	1.37	1.94	..	.71
R			..	70-81.9	68-86.9	62-78.9	62-99.9	64-78.9	..	62-99.9
Levels 155 - 164										
N	2	2	7	16	22	40	33	20	4	146
M	81.5	76.9	73.5	68.9	71.7	71.3	71.9	71.8	74.5	71.7
SD	4.74	10.0	6.47	5.08	5.61	5.40	5.50	5.85	2.70	5.8
E	4.74	10.0	2.64	1.31	1.22	.86	.96	1.34	1.56	.27
R	76.7-86.2	66-87.9	66-87.9	60-79.9	62-81.9	60-89.9	60-83.9	62-85.9	72-77.9	60-89.9
Levels 165 - 174										
N	2	4	18	42	56	78	39	15	4	258
M	82.9	72.9	73.7	72.1	71.8	70.8	71.4	67.6	76.5	71.5
SD	10.	5.48	6.28	5.78	5.92	5.56	5.92	3.46	3.26	6.12
E	10.0	3.16	1.52	.89	.79	.63	.95	.93	1.88	.38
R	72-93.9	66-81.9	60-83.9	60-87.9	58-85.9	58-89.9	58-85.9	60-75.9	70-79.9	58-93.9

TABLE 26--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	All Types
					Levels 175 - 184					
N	8	11	30	48	47	40	14	7		205
M	76.3	72.9	74.8	73.7	71.3	72.2	71.1	70.7		72.5
SD	6.52	6.09	6.08	6.91	5.20	6.0	4.7	3.10		5.23
E	2.47	1.92	1.13	.99	.76	.99	1.30	1.26		.04
R	64-85.9	62-87.9	62-89.9	60-89.9	58-85.9	60-97.9	60-77.9	68-77.9		58-97.9
					Levels 185 - 194					
N	9	16	17	20	12	8	2			84
M	85.2	75.6	74.7	72.2	71.6	72.2	80.9			74.6
SD	7.7	6.7	5.4	4.94	5.72	3.92	12.0			87.14
E	2.72	1.73	1.35	1.12	1.72	1.48	12.0			.78
R	74-95.9	64-97.9	64-85.9	62-81.9	62-83.9	66-81.9	68-93.9			62-97.9
					Levels 195 - 204					
N	10	3	4	3		1				21
M	85.6	77.2	72.8	72.8		63.3				78.4
SD	6.37	1.24	8.22	7.98		..				9.14
E	2.12	.62	4.74	5.62		..				2.04
R	73-99.0	75-79.9	65-86.9	635-83.9		..				63.3-99.0
					Total Number					
	31	36	77	131	141	179	107	49	9	760

TABLE 27

HAND GRIP

	CHANNELS										
	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 95 - 104											
N	1		2		1	1	3	2	1		11
M											106.27
SD											29.74
E											9.37
R											80-129
Levels 105 - 114											
N						6	8	13	5	1	33
M						116.16	145.75	124.5	110.5	135	123.3
SD						13.43	34.75	31.9	16.24	..	31.31
E						6.01	13.13	9.20	8.12	..	5.45
R						95-135	85-195	75-185	85-135	..	85-195
Levels 115 - 124											
N	2			1	3	9	25	15	4	2	61
M	135			80	121.2	120.1	124.6	117.2	129.5	109.5	121.9
SD	30			..	9.42	15.7	14.5	18.1	8.7	2.5	17.63
E	30			..	6.67	5.56	2.96	4.83	5.01	2.45	2.26
R	105-			..	95-135	105-155	85-145	75-155	125-145	85-135	75-165

TABLE 27--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 125 - 134											
N	2		2	9	13	40	30	25	9	1	131
M	134.5		134.5	142.3	136.0	143.0	140.2	146.1	141.2	124.5	141.8
SD	..		10.	28.9	17.9	24.4	23.0	29.1	12.5	..	24.51
E	..		10.	10.24	5.17	3.86	4.21	5.93	4.41	..	2.14
R	..		125-145	105-225	105-175	85-215	85-205	95-195	125-165	..	85-225
Levels 135 - 144											
N	4	4	4	5	23	18	42	27	11	4	142
M	159.5	137	139.5	120.5	151.9	162.8	159.3	153.8	174.5	137	155.5
SD	33.5	34.9	32.0	18.5	32.9	21.9	25.2	23.2	23.4	16.4	28.19
E	19.3	20.15	18.48	9.27	7.01	5.31	3.89	4.56	7.39	9.46	2.37
R	125-215	105-195	115-195	105-155	85-215	125-205	125-245	125-205	145-215	125-165	85-245
Levels 145 - 154											
N	1	2	13	16	44	71	95	50	20	3	315
M	170	159	191.4	177.1	190	195.1	191.6	188.3	190.5	209.5	191.2
SD	..	30.1	44.7	30.2	36.6	28.8	34.0	27.8	27.0	32.6	16.39
E	..	30.1	12.1	7.79	5.52	3.42	3.49	3.93	6.19	23.0	.92
R	..	130-190	130-250	130-230	130-290	130-270	130-310	130-230	150-230	170-250	130-310
Levels 155 - 164											
N	3	5	25	35	66	171	136	83	14	3	541
M	157.8	210.5	212.1	204.5	216.2	217.2	212.8	212.8	215.2	201.7	213.7
SD	20.5	39.2	29.0	40.8	37.2	33.8	31.5	28.2	32.4	9.4	33.49
E	14.5	19.5	5.92	6.90	4.58	2.59	2.70	3.10	8.98	6.66	1.44
R	135-185	165-275	155-275	105-265	115-295	105-325	115-285	135-285	165-265	195-215	105-325

TABLE 27--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 165 - 174											
N	11	29	61	141	209	216	162	42	9	1	881
M	216.8	214.3	229.8	240.6	241.	236.8	237.4	225.7	249.5	270	236.9
SD	52.7	43.2	41.2	34.5	33.	33.8	32.2	30.6	31.96	..	34.24
E	16.7	8.16	5.28	2.90	2.28	2.30	2.53	4.72	11.30	..	1.15
R	110-290	130-290	130-370	170-350	130-210	130-330	130-350	150-310	210-290	..	130-370
Levels 175 - 184											
N	29	36	77	118	155	137	53	13	1	1	620
M	219.2	249.5	251.1	248.2	260.4	257.9	250.7	262.2	265	215	253
SD	45.5	38.0	42.2	32.5	33.5	35.8	35.6	29.6	..	..	35.07
E	8.6	6.43	4.81	2.99	2.69	3.06	4.88	8.55	..	..	1.41
R	115-295	165-345	155-345	175-345	175-365	195-385	175-325	205-305	..	..	115-385
Levels 185 - 194											
N	26	43	47	61	46	28	4	1	1	..	262
M	236.8	252.8	262.4	264.3	273.4	271.6	284.5	255	245	..	261.8
SD	31.4	35.01	37.96	33.4	33.6	37.0	10.	..	..	..	36.55
E	6.96	5.05	5.54	4.27	4.96	7.13	5.77	..	..	..	2.26
R	165-315	195-345	195-335	195-345	125-365	155-355	275-295	..	..	..	125-365
Levels 195 - 204											
N	25	15	13	8	1	3					65
M	251.7	273.2	299.1	284.5	255.	251.1					271.6
SD	17.46	42.2	33.2	32.01	..	24.9					40.78
E	6.76	11.29	9.59	12.1	..	17.6					5.06
R	185-335	175-345	255-365	245-355	..	225-285					175-365

TABLE 27--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
					Levels 205 - 234						
N	21	3	2								26
M											261.4
SD											36.5
E											7.3
R											160-350
					Total Number						
	103	139	242	394	560	699	555	269	74	16	3088

TABLE 28

PARALLEL BAR DIPS

	CHANNELS										
	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 95 - 104											
N	1		2		1	1	3	2	1		11
M											1.64
SD											1.15
E											.36
R											0-4
Levels 105 - 114											
N						6	8	12	5	1	32
M						2.5	2.5	1.5	1.8	7	2.16
SD						3.09	2.17	1.04	1.46	..	2.44
E						1.38	.82	.31	.73	..	.43
R						0-9	0-9	0-4	0-4	..	0-9
Levels 115 - 124											
N	2			1	3	11	25	14	4	2	62
M	2			2	3.33	1.82	2.20	2.14	2	4	2.21
SD	..			..	2.05	2.3	1.8	2.17	1.73	1.0	2.46
E	..			..	1.45	.72	.36	.60	1.00	1.00	.26
R	..			..	1-6	0-7	0-7	0-7	1-5	3-5	0-7
Levels 125 - 134											
N	3		2	9	12	39	32	25	9		131
M	1.67		1.5	2.56	3.33	3.87	2.56	3.52	1.89		3.12
SD	1.25		1.5	3.32	3.72	3.58	2.67	2.43	1.73		3.08
E	.84		1.5	1.17	1.12	.57	.47	.50	.61		.27
R	0-3		0-3	0-11	0-12	0-13	0-14	0-10	0-6		0-14

TABLE 28--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
					Levels 135 - 144						
N	4	3	4	5	20	18	41	26	12	4	137
M	2.50	2.67	1.75	.60	2.65	4.06	3.05	2.81	2.92	1.5	2.85
SD	2.59	2.05	1.08	.8	3.5	3.8	2.2	3.02	2.54	1.11	2.86
E	1.49	1.45	.62	.4	.79	.92	.34	.60	.76	.64	.24
R	1-7	0-5	0-3	0-2	0-13	0-12	0-8	0-11	0-8	0-3	0-13
					Levels 145 - 154						
N	3	3	14	20	50	77	100	53	22	2	344
M	7.66	3.00	6.71	3.95	5.36	6.50	6.14	4.25	3.5	2	5.50
SD	4.03	4.24	1.74	4.16	4.72	4.20	5.12	3.08	4.09	1.0	4.45
E	2.85	2.99	1.74	.95	.67	.48	.51	.42	.89	1.0	.24
R	2-11	0-9	0-18	0-14	0-27	0-17	0-30	0-13	0-15	1-3	0-30
					Levels 155 - 164						
N	8	10	38	64	118	188	147	87	16	3	679
M	1.57	8.4	6.61	7.27	6.92	7.87	5.99	5.46	4.75	.67	6.65
SD	1.098	4.32	5.84	4.41	4.67	4.19	3.80	3.18	3.8	.47	4.42
E	.41	1.44	.95	.55	.43	.31	.31	.34	.98	.33	.17
R	0-3	1-15	0-20	0-18	0-27	0-30	0-18	0-14	0-13	0-1	0-30
					Levels 165 - 174						
N	11	29	68	153	226	251	190	50	7	1	986
M	3.18	6.07	7.65	8.20	7.61	7.42	6.89	6.32	5.43	7	7.36
SD	4.45	4.78	4.83	4.52	3.91	3.91	3.98	3.37	2.36	..	4.22
E	1.41	.89	.59	.37	.26	.25	.29	.48	.96	..	.13
R	0-15	0-18	0-23	0-23	0-19	0-25	0-25	0-15	2-10	..	0-25

TABLE 28--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 175 - 184											
N	30	36	77	124	166	146	56	15	2		652
M	4.30	6.75	6.54	7.22	7.56	6.84	5.70	7.47	4.5		6.73
SD	3.68	4.07	4.72	4.18	4.28	3.93	3.7	4.7	2.5		4.10
E	.67	.68	.54	.38	.33	.33	.49	1.25	2.50		.16
R	0-13	0-16	0-20	0-22	0-23	0-20	0-17	1-21	2-7		0-23
Levels 185 - 194											
N	27	45	52	61	50	30	6	1	1		273
M	3.70	4.87	6.25	5.79	7.	6.27	6.5	1.	4.		5.73
SD	3.34	4.17	3.9	3.97	4.41	3.73	2.45	..	..		4.04
E	.66	.62	.53	.51	.62	.68	1.09	..	..		.24
R	0-10	0-18	0-17	0-16	0-15	1-16	4-11	..	..		0-18
Levels 195 - 204											
N	23	19	17	9	1	3	1				73
M	2.65	3.89	7.94	5.67	4.	2.	1.				4.55
SD	2.74	3.06	4.20	2.86	..	1.0	..				3.81
E	.57	.72	1.05	1.01	..	1.0	..				.45
R	0-10	0-11	0-18	2-12	..	1-3	..				0-18
Levels 205 - 234											
N	23	2	2								27
M											2.18
SD											2.22
E											4.35
R											0-7
Total Number											
	135	147	276	446	647	770	609	285	79	13	3407

TABLE 29

PULL-UPS

	CHANNELS										
	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 85 - 104											
N	1		2		1	3	12	8	3	1	31
M											5.03
SD											2.78
E											.56
R											0-17
Levels 105 - 114											
N		1	3	5	6	9	16	15	9	1	65
M		3.0	4.0	4.0	4.0	3.67	4.31	4.73	2.67	10.0	4.09
SD		..	..	..	3.37	3.50	2.99	2.05	2.86	..	2.60
E		..	..	..	.26	1.24	.77	.55	1.01	..	.32
R		..	..	..	3-5	0-11	0-9	0-9	0-7	..	0-11
Levels 115 - 124											
N	1			3	10	18	35	26	11	4	108
M	1.0			8.33	4.30	4.22	3.97	4.0	4.64	4.75	4.19
SD	..			5.4	2.45	4.48	2.6	3.04	2.84		3.43
E	..			3.82	.82	1.08	.44	.61	.90		.33
R	..			1-14	1-9	0-17	0-11	0-11	1-12	0-8	0-17
Levels 125 - 134											
N	3	1	4	11	23	54	74	44	15	6	235
M	4.67	..	3.0	3.91	3.87	4.41	5.23	5.14	3.0	5.33	4.73
SD	3.06	..	2.12	4.5	3.26	2.8	3.54	2.96	3.77	3.12	3.33
E	1.24	..	1.22	1.42	.70	.38	.41	.45	1.0	1.56	.22
R	3-6	..	1-7	0-13	0-12	0-15	0-16	0-12	0-11	0-10	0-16

TABLE 29--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 135 - 144											
N	8	4	8	13	47	56	76	54	30	5	301
M	3.75	2.00	1.38	3.63	5.38	7.11	5.80	5.59	6.7	2.40	5.66
SD	3.79	2.91	1.22	3.45	4.49	4.56	3.68	3.29	3.34	1.67	4.0
E	1.43	1.67	.05	.96	.65	.61	.42	.45	.61	.84	.23
R	0-12	0-7	0-3	0-10	0-16	0-20	0-18	0-14	0-12	0-4	0-20
Levels 145 - 154											
N	2	8	17	41	93	150	166	97	38	4	616
M	7	2.62	5.88	6.54	7.74	7.70	7.86	6.37	6.71	7.25	7.27
SD	7	..	5.07	4.74	4.63	3.61	4.05	4.6	3.6	2.06	4.12
E	6.71	.90	1.27	.74	.48	.29	.31	.47	.58	1.46	.17
R	0-14	0-3	0-17	0-18	0-17	0-18	0-17	0-18	0-14	3-10	0-18
Levels 155 - 164											
N	7	16	38	61	121	314	231	144	28	6	966
M	7	7.19	8.37	8.64	9.20	8.46	7.75	7.10	6.29	4.40	8.07
SD	7.63	5.0	4.9	4.6	3.8	3.7	3.7	3.22	3.24	3.1	3.92
E	3.11	1.29	.79	.59	.34	.21	.24	.27	.62	1.40	.13
R	0-23	1-22	0-20	0-25	1-19	1-23	0-24	0-18	0-14	2-11	0-25
Levels 165 - 174											
N	27	37	92	201	337	366	261	67	17	2	1407
M	3.33	5.51	7.42	8.60	8.50	8.54	8.16	7.51	7.42	12	8.18
SD	3.52	3.72	4.10	3.76	3.6	3.53	3.50	3.11	2.98	6.0	3.73
E	1.69	1.62	.43	.27	.19	.18	.22	.38	.74	6.0	.09
R	0-12	0-13	0-16	1-21	0-25	0-20	0-20	1-13	3-15	6-18	0-25

TABLE 29--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 175 - 184											
N	44	55	112	171	222	183	70	24	3	3	887
M	4.43	6.04	6.71	7.88	8.02	7.67	7.47	6.71	7	7.05	7.31
SD	2.59	3.85	3.56	4.25	3.94	3.75	3.37	3.54	3.26	2.94	3.82
E	.53	.48	.40	.30	.25	.25	.42	.68	1.15	2.08	.13
R	0-13	0-13	0-20	0-23	0-25	0-18	0-20	2-15	5-9	3-10	0-25
Levels 185 - 194											
N	44	65	61	86	59	33	7	1	2	1	359
M	3.34	4.78	6.21	6.27	5.71	7.21	7.57	4	1.5	5	5.84
SD	2.69	3.54	3.72	3.75	3.05	3.7	2.61	..	.5	..	3.59
E	1.41	1.44	.48	.40	.40	.64	1.07	..	.5	..	.19
R	0-10	0-15	1-16	0-19	0-12	0-15	5-13	..	1-2	..	0-19
Levels 195 - 204											
N	33	26	19	12	3	6	2				101
M	2.64	3.85	6.95	6.25	5.33	4.00	4.00				4.59
SD	2.49	2.23	3.20	3.14	1.25	2.07	1				3.43
E	.43	.45	.75	.95	.88	.92	.71				.34
R	0-13	0-8	1-12	2-12	4-7	2-10	3-5				0-17
Levels 205 - 234											
N	24	4	3								31
M											2.30
SD											4.11
E											.75
R											0-12
Total Number											
	194	217	359	604	922	1192	950	480	156	33	5107

TABLE 30

PUSH-UPS

	CHANNELS										
	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
					Levels 85 - 104						
N						3	9	6	2		20
M											16.7
SD											8.11
E											1.8
R											5-32
					Levels 105 - 114						
N		1			2	4	11	14	8		40
M		7			17		19.3	17.7	21.4		18.6
SD		..			..		10.7	7.5	9.5		8.69
E		..			...		3.4	1.4	3.6		1.4
R		..			..	15-24	5-44	5-34	5-44		5-44
					Levels 115 - 124						
N		1		2	8	11	18	20	6	3	69
M		15		14.5	13.9	11.5	15.9	14.5	12.	13.7	14.1
SD		..		7.5	7.0	7.2	10.5	9.1	9.1	9.4	9.4
E		..		7.5	2.7	2.2	2.6	2.0	4.0	6.7	1.1
R		..		5-24	0-34	0-29	0-39	0-29	0-25	5-29	0-39
					Levels 125 - 134						
N	1	1	2	7	16	28	49	19	14	5	142
M	15	2	19.5	15.7	15.4	19.1	16.7	19.1	17.4	16	17.3
SD	..	..	12.5	9.1	7.4	9.8	8.6	6.5	4.4	3.0	8.26
E	..	..	12.5	3.8	2.0	1.9	1.2	1.6	1.2	1.5	.7
R	..	..	5-34	0-29	5-29	5-44	0-44	5-34	10-24	10-24	0-44

TABLE 30--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
					Levels 135 - 144						
N	5	2	4	11	35	46	55	37	21	4	220
M	16.8	14.5	14.3	22.9	17.7	20.	17.6	16.5	17.5	16.6	18.
SD	6.3	2.5	4.4	9.8	8.2	10.7	7.7	7.7	6.5	5.4	8.8
E	3.1	2.5	2.5	3.7	1.3	1.6	1.0	1.2	1.4	3.1	.6
R	10-29	10-19	5-19	10-39	5-44	0-54	0-39	0-39	5-39	5-24	0-49
					Levels 145 - 154						
N	5	9	27	46	113	115	104	61	27	1	508
M	2.3	16.4	21.8	24.4	24.5	22.9	22.3	19.3	17.4	7	22.3
SD	11.1	7.2	12.8	12.9	11.8	11.8	8.7	8.3	7.7	..	10.8
E	5.6	2.4	2.4	1.8	1.0	1.0	.8	1.0	1.5	..	.5
R	10-44	5-34	5-54	0-64	0-64	0-95	5-49	0-49	5-39	..	0-95
					Levels 155 - 164						
N	7	12	22	34	82	177	144	75	16	4	573
M	14.6	21.2	26.3	27.4	27.2	24.4	22.6	21.3	18.3	7	23.7
SD	6.9	11.7	15.8	16.3	10.4	9.5	10.2	8.8	10.1	3.5	10.9
E	2.4	3.4	3.4	2.9	1.8	.7	.9	1.0	2.8	1.4	.5
R	5-29	0-49	5-74	5-95	5-74	5-74	5-64	5-49	5-44	0-14	0-95
					Levels 165 - 174						
N	22	17	36	80	175	174	125	34	9	..	672
M	18.1	21.1	23.1	27.6	24.7	25.3	25.0	21.1	20		24.6
SD	12.7	10.8	11.1	13.4	9.7	8.0	10.3	7.1	6.3		10.2
E	2.8	2.7	1.9	1.5	.8	.6	.9	1.4	2.7		.4
R	0-44	5-44	5-59	0-79	0-54	5-49	0-64	0-39	10-29		0-79

TABLE 30--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 175 - 184											
N	14	18	36	63	76	74	35	12		2	330
M	20.1	22.8	23.7	26.6	25.7	23.	26.3	29.1		12	24.7
SD	8.1	6.3	14.3	13.8	12.6	9.4	10.1	11.8		..	11.1
E	2.2	1.5	2.3	1.7	1.5	1.1	1.9	3.6		..	.7
R	0-54	10-39	10-95	0-74	0-64	0-74	5-64	10-54		..	0-95
Levels 185 - 194											
N	19	26	17	23	24	8	3	1	1	1	123
M	15.3	19.7	21.1	20.7	21.6	19.5	22	17	17	7	19.8
SD	7.1	10.3	8.1	9.0	7.5	11.2	7.1	..	..	..	8.9
E	1.7	2.0	2.0	1.9	1.6	1.3	5.0	..	..	..	.8
R	5-29	0-44	5-39	5-44	10-39	5-39	15-34	..	..	..	0-44
Levels 195 - 204											
N	15	12	6	5	2	5	2				47
M	17	21.6	20.3	17	17	20	24				17.6
SD	8.5	10.7	8.0	3.2	0	11.5	5.4				9.6
E	2.3	3.2	3.6	1.6	0	5.8	5.4				1.4
R	0-34	5-39	5-34	10-24	0	5-34	17-27				0-34
Levels 205 - 234											
N	8										8
M	18.9										18.9
SD	8.6										8.6
Total Number											
	96	99	150	271	533	645	555	279	102	22	2752

TABLE 31

SARGENT JUMP

CHANNELS

	Above A_4	A_4	A_3	A_2	A_1	Mcc	B_1	B_2	B_3	Below B_3	All Types
Levels 85 - 104											
N	1		2	1	1	3	11	8	3	1	31
M											13.5
SD											2.07
E											.38
R											9-17
Levels 105 - 114											
N			1		2	9	19	21	11	1	64
M			12.5		13	13.45	14.24	14.31	14.0	13.5	14.1
SD			..		.5	1.0	.21	.14	.46	..	2.20
E			..		.5	.71	.56	.48	.67	..	.27
R			..		12.5-13.5	10.5-16.5	10.5-19.5	10.5-18.5	9.5-18.5	..	9.5-19.5
Levels 115 - 124											
N	2	1		3	11	20	34	25	11	4	111
M	11.5	12.5		13.8	13.1	14.6	15.1	15.1	15.1	15.8	14.8
SD	3.2	..		2.5	2.0	2.2	2.1	2.6	2.4	.82	2.38
E	3.16	..		1.75	.64	.50	.37	.52	.75	1.51	.23
R	95-13.5	..		10.5-16.5	9.5-15.5	11.5-18.5	10.5-18.5	10.5-21.5	11.5-20.5	14.5-16.5	9.5-21.5

TABLE 31--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 125 - 134											
N	3	1	4	12	23	57	71	46	18	6	241
M	15.5	13.5	13.7	14.9	14.2	15.9	15.4	16.4	16.3	15.6	15.6
SD	1.0	..	2.3	2.5	1.9	2.5	2.4	2.5	2.3	1.7	2.48
E	1.0	..	1.31	.75	.40	.33	.29	.37	.56	.75	.15
R	14.5-16.5	..	11.5-17.5	11.5-21.5	10.5-18.5	10.5-22.5	10.5-23.5	10.5-23.5	13.5-22.5	12.5-17.5	10.5-23.5
Levels 135 - 144											
N	8	4	9	14	48	56	79	56	28	5	307
M	15.1	13.2	13.1	16	16.1	16.1	16.5	16.7	17.1	14.9	16.2
SD	2.9	1.8	1.3	2.9	2.4	2.9	2.5	2.6	3.3	1.5	2.78
E	1.1	1.02	.47	.80	.35	.39	.28	.36	.64	.75	.16
R	11.5-19.5	10.5-15.5	11.5-14.5	12.5-22.5	10.5-22.5	10.5-22.5	11.5-26.	11.5-21.5	11.5-26.0	12.5-16.	10.5-26.0
Levels 145 - 154											
N	10	16	40	72	175	145	162	96	41	5	762
M	15.8	14.8	17.6	18.2	18.2	18.3	18.5	18.4	17.1	20.5	18
SD	3.3	3.3	4.0	3.5	2.9	3.0	4.5	2.6	2.6	2.2	3.03
E	1.1	.86	.65	.41	.23	.25	.57	.27	.41	.11	.11
R	11-21	7-23	10-30	10-28	10-27	6-26	9-25	11-24	11-24	16-22	6-30
Levels 155 - 164											
N	4	12	34	56	110	294	220	133	23	6	892
M	15.5	16.9	18.2	18.8	19.2	19.2	19.1	19.0	19.1	17.1	19.0
SD	4.9	3.7	3.4	3.1	2.6	2.8	2.9	2.6	2.9	2.6	2.9
E	2.8	1.12	.50	.42	.25	.16	.20	.23	.64	1.17	.10
R	9-22	11-20	10-26	11-26	11-26	11-29	7-26	12-29	12-26	13-21	7-29

TABLE 31--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 165 - 174											
N	26	40	86	195	318	344	233	59	16	2	1319
M	16.5	18.6	19.8	20.5	20.4	20.6	20.5	21.1	19.6	18.5	19.5
SD	2.5	3.9	4.0	3.1	3.2	2.9	2.9	3.0	3.2	2.0	2.7
E	.52	.63	.44	.23	.18	.16	.20	.40	.83	1.41	.20
R	7-23	6-25	7-29	11-29	10-27	11-27	13-28	14-28	14-23	16-20	6-29
Levels 175 - 184											
N	43	53	104	154	202	172	66	22	4	3	823
M	17.4	19.1	19.4	20.4	20.8	20.9	20.4	20.5	21.7	17.8	20.3
SD	3.6	3.9	2.9	2.8	2.7	2.7	2.9	2.3	1.6	2.5	3.1
E	.57	.54	.29	.23	.19	.21	.36	.49	.94	1.76	.11
R	10-25	10-29	9-26	13-30	9-27	15-29	15-28	16-24	20-24	14-20	9-30
Levels 185 - 194											
N	40	68	58	82	60	32	7	1	2	1	351
M	17.8	18.8	19.7	20.7	20	20.8	19.7	20	21	24	19.7
SD	3.9	3.1	2.7	3.2	3.1	3.2	2.6	..	.5	..	3.2
E	.62	.38	.35	.35	.41	.57	1.06	..	.5	..	.17
R	11-29	11-24	13-26	13-30	8-25	12-25	17-23	..	20-21	..	8-30
Levels 195 - 204											
N	34	22	17	11	2	5	3				94
M	16.8	18.6	21.3	18.7	22	20.5	17.5				18.9
SD	2.3	2.9	2.8	1.5	1.5	2.0	4.9				3.6
E	.63	.62	.70	.49	1.5	1.02	3.46				.37
R	6-24	11-24	14-24	17-23	20-23	18-24	10-21				6-24

TABLE 31--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 205 - 234											
N	31	4	3								38
M											17.3
SD											3.3
E											.54
R											9-21
Total Number											
	202	221	358	600	952	1137	905	467	157	34	5033

TABLE 32

SIT-UPS

	CHANNELS										
	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 85 - 104											
N											22
M											26.7
SD											17.02
E											3.72
R											
Levels 105 - 114											
N					3	4	6	16	9		38
M											35.98
SD											16.95
E											2.75
R											10-100
Levels 115 - 124											
N				3	9	9	13	20	5	1	60
M				25.3	31.5	33.7	24.7	32.3	30	32	30.67
SD				2.37	11.4	15.7	12.3	15.95	16.8	..	14.6
E				1.62	4.03	5.55	3.55	3.66	8.4	..	1.88
R				20-29	10-49	10-74	5-54	5-64	15-64	..	5-74
Levels 125 - 134											
N		1	1	7	15	22	44	25	9	3	127
M		32.0	22.0	29.1	39.3	31.5	33.6	44.8	40.3	49.7	34.4
SD		..	..	12.2	23.6	10.95	19.8	27.3	13.9	35.7	16.77
E		..	..	4.95	6.32	2.29	2.99	5.45	4.92	25.2	1.50
R		..	..	5-54	10-74	15-54	5-100	10-100	20-64	20-100	5-100

TABLE 32--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 135 - 144											
N		2	4	9	28	34	37	29	13	4	160
M		32	38.3	35.9	41.3	34.8	38.6	41.8	38.2	37	39.2
SD		20	14.8	20.1	23.92	19.8	21.5	14.5	20.2	24.23	21.25
E		20	8.55	6.65	4.61	3.39	3.54	2.74	5.85	13.9	1.68
R		10-54	25-69	15-89	5-100	5-100	5.100	20-74	10-59	10-79	5-100
Levels 145 - 154											
N	2	9	21	21	67	69	79	33	14	1	316
M	54.5	26.4	41.3	44.6	43.6	43.9	43.7	42.9	41	37	42.8
SD	2.5	17.7	18.98	19.6	20.9	23.5	21.5	22.6	15.0	..	22.04
E	2.5	6.26	4.25	4.39	2.57	2.83	2.42	3.95	4.16	..	1.28
R	50-59	5-74	10-100	10-100	10-100	5-100	10-100	5-100	20-89	..	5-100
Levels 155 - 164											
N		8	15	17	44	89	82	44	7	2	308
M		42.6	49.3	58.8	46.3	53.0	47.7	55.3	55.6	24.5	51.03
SD		26.5	23.2	26.2	18.8	21.0	23.02	23.6	30.8	2.5	23.35
E		9.27	6.21	6.55	2.84	2.23	2.55	3.57	12.5	2.5	1.32
R		10-64	20-59	20-100	10-100	20-100	5-100	10-100	20-100	20-29	5-100
Levels 165 - 174											
N	12	11	20	48	90	80	65	13			339
M	34.2	32.9	45.5	55.7	49.8	58.2	56.6	62.3			53.3
SD	23.4	10.2	17.6	25.4	24.3	25.5	26.0	23.2			25.39
E	7.05	3.22	4.04	3.69	2.56	2.86	3.23	6.68			1.38
R	5-100	20-54	5-74	5-100	10-100	15-100	5-100	20-100			5-100

TABLE 32--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 175 - 184											
N	12	7	14	28	41	33	17	2		1	155
M	29.9	34.8	43.8	56.8	60.2	54.7	68.8	42		37	43.23
SD	10.4	8.4	19.4	23.6	24.4	25.2	25.8	8.5			27.12
E	3.14	3.42	5.39	4.55	3.79	4.39	6.45	8.5			2.17
R	10-59	20-49	20-100	20-100	25-100	15-100	25-100	30-100			10-100
Levels 185 - 194											
N	8	15	10	11	15	4	1	1			65
M	30.8	40.7	44.5	44.3	46.7	45.8	32	42			42.23
SD	11.4	15.5	16.4	20.3	21.7	10.2					18.95
E	4.27	4.13	5.45	6.40	5.80	5.90					2.35
R	15-54	20-59	10-84	20-100	20-100	35-64					15-100
Levels 195 - 204											
N	11	7	7	1	1	2	1				30
M	39.7	37	29.9	42	42	42	32				35.2
SD											11.73
E											2.18
R											4-74
Levels 205 - 224											
N											5
M											28.4
SD											11.41
E											5.7
R											18-48

TABLE 32--Continued

Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Total Number										
50	60	92	145	313	349	355	189	59	13	1625

TABLE 33

SQUAT JUMPS

	CHANNELS										
	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
					Levels 105 - 114						
N						2	3	6	3		14
M											50.3
SD											13.24
E											3.68
R											
					Levels 115 - 124						
N		1		1	2	4	11	9	2	2	32
M		47		27	59.5	71	50.6	40.9	49.5	42	49.2
SD		..		..	2.5	22.7	15.1	9.05	2.5	..	18
E		..		..	2.5	13.1	4.78	3.19	2.5	..	3.18
R		..		..	55-67	25-100	25-87	25-57	47-52	..	25-100
					Levels 125 - 134						
N			1	4	7	15	21	15	10	3	76
M			22	33.1	57.4	43.3	46.0	50.3	43.5	58.7	46.5
SD			..	11.7	27.12	12.4	17.6	12.9	15.4	12.9	17.31
E			..	6.76	11.05	3.33	3.93	3.43	5.14	9.12	1.95
R			..	25-54	30-100	25-64	20-100	30-84	25-79	40-74	25-100
					Levels 135 - 144						
N	2	1		3	18	21	39	24	14	4	126
M	75	57		60.3	50.9	48.4	43.8	40.1	53.0	34.5	46.2
SD	25	..		11.79	14.4	15.95	19.1	13.3	20.2	14.64	17.4
E	25	..		8.36	3.48	3.56	3.06	2.77	5.60	8.43	1.55
R	50-100	..		50-79	25-79	30-100	10-100	15-74	20-100	20-49	10-100

TABLE 33--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 145 - 154											
N	3	3	9	15	39	86	83	50	21	2	311
M	42	37	58.7	52.0	55.8	49.4	52.0	49.6	44.8	42	50.8
SD	27.1	..	24.5	20.6	21.5	16.6	19.4	17.3	13.4	..	18.65
E	19.1	..	8.67	5.49	3.44	1.78	2.13	2.46	2.97	..	1.06
R	30-64	25-49	20-100	20-100	20-100	15-100	15-100	15-100	15-79	..	15-100
Levels 155 - 164											
N	6	11	33	56	119	164	138	66	10	3	606
M	43.6	48.1	49.3	47.7	52.2	52.4	49.9	48.2	32.5	37	51.2
SD	14.04	19.95	17.6	21.08	18.0	17.1	18.7	13.6	9.6	5.0	18.10
E	6.27	6.32	3.07	2.47	1.65	1.33	1.59	1.68	3.2	5.0	.734
R	35-64	20-79	20-100	20-100	10-100	10-100	10-100	10-89	10-44	30-49	10-100
Levels 165 - 174											
N	8	15	36	73	149	162	102	30	4	1	580
M	45.7	43.3	57.1	58.1	53.3	52.6	54.3	50.0	43.2	52	53.6
SD	20-4	16-7	20-3	21.98	17.3	17.5	19.1	15.6	7.4	..	18.4
E	9.15	4.45	3.37	2.57	1.42	1.37	1.89	2.85	4.27	..	.885
R	25-94	20-74	25-100	5-100	5-100	5-100	20-100	25-100	30-54	..	5-100
Levels 175 - 184											
N	20	17	33	60	62	65	29	9	1		296
M	39.7	51.1	52.9	45.6	56.3	51.2	49.9	45.4	42		50.6
SD	12.8	18.9	16.6	15.2	21.1	12.7	16.0	10.3	..		17.3
E	2.94	4.72	2.9	1.97	2.68	1.58	2.97	3.64	..		1.00
R	30-64	30-100	20-94	10-100	15-100	30-100	25-94	25-64	..		15-100

TABLE 33--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 185 - 194											
N	17	22	17	22	20	8	2	1	1	1	111
M	39.4	46.7	44.9	44.7	48.0	52.0	4.45	52	32	32	45.3
SD	8.9	19.7	14.0	14.1	18.5	17.2	2.5	..	..	..	16.0
E	2.22	4.30	3.51	3.08	4.26	6.5	2.5	..	..	..	1.52
R	25-59	10-100	20-74	10-74	15-100	25-100	40-49	..	..	..	10-100
Levels 195 - 204											
N	12	10	5	3	1	4					35
M	31.2	38	64	42	42	55.8					40.7
SD	9.7	18.0	17.5	4.1	..	5.5					14.80
E	2.92	6.0	8.25	2.88	..	3.14					2.5
R	15-52	15-82	45-100	35-47	..	45-62					15-100
Levels 205 - 225											
N	7										7
M											31.6
SD											13.80
E											5.63
R											5-55
Total Number											
	75	80	134	237	417	532	429	211	66	16	2194

TABLE 34

STANDING BROAD JUMP

	Channels: Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 85 - 104											
N	1		2		1	3	9	8	3	1	29
M											69.2
SD											11.3
E											2.14
R											58-84
Levels 105 - 114											
N		1			2	9	18	23	12	1	66
M		72			67	67	67.3	73.9	71.6	62	68.6
SD		..			5.0	9.2	10.6	11.9	6.1		10.3
E		..			5.0	3.24	2.57	2.54	1.83		1.27
R		..			60-72	57-77	45-89	45-89	55-92		45-92
Levels 115 - 124											
N		1		3	11	19	33	25	11	4	107
M		82		65.33	75.6	65.7	67.5	67.2	68.4	73.3	68.3
SD		..		10.9	7.4	10.5	8.0	12.4	9.2	6.5	10.05
E		..		2	2.34	2.42	1.39	2.53	2.91	3.92	.97
R		..		55-84	55-84	40-84	45-84	25-89	50-84	65-84	25-89

TABLE 34--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 125 - 134											
N	3	1	4	12	23	54	70	45	17	6	235
M	68.7	62	67	67	70.0	69.7	72.8	74.3	72.3	74.5	71.5
SD	13.12	..	6.12	10.0	8.1	10.7	9.6	8.1	7.4	4.9	9.17
E	.93	..	3.52	3.01	1.73	1.45	1.15	1.22	1.84	2.19	.96
R	55-89	64	55-74	50-89	60-84	40-99	50-104	60-99	55-89	70-84	40-104
Levels 135 - 144											
N	7	4	8	14	47	57	75	55	26	5	298
M	63.4	62.2	62.6	73.4	74.0	76.7	75.7	75.5	78.3	67.	74.8
SD	13.0	7.0	10.1	12.9	11.6	9.9	8.4	8.8	6.3	8.4	10.48
E	5.32	4.02	3.82	3.57	1.69	1.52	.97	1.17	1.26	4.17	6.10
R	45-84	50-79	45-74	45-94	40-99	55-99	55-99	45-94	65-94	55-84	40-99
Levels 145 - 154											
N	3	8	19	34	86	134	140	86	41	4	555
M	78.6	70.8	75.2	75.9	78.3	80.1	81.0	79.7	78.1	82.	79.3
SD	10.3	8.2	12.2	11.1	10.7	9.2	9.8	9.4	9.3	14.7	10.18
E	7.25	3.09	2.87	1.91	1.07	.79	.83	1.01	1.45	10.4	.43
R	65-94	60-84	40-99	50-99	50-104	55-104	45-109	50-104	50-99	60-99	40-99
Levels 155 - 164											
N	13	27	59	80	172	236	172	121	21	8	909
M	70.5	81.1	81.5	82.1	83.9	84.6	83.7	83.9	82.4	77.63	83.31
SD	9.8	8.0	12.1	10.7	10.6	8.6	9.1	9.1	5.9	13.0	9.89
E	2.97	1.57	1.56	1.19	.81	.56	.69	.84	1.32	4.6	.33
R	47-91	62-100	56-100	65-100	50-109	65-109	56-100	53-106	71-97	620-103	47-109

TABLE 34--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
Levels 165 - 174											
N	29	29	73	105	230	190	117	39	10	2	824
M	75.6	79.2	82.3	87.1	85.0	85.4	84.2	83.0	81.6	85.5	84.48
SD	14.9	12.8	10.9	7.4	9.3	8.9	8.3	5.2	6.8	10.5	9.89
E	2.83	2.43	1.28	.75	.61	.65	.77	.84	2.26	10.5	.35
R	47-109	56-100	50-100	71-100	47-103	62-109	47-106	62-94	68-91	74-97	47-109
Levels 175 - 184											
N	30	31	49	76	103	83	33	14	2	3	424
M	73.7	79.4	82.9	87.2	86.3	86.2	87.0	87.7	97.0	90.0	85.03
SD	13.3	11.6	8.9	9.5	9.9	6.2	9.0	6.2	..	8.7	8.33
E	2.46	2.07	1.27	1.09	.99	.68	1.57	1.73	..	4.35	.40
R	45-99	50-99	65-99	60-114	60-114	65-104	65-99	75-99	..	75-99	45-114
Levels 185 - 194											
N	26	34	23	33	29	12	3	1	1	1	163
M	74.1	79.2	82.2	85.8	83.9	82.8	92	97	87	77	81.9
SD	13.0	10.4	8.5	9.1	7.9	8.6	5	..	..	..	10.75
E	2.53	1.78	1.82	1.59	1.49	2.60	3.53	..	..	..	.84
R	50-99	50-104	60-99	65-104	70-99	65-99	85-99	85-102	..	..	50-104
Levels 195 - 204											
N	21	14	9	3	2	4	3				56
M	72.2	77.0	88.1	87	89.5	92	80.3				79.3
SD	13.3	9.7	9.1	5.0	2.5	7.9	6.24				14.11
E	2.98	2.69	3.20	5.0	2.5	4.55	4.40				1.89
R	35-97	62-97	70-97	80-92	85-92	80-102	70-87				35-102

TABLE 34--Continued

	Above A_4	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Below B_3	All Types
					Levels 205 - 230						
N	18	2	1								21
M											74.76
SD											6.85
E											1.51
R											60-88
					Total Number						
	151	152	247	360	706	801	673	417	144	35	3687

APPENDIX B

MEAN SCORES FOR CHANNEL GROUPS CLASSIFIED

BETWEEN LEVELS 155 - 184

TABLE 35

THE BURPEE TEST IN TEN SECONDS

Levels 155 - 184

Channel	Number Of Cases	Range in Score	Mean	S.D.	S.E.
A_5 ...	46	4.00-9.00	6.3	1.25	.184
A_4 ...	64	4.75-8.50	6.4	.94	.117
A_3 ...	141	4.00-9.50	6.6	.93	.078
A_2 ...	267	3.00-9.50	6.7	.98	.075
A_1 ...	417	3.00-9.75	6.6	.88	.043
M ...	487	3.50-9.00	6.6	.96	.043
B_1 ...	319	4.00-9.75	6.6	.92	.051
B_2 ...	139	3.75-9.75	6.4	.91	.077
B_3 ...	28	4.50-8.25	6.2	.95	.183
Total	1918	3-9.75	6.5	.97	.022

COMPARISON OF DIFFERENCES BETWEEN MEANS
OF SELECTED CHANNELS

Channels	Difference	S.E.	C.R.
A_5 and A_2 ...	.5	.19	2.47
A_4 and A_2 ...	.3	.13	2.53
B_3 and A_2 ...	.6	.19	3.00
B_2 and A_2 ...	.3	.097	3.40
B_1 and A_2 ...	.2	.078	2.05

TABLE 36

THE BURPEE TEST IN SIXTY SECONDS

Levels 155 - 184

Channel	Number Of Cases	Range in Score	Mean	S.D.	S.E.
A_5 ...	54	17-44	26.9	7.17	.97
A_4 ...	49	14-41	28.2	5.81	.83
A_3 ...	121	14-47	31.4	6.32	.57
A_2 ...	224	14-56	32.3	5.89	.39
A_1 ...	427	14-71	32.2	5.67	.27
M ...	480	14-65	32.1	5.83	.26
B_1 ...	340	14-59	31.2	5.73	.31
B_2 ...	122	14-52	31.6	5.62	.51
B_3 ...	34	20-41	30.1	6.29	1.07
Total	1856	14-71	31.62	5.96	.14

COMPARISON OF DIFFERENCES BETWEEN MEANS OF SELECTED CHANNELS

Channels	Difference	S.E.	C.R.
A_5 and A_2 ...	5.4	1.04	5.16
A_4 and A_2 ...	4.2	.91	4.58
A_4 and M ...	3.9	.87	4.58
B_2 and M	.5	.57	.89
B_2 and A_2 ...	.7	.64	1.07
B_3 and M ...	2.1	1.10	1.88
B_3 and A_2 ...	2.3	1.13	2.00

TABLE 37

THE DODGING RUN

Levels 155 - 184

Channel	Number Of Cases	Range in Seconds	Mean Seconds	S.D.	S.E.
A_4 ...	91	22-40	26.2	2.79	.29
A_3 ...	137	22-32	26.1	1.86	.16
A_2 ...	261	20-35	25.7	2.04	.13
A_1 ...	373	22-35	25.9	1.92	.09
M ...	456	21-33	25.9	1.85	.08
B_1 ...	306	21-37	26.1	2.45	.14
B_2 ...	124	20-35	25.7	2.27	.20
B_3 ...	22	23-32	26.7	1.95	.41
Total	1770	20-40	25.90	2.13	.51

COMPARISON OF DIFFERENCES BETWEEN MEANS
OF SELECTED CHANNELS

Channels	Difference	S.E.	C.R.
A_4 and A_2 ...	.49	.31	1.58
A_4 and B_2 ...	.56	.35	1.60
A_3 and A_2 ...	.36	.20	1.80
B_3 and M ...	.78	.41	1.90

TABLE 38

THE 440 YARD RUN

Levels 155 - 184

Channel	Number Of Cases	Range of Time	Mean (Seconds)	S.D.	S.E.
A_4 ...	29	62.9-92.9 sec.	75.50	8.95	1.69
A_3 ...	55	60.9-88.9 sec.	74.29	6.22	.84
A_2 ...	106	60.9-88.9 sec.	72.33	6.43	.62
A_1 ...	125	58.9-84.9 sec.	71.61	5.61	.50
M ...	158	58.9-88.9 sec.	71.52	6.36	.51
B_1 ...	86	58.9-84.9 sec.	71.55	7.98	.86
B_2 ...	50	60.9-84.9 sec.	70.99	5.21	.74
Total	609	58.9-92.9 sec.	71.92	5.78	.23

COMPARISON OF DIFFERENCES BETWEEN MEANS
OF SELECTED CHANNELS

Channels	Difference	S.E.	C.R.
A_4 and A_1 ...	4.89	1.76	2.21
A_3 and A_1 ...	2.68	.98	2.73
A_3 and M ...	2.77	.98	2.82
A_3 and B_2 ...	3.30	1.12	2.95
A_3 and B_1 ...	2.74	1.20	2.28

TABLE 39

THE HAND GRIP

Levels 155 - 184

Channel	Number Of Cases	Range	Mean (Lbs.)	S.D.	S.E.
A_4 ...	113	119-340 lbs.	225.3	45.41	4.25
A_3 ...	163	129-379 lbs.	221.8	45.27	3.54
A_2 ...	294	119.359 lbs.	239.4	37,00	2.16
A_1 ...	430	129-369 lbs.	244.2	36.96	1.78
M ...	524	109-389 lbs.	235.9	37.66	1.64
B_1 ...	351	119-389 lbs.	229.9	35.61	1.90
B_2 ...	140	139-319 lbs.	221.6	32.37	2.73
B_3 ...	29	179-299 lbs.	227.9	32.84	6.22
Total	2044	109-389 lbs.	235.65	37.34	.83

COMPARISON OF DIFFERENCES BETWEEN MEANS
OF SELECTED CHANNELS

Channels	Differences	S.E.	C.R.
A_4 and A_1 ...	18.8	4.60	4.09
A_3 and A_1 ...	22.3	3.96	5.63
A_2 and A_1 ...	4.8	2.59	1.86
M and A_1 ...	8.2	2.42	3.40
B_1 and M ...	6.1	2.50	2.42
B_2 and M ...	14.3	3.18	4.49
B_3 and M ...	8.0	6.43	1.25

TABLE 40

PARALLEL BAR DIPS

Levels 155 - 184

Channel	Number Of Cases	Range	Mean	S.D.	S.E.
A_5 ...	49	0-15	3.6	4.79	.69
A_4 ...	75	0-18	6.7	4.45	.51
A_3 ...	183	0-23	6.9	5.04	.37
A_2 ...	341	0-23	7.7	4.40	.22
A_1 ...	510	0-27	7.4	4.23	.19
M ...	585	0-30	7.4	4.03	.17
B_1 ...	393	0-25	6.4	3.91	.19
B_2 ...	152	0-21	5.9	3.48	.28
B_3 ...	29	0-13	4.4	3.59	.68
Total	2317	0-27	7.0	4.25	.09

COMPARISON OF DIFFERENCES BETWEEN MEANS
OF SELECTED CHANNELS

Channels	Difference	S.E.	C.R.
A_5 and A_2 ...	4.1	.72	5.70
A_4 and A_2 ...	1.0	.55	1.74
A_3 and A_2 ...	.7	.43	1.65
B_1 and M ...	1.0	.25	4.16
B_2 and M ...	1.5	.32	4.62
B_3 and M ...	3.1	.70	4.38

TABLE 41

PULL-UPS

Levels 155 - 184

Channel	Number Of Cases	Range	Mean	S.D.	S.E.
A_5 ...	78	0-23	3.9	4.14	.47
A_4 ...	108	0-22	6.0	3.89	.37
A_3 ...	242	0-20	7.4	4.35	.28
A_2 ...	433	0-25	8.3	3.98	.19
A_1 ...	680	0-25	8.5	3.70	.14
M ...	863	0-23	8.3	3.57	.12
B_1 ...	562	0-24	7.9	3.57	.15
B_2 ...	235	0-18	7.2	3.20	.21
B_3 ...	59	0-18	6.9	3.35	.43
Total	3260	0-25	7.9	3.83	.067

COMPARISON OF DIFFERENCES BETWEEN MEANS OF SELECTED CHANNELS

Channels	Difference	S.E.	C.R.
A_5 and A_1 ...	4.5	.49	9.20
A_4 and A_1 ...	2.5	.39	6.28
A_3 and A_1 ...	1.1	.31	3.58
B_1 and M ...	.4	.19	2.26
B_2 and M ...	1.2	.24	4.83
B_2 and B_1 ...	.7	.26	2.82
B_3 and M ...	1.4	.45	3.20
B_3 and B_1 ...	1.0	.21	4.82

TABLE 42

PUSH-UPS

Levels 155 - 184

Channel	Number Of Cases7	Range	Mean	S.D.	S.E.
A_5 ...	51	2-52	18.6	10.61	1.48
A_4 ...	47	2-47	21.8	9.67	1.41
A_3 ...	94	5-100	24.1	13.61	1.40
A_2 ...	177	2-100	27.2	1.06	14.15
A_1 ...	333	2-72	25.6	10.63	.58
M ...	425	2-72	24.5	8.92	.43
B_1 ...	304	2-62	24.	10.41	.59
B_2 ...	152	2-52	21.	9.54	.95
Total	1583	2-100	24.3	10.85	.27

COMPARISON OF DIFFERENCES BETWEEN MEANS
OF SELECTED CHANNELS

Channels	Differences	S.E.	C.R.
A_2 and A_5 ...	8.6	1.81	4.75
A_2 and A_4 ...	5.4	1.76	3.08
A_2 and A_3 ...	3.1	1.75	1.79
A_2 and A_1 ...	1.7	1.20	1.39
A_2 and M ...	2.7	1.14	2.36
A_2 and B_1 ...	3.2	1.21	2.66
A_2 and B_2 ...	6.2	1.42	4.39

TABLE 43

THE SARGENT JUMP

Levels 155 - 184

Channel	Number Of Cases	Range	Mean	S.D.	S.E.
A_5 ...	73	7-25 Inches	16.9 Inches	3.36	.39
A_4 ...	105	6-29 Inches	18.6 Inches	3.97	.38
A_3 ...	224	7-29 Inches	19.4 Inches	3.50	.23
A_2 ...	405	11-30 Inches	20.2 Inches	3.07	.15
A_1 ...	630	10-27 Inches	20.3 Inches	3.02	.12
M ...	810	11-29 Inches	20.1 Inches	2.95	.10
B_1 ...	519	7-28 Inches	19.9 Inches	3.06	.13
B_2 ...	214	12-29 Inches	19.7 Inches	2.86	.19
B_3 ...	43	12-26 Inches	19.5 Inches	3.00	.46
Below B_3 ...	11	13-21 Inches	17.9 Inches	2.82	.89
Below B_2 ...	54	12-29 Inches	18.5 Inches	3.12	.43
Total	3088	6-29 Inches	19.7 Inches	2.73	.49

COMPARISON OF DIFFERENCES BETWEEN MEANS
OF SELECTED CHANNELS

Channels	Difference	S.E.	C.R.
A_5 and A_2 ...	3.3	.42	7.70
A_4 and A_2 ...	1.6	.42	3.82
B_3 and A_1 ...	.87	.47	1.63
B_4 and A_1 ...	2.4	.90	2.64
B_4 and M ...	1.7	.44	3.79

TABLE 44

SIT-UPS

Levels 155 - 184

Channel	Number Of Cases	Range	MeanMean	S.D.	S.E.
A_5 ...	24	7-57	32.1	18.29	4.41
A_4 ...	26	12-62	36.4	17.22	3.45
A_3 ...	49	7-10	46.2	20.08	2.86
A_2 ...	93	7-10	56.6	25.10	2.62
A_1 ...	175	12-100	51.3	23.64	1.78
M ...	202	17-100	55.3	23.76	1.66
B_1 ...	164	7-10	53.4	25.42	1.98
B_2 ...	69	22-87	55.1	24.66	2.97
Total	805	7-10	50.49	25.27	.89

COMPARISON OF DIFFERENCES BETWEEN MEANS
OF SELECTED CHANNELS

Channels	Differences	S.E.	C.R.
A_5 and A_2 ...	24.5	5.13	4.27
A_5 and M ...	23.2	4.71	4.94
A_4 and B_1 ...	16.9	3.97	4.28
A_4 and B_2 ...	18.7	4.55	4.10
A_4 and M ...	18.9	3.82	4.95
A_3 and M ...	9.2	3.30	2.77
B_1 and M ...	1.9	2.58	.75
B_2 and M ...	.2	3.40	.06

TABLE 45

THE SQUAT JUMPS

Levels 155 - 184

Channel	Number Of Cases	Range	Mean	S.D.	S.E.
A_5 ...	34	17-92	41.8	15.39	2.64
A_4 ...	43	22-10	47.6	18.71	2.82
A_3 ...	102	22-10	53.2	18.61	1.84
A_2 ...	189	7-10	51.2	20.55	1.49
A_1 ...	330	7-10	53.5	18.37	1.02
M ...	391	7-10	52.3	16.63	.84
B_1 ...	269	12-10	51.6	18.69	1.14
B_2 ...	124	12-10	46.8	18.03	1.64
Total	1482	7-97	52.1	18.10	.47

COMPARISON OF DIFFERENCES BETWEEN MEANS OF SELECTED CHANNELS

Channels	Difference	S.E.	C.R.
A_5 and A_3 ...	11.4	3.21	3.54
A_5 and A_2 ...	9.4	3.76	2.48
A_5 and A_1 ...	11.6	2.83	4.11
A_5 and M ...	10.4	2.77	3.77
A_4 and A_1 ...	5.8	2.99	1.94
A_4 and M ...	4.6	2.94	1.57
B_2 and A_1 ...	6.6	1.93	3.42
B_2 and M ...	5.4	1.83	2.96

TABLE 46

THE STANDING BROAD JUMP

Levels 155 - 184

Channel	Number Of Cases	Range (Inches)	Mean (Inches)	S.D.	S.E.
A_5 ...	72	47-108	73.9	13.56	1.59
A_4 ...	87	52-99	79.9	11.09	1.18
A_3 ...	181	57-99	82.2	10.82	.79
A_2 ...	261	54-112	85.6	9.43	.58
A_1 ...	505	48-112	84.9	9.90	.44
M ...	509	63-108	85.1	8.43	.37
B_1 ...	322	57-105	84.2	8.89	.49
B_2 ...	174	67-105	84.0	8.33	.63
B_3 ...	46	69-98	82.4	8.93	1.31
Total	2157	48-108	84.1	9.62	.21

COMPARISON OF DIFFERENCES BETWEEN MEANS OF SELECTED CHANNELS

Channels	Difference	S.E.	C.R.
A_5 and A_3 ...	8.3 inches	1.77	4.70
A_5 and M ...	11.3 "	1.63	6.91
A_4 and A_3 ...	2.3 "	1.42	1.63
A_4 and M ...	5.3 "	1.23	4.27
B_2 and M ...	1.1 "	.73	1.56
B_3 and M ...	2.8 "	1.36	2.03

APPENDIX C

SCORES OF RELIABILITY AND OBJECTIVITY TESTS

TABLE 47

RELIABILITY TEST SCORES
FOR
THE BURPEE TEST IN TEN SECONDS

Test I	Test II
7	7 1/4
5.5	7
5	6 1/2
6	7
7 3/4	9
7	7 1/4
6	6
7 1/2	7 1/2
6 1/4	7
6 3/4	6 1/2
8.5	7.5
8 1/2	8 1/2
8 3/4	7 1/2
6	6 1/2
2	7
6.5	7
8	8
8.5	8
6 1/2	6
6 1/2	6 1/2
7	7
5	5 1/2
6 1/2	7
7	8
4	5
7	8
6 1/2	7
7	7
6 3/4	7
6	6
6	7
6	7
7	7
7 1/2	8
8	8
8	8
6 1/2	6 1/2
8	7 1/2

$r = .754 \pm .047$:

TABLE 47

RELIABILITY TEST SCORES
FOR
THE BURPEE TEST IN TEN SECONDS

Test I	Test II
7	7 1/4
5.5	7
5	6 1/2
6	7
7 3/4	9
7	7 1/4
6	6
7 1/2	7 1/2
6 1/4	7
6 3/4	6 1/2
8.5	7.5
8 1/2	8 1/2
8 3/4	7 1/2
6	6 1/2
2	7
6.5	7
8	8
8.5	8
6 1/2	6
6 1/2	6 1/2
7	7
5	5 1/2
6 1/2	7
7	8
4	5
7	8
6 1/2	7
7	7
6 3/4	7
6	6
6	7
6	7
7	7
7 1/2	8
8	8
8	8
6 1/2	6 1/2
8	7 1/2

$r = .754 \pm .047$:

TABLE 48

RELIABILITY TEST SCORES
FOR
THE DODGING RUN

Test I	Test II
27.2	26.1
26.5	25.2
26.2	25.7
22.1	21.2
23.9	24.4
27.9	27.1
26	27.7
24.3	24
24.5	24.2
23.4	25.9
27.5	28
29.5	27.9
25	25
27.4	27.9
29.4	31
29.3	30.3
28.1	28.5
27.6	25
26	26.5
28	30.6
23.5	22.1
27.4	27.2
24.7	24.4
27	27
29	31
24	24.1
25.6	25.8
24.5	24.8
24.1	24.5
28.6	28.8
26.1	26.1
24.9	25
27.3	28.2
27.5	27.5
28	28.1
28	28.5
27	27.9
25.8	26.8

$r = .886 \pm .023$

TABLE 50

RELIABILITY TEST SCORES FOR THE HAND GRIP

Sum of Right and Left Hands

Test I	Test II
193 lbs.	171 lbs.
266	253
244	220
211	200
173	160
218	213
237	234
183	200
230	212
191	193
298	299
262	248
232	239
231	238
249	240
276	269
211	221
254	244
291	286
190	190
210	210
241	240
238	220
189	197
222	235
232	225
252	253
229	250

$r = .949 \pm .013$

TABLE 50

RELIABILITY TEST SCORES
FOR
PARALLEL BAR DIPS

Test I	Test II
9	10
10	11
1	1
16	17
11	14
13	15
1	2
5	9
13	13
11	11
6	4
14	14
6	8
5	3
0	1
2	3
11	11
3	3
5	5
2	2
17	19
7	8
10	12
16	16
4	3
10	5
4	5
6	6
10	11
3	3
6	8
9	8
7	7
6	7
16	16
4	4
7	9
10	10

$r = .951 \pm .010$

TABLE 51

RELIABILITY TEST SCORES
FOR
PULL-UPS

Test I	Test II
13	11
11	11
4	4
15	15
10	15
7	7
1	3
11	12
12	13
15	14
10	9
14	14
8	10
14	15
2	3
5	5
13	13
2	4
8	8
6	6
14	13
10	10
10	13
10	11
7	5
11	13
6	7
6	10
12	12
5	4
10	11
13	14
8	8
8	9
16	17
1	1
10	10
8	10

$r = .937 \pm .013$

TABLE 52

RELIABILITY TEST SCORES
FOR
THE SARGENT JUMP

First Jump	Second Jump
20 inches	21.5 inches
22.5	22
17.5	18
22	22.5
18	19
21	23
22	21
23	23.5
15.5	16
19	19.5
20	21
24	23.5
20	19
24	22
19	18
22.5	23
20	20.5
20	20
20	21
20	19
18	17
20	21.5
17	16.5
22	21.5
21.5	23
20	18
19.5	20.5
23.5	22
24	21
16	15
21	21
19	20.5
20	18.5
21	20.5
20	19
21.5	22
22.5	22.5
18	17

$r = .867 \pm .027$

TABLE 53

OBJECTIVITY TEST SCORES
FOR
THE BURPEE TEST IN TEN SECONDS

A's Score	B's Score	C's Score
8 1/2	8 1/4	8 1/4
8 1/2	8 1/2	8 1/2
6 1/2	6 1/2	6 1/4
6	6	6
4	4	4 1/4
8 1/2	8 1/2	8 1/2
6 1/2	6 1/2	6 1/2
8	8	8
7	7	7
8	8	8
7	7	7
6	6	6 1/4
7	7	7
6	6 1/4	6
8 3/4	8 3/4	8 3/4
8	8	8
8	8	8
6 3/4	7	6 1/2
5 3/4	6	5
5 1/2	..	5 1/4
7	7 3/4	..
6	6	6
7	7	7
6 1/2	6 1/2	6 1/4

TABLE 54

OBJECTIVITY TEST SCORES
FOR
THE DODGING RUN

A's Score	B's Score
27.5	27.5
29.5	29.0
25.0	25.0
27	27.3
29.4	29.5
29.3	29.4
28.1	28.1
27.6	27.6
26	26
28	28.2
27	27
29	29
24	24
25.6	25.3
24.5	24.3
24.1	24.2
28.6	28.5
26.1	26.1
24.9	24.8
27.3	27.1
27.5	27.6
28	28
28	28
27	27
25.8	26

TABLE 55

OBJECTIVITY OF TEST SCORES
FOR
THE HAND GRIP

A's Score	B's Score	C's Score
241	239	240
238	238	238
230	230	230
193	193	193
266	266	265
218	218	218
282	282	282
238	238	238
210	210	210
249	249	249
183	183	183
211	212	211
237	237	237
231	231	231
200	200	200
229	229	228
276	276	276
234	234	234
211	211	211
254	254	254
190	189	189
282	282	282
244	244	244
227	227	227
222	...	227

TABLE 56

OBJECTIVITY TEST SCORES
FOR
THE PARALLEL BAR DIPS

A's Score	B's Score	C's Score
9	9	9
7	7	7
5	5	5
6	6	6
14	14	14
2	2	2
6	7	7
4	4	4
3	3	3
4	4	4
11	11	11
16	16	16
5	5	5
10	10	10
10	10	10
5	5	5
6	6	6
3	3	3
6	6	6
16	16	16
4	4	4
9	9	8
..	2	2
7	7	8
3	4	4

TABLE 57

OBJECTIVITY TEST SCORES
FOR
THE PULL-UPS

A's Score	B's Score	C's Score
13	13	13
8	8	8
8	8	8
10	10	10
14	14	14
5	5	5
10	10	10
7	7	7
2	2	2
6	6	6
13	13	13
10	10	10
7	7	7
8	8	8
11	11	11
5	5	5
14	14	14
6	6	6
5	5	5
8	..	8
8	8	8
16	16	16
1	1	1
13	13	14
10	10	9

TABLE 58

OBJECTIVITY TEST SCORES
FOR
THE SARGENT JUMP

A's Score	B's Score	C's Score
18	15	17
24	25	24
20	20	19
15	15	16
23	22	22
20	21	21
23	20	20
14	14	15
20	22	21
20	20	23
21	23	21
19	17	18
23	20	24
24	24	24
18	18	18
20	20	20
20	20	21
22 1/2	22 1/2	22 1/2
18	20	20
25	25	25
24	25	24
25	24	25
18	15	18
24	23	23
22.5	23 1/2	23.5
..	19	17 1/4

APPENDIX D

REFERENCE TABLES OF GRID RATINGS

ON ATHLETES

TABLE 59

PHYSIQUE CHANNELS OF PROFESSIONAL BASEBALL PLAYERS

Channel	Catchers %	Pitchers %	Infielders %	Outfielders %	All Positions %
A_5 ...	3	3	1	4	3
A_4 ...	15	11	5	13	11
A_3 ...	27	16	20	24	20
A_2 ...	34	24	33	33	30
A_1 ...	14	27	30	20	25
M ...	7	15	10	4	10
B_1 ...	..	3	1	1	1
B_2 ...	..	1	..	1	1
No. Cases	105	337	242	182	866
Average Channel	A_3	A_2	A_2	A_2	A_2

TABLE 60

AVERAGE LEVELS OF PROFESSIONAL BASEBALL PLAYERS

Channel	Catchers	Pitchers	Infielders	Outfielders
A_5 ...	213	200	184	192
A_4 ...	193	196	191	192
A_3 ...	194	195	188	188
A_2 ...	189	192	185	188
A_1 ...	187	189	183	185
M ...	184	188	181	183
B_1 ...	...	183	181	160
B_2 ...	...	173	177	184
No. Cases	105	337	242	182
Average Level	191	192	185	188

TABLE 61

PHYSIQUE CHANNELS OF HIGH SCHOOL BASEBALL PLAYERS

Channel	Catchers %	Pitchers %	Infielders %	Outfielders %	Total %
A_5 ...	5	..	..	..	1
A_4 ...	5	8	3	3	4
A_3 ...	5	..	5	13	7
A_2 ...	30	21	18	16	20
A_1 ...	45	29	34	19	28
M ...	10	21	29	29	25
B_1 ...	..	15	7	17	12
B_2 ...	..	5	4	3	3
No. Cases	20	38	77	63	21
Average Channel	A_2	A_1	A_1	A_1	A_1
Average Level	176	173	171	171	172

TABLE 62

PHYSIQUE CHANNELS OF COLLEGE BASKETBALL PLAYERS

Channel	Forwards %	Guards %	Centers %	All Positions %
A_5 ...	1	1	3	2
A_4 ...	1	3	1	2
A_3 ...	5	9	3	7
A_2 ...	17	23	6	16
A_1 ...	39	40	27	37
M ...	24	17	35	23
B_1 ...	10	5	21	10
B_2 ...	4	1	4	2
B_3 ...	..	1	..	1
No. Cases	128	133	68	371
Average Channel	A_1	A_1	M	A_1

TABLE 63

PHYSIQUE CHANNELS OF HIGH SCHOOL BASKETBALL PLAYERS

Channel	Forwards %	Guards %	Centers %	All Positions %
A_4 ...	2			
A_3 ...	4	11		5
A_2 ...	16	17	7	15
A_1 ...	31	39	25	33
M ...	25	18	36	25
B_1 ...	15	11	25	16
B_2 ...	5	4	..	4
B_3 ...	2	..	.7	2
No. Cases	55	46	28	129
Average Channel	A_1	A_1	M	A_1

TABLE 64

AVERAGE LEVELS OF BASKETBALL PLAYERS

	College Players			High School Players		
Channel	Forwards	Guards	Centers	Forwards	Guards	Centers
A_5 ...	204	209	203	...	...	...
A_4 ...	178	187	...	193	...	...
A_3 ...	190	190	200	181	182	...
A_2 ...	187	189	206	175	177	176
A_1 ...	182	184	193	176	176	179
M ...	182	181	191	171	174	188
B_1 ...	184	181	189	164	175	181
B_2 ...	185	180	185	170	170	...
B_3 ...	...	156	...	...	...	173
No. Cases	128	132	68	55	46	28
		N = 328				N = 129
Average Level	184	185	193	173	176	182

TABLE 65

PHYSIQUE CHANNELS OF OUTSTANDING BASKETBALL PLAYERS

	Number of Cases					
	College Players			High School Players		
Channel	Forwards	Guards	Centers	Forwards	Guards	Centers
A_5 ...		1				
A_4 ...			1			
A_3 ...	1		1		3	
A_2 ...	8	7	1	1	2	1
A_1 ...	8	10	1	9	4	1
M ...	2	4	7	2	1	2
B_1 ...	4	1	1	3	1	1
B_2 ...	1		1	1	1	1
Total	24	23	13 N = 60	16	12	6 N = 34
Average Channel	A_1	A_1	M	A_1	A_1	M
Average Level	185	186	185	176	178	180

TABLE 66

PHYSIQUE CHANNELS OF COLLEGE BOXERS

	Number of Boxers									
	Weight Classes									
Channel	Over 180 Lbs.	170-179 Lbs.	160-169 Lbs.	150-159 Lbs.	140-149 Lbs.	130-139 Lbs.	120-129 Lbs.	100-109 Lbs.	Under 100 Lbs.	Total
A_4 ...	3			1						4
A_3 ...	2	1		1						4
A_2 ...	2	1	2	3						8
A_1 ...			3	4	1	1				9
M ...		1	2	1	1	1	1			7
B_1 ...				1	2	1		1		5
B_2 ...							2		1	3
B_3 ...								1		1
Total	7	3	7	11	4	3	3	2	1	41
Average Channel	A_3	A_1-A_2	A_1	A_1	B_1	M	B_2	B_2	B_2	A_1

TABLE 67

PHYSIQUE CHANNELS OF CREW MEMBERS (OARSMEN)

	Number of Cases				
Levels	A_2	A_1	M	B_1	Total
195-199	1	3	2	..	6
190-194	1	4	6	1	12
185-189	..	3	6	1	10
180-184	..	..	2	1	3
Total	2	10	16	3	31
Percent of Total	6	32	52	10	100
Average Level	195	193	189	187	190

TABLE 68

PHYSIQUE CHANNELS OF COLLEGE FENCERS

	Number of Fencers					
Levels	A_2	A_1	M	B_1	B_2	Total
190-199	1	2	..	..	..	3
180-189	1	3	1	..	..	5
170-179	2	4	..	1	1	8
160-169	1	..	1	1	..	3
150-159	..	1	..	..	..	1
Total	5	10	2	2	1	20
Percent of Total	25	50	10	10	5	
Average Level	179	180	175	170	175	

TABLE 69

PHYSIQUE CHANNELS OF COLLEGE FOOTBALL PLAYERS

Channel	Guards %	Tackles %	Centers %	Backs %	Ends %	All Positions %
A_5* ...	14	21	5	3	..	8
A_4 ...	24	14	15	11	3	13
A_3 ...	24	23	18	20	9	19
A_2 ...	25	22	28	27	21	25
A_1 ...	11	13	23	27	36	23
M ...	2	6	8	9	22	9
B_1 ...	..	1	3	3	7	3
B_2 ...	..	..	..	..	1	..
No. Cases	405	359	191	820	423	2198
Average Channel	A_3	A_3	A_2	A_2	A_1	A_2

*Includes 66 players of channel classes more stocky in build than A_5..

TABLE 70

AVERAGE LEVELS OF COLLEGE FOOTBALL PLAYERS

Channel	Guards	Tackles	Centers	Backs	Ends	All Positions
A_5* ...	200	209	200	194	193	200
A_4 ...	190	200	193	188	194	192
A_3 ...	189	198	191	187	193	190
A_2 ...	188	196	190	184	191	188
A_1 ...	182	192	188	181	188	185
M ...	189	190	185	178	186	183
B_1 ...	172	...	178	171	182	179
B_2 ...	...	...	...	164	180	178
No. Cases	405	359	191	820	423	2198
Average Level	189	200	190	184	189	190

*Includes 66 players of physique classes more stocky in build than A_5.

TABLE 71

PHYSIQUE CHANNELS OF OUTSTANDING COLLEGE FOOTBALL PLAYERS

Channel	Guards %	Tackles %	Ends %	Backs %	Centers %
A_6 ...	7.2	8.0	..	..	..
A_5 ...	14.3	8.0	..	..	6.7
A_4 ...	39.2	28.0	7.2	18.6	40.0
A_3 ...	21.4	36.0	25.0	15.7	26.6
A_2 ...	10.7	..	26.0	25.7	13.3
A_1 ...	7.2	16.0	35.6	31.4	6.7
M ...	..	4.0	7.1	8.6	6.7
No. Cases	28	25	28	70	16 N = 166
Mean Channel	A_4	A_3	A_2	A_2	A_3
Mean Level	195	203	193	187	193

TABLE 72

PHYSIQUE CHANNELS OF HIGH SCHOOL FOOTBALL PLAYERS

Channel	Guards %	Tackles %	Centers %	Backs %	Ends %	All Positions %
A_5*...	8	15	7	3	1	6
A_4 ...	4	9	4	5	1	5
A_3 ...	16	18	12	11	5	12
A_2 ...	31	23	24	23	9	22
A_1 ...	22	16	25	36	43	30
M ...	16	17	18	15	29	19
B_1 ...	3	1	7	4	8	4
B_2 ...	..	1	3	2	4	2
No. Cases	127	134	72	254	133	710
Average Channel	A_2	A_2	A_1	A_1	A_1	A_2

*Includes 19 players who were classified as more stocky than A_5.

TABLE 73

AVERAGE LEVELS OF HIGH SCHOOL FOOTBALL PLAYERS

Channel	Guards	Tackles	Centers	Backs	Ends	All Positions
A_5* ...	184	203	198	183	207	195
A_4 ...	186	198	189	181	189	188
A_3 ...	175	191	182	180	192	183
A_2 ...	176	186	180	175	182	180
A_1 ...	176	185	180	174	180	182
M ...	171	178	178	170	177	175
B_1 ...	170	178	172	167	173	171
B_2 ...	...	175	170	168	172	170
No. Cases	127	134	72	253	133	719
Mean Level	177	189	180	175	179	180

*Includes 19 players who were classified as more stocky than A_5.

TABLE 74

PHYSIQUE CHANNELS OF OUTSTANDING HIGH SCHOOL FOOTBALL PLAYERS

	Number of Players					
Channel	Guards	Tackles	Centers	Backs	Ends	Total
A_6 ...	1	1				2
A_5 ...	1	3		1		5
A_4 ...	1	2	1	4		8
A_3 ...	3	1	2	6	1	13
A_2 ...	5	3	3	9	3	23
A_1 ...	4	1	1	16	7	29
M ...				3	1	4
B_1 ...				1	4	5
Total	15	11	7	40	16	89
Average Channel	A_2A_3	A_4	A_2	A_2	A_1	
Average Level	180	195	187	178	183	

TABLE 75

PHYSIQUE CHANNELS OF HOCKEY PLAYERS

Channel	Wings & Centers %	Defense %	Goalies %	All Positions %
A_5* ...	2	5	..	7
A_4 ...	2	24	29	17
A_3 ...	22	14	57	23
A_2 ...	29	29	14	24
A_1 ...	38	19	..	23
M ...	7	9	..	6
No. Cases	45	21	7	107
Average Channel	A_2	A_2	A_3	A_2
Average Level	184	185	184	184

*Includes three players who were classified as more stocky than A_5.

TABLE 76

PHYSIQUES AND CHANNELS OF SWIMMERS

Channel	% Free Style	% Middle Distance	% Breast Stroke	% Back Stroke	% Diving	% All Events	% Free Style	% Middle Distance	% Breast Stroke	% Back Stroke	% Diving	% All Events
A_5* ...	..	7	..	..	..	2	1	5	..	..	..	1
A_4 ...	2	4	11	7	..	4	3	22	3	1	..	3
A_3 ...	16	18	6	15	26	16	4	10	3	6	10	5
A_2 ...	16	25	17	21	27	20	12	17	11	19	24	15
A_1 ...	39	21	28	21	7	28	25	27	24	15	24	24
M ...	22	14	27	21	33	22	25	27	33	22	25	27
B_1 ...	2	7	11	14	7	6	25	10	17	19	15	18
B_2 ...	2	4	..	..	..	2	5	2	6	11	..	5
B_3 ...	..	..	..	..	..	..	..	..	3	6	2	1
B_4 ...	..	..	..	..	..	..	..	..	..	1	..	1
No. Cases	54	28	18	14	15	129	183	41	64	69	41	398
Average Channel	A_1	A_1A_2	A_1	A_1	A_1A_2	A_1	MA_1	A_1	MA_1	MA_1	A_1	MA_1
Average Level	181	183	183	180	173	182	171	175	170	170	167	170

*Includes one high school swimmer classified as A_6.

TABLE 77

PHYSIQUE CHANNELS OF TRACK AND FIELD ATHLETES

Channel	100 Yd. Dash %	220 Yd. Run %	440 Yd. Run %	880 Yd. Run %	Mile Run %	2 Mile Run %	220 Yd. Low Hurdles %	120 Yd. High Hurdles %	Shot Put %	Discus %	Pole Vault %	High Jump %	Broad Jump %
College Athletes													
A_5 ...	5	..	..	..	..	..	6	..	10	10	..	..	..
A_4 ...	15	13	3	..	..	..	11	5	10	11	7	..	9
A_3 ...	15	17	9	5	11	..	6	5	20	17	..	..	..
A_2 ...	15	17	3	5	..	23	6	11	40	39	14	..	18
A_1 ...	25	26	14	5	21	12	22	26	15	17	50	21	36
M ...	15	13	47	58	26	23	27	26	5	5	14	14	9
B_1 ...	10	13	18	18	26	23	16	21	..	..	14	43	18
B_2 ...	..	..	3	11	16	18	6	5	..	..	..	7	..
B_3 ...	..	..	3	..	..	..	..	..	..	..	..	14	9
No. Cases	20	23	34	19	19	17	18	19	20	18	14	14	11
													N = 246
Average Channel	A_2A_1	A_1	M	M	M	M	A_1M	A_1M	A_2	A_2	A_1	B_1	A_1M
Average Level	179	180	175	177	174	173	180	180	198	196	177	177	177
High School Athletes													
A_5 ...	2	2	..	..	..	..	..	..	6	4	..	..	..
A_4 ...	2	2	..	..	..	..	..	..	16	18	..	..	..
A_3 ...	5	2	..	..	..	..	6	8	12	14	10	..	..
A_2 ...	19	19	16	7	3	..	10	15	31	14	5	4	29
A_1 ...	31	35	29	19	16	14	35	42	22	27	60	52	47
M ...	31	31	42	52	40	..	29	15	9	14	10	26	18
B_1 ...	9	8	10	22	27	43	3	8	3	9	10	9	6
B_2 ...	..	..	3	..	10	29	16	11	..	..	5	9	..
B_3 ...	..	..	..	..	3	14	..	..	..	..	..	..	..
No. Cases	42	48	31	27	30	7	31	26	32	22	20	23	17
													N = 356
Average Channel	A_1	A_1	M	M	M	B_1B_2	A_1M	M	A_2	A_2	A_1	M	A_1
Average Level	170	170	170	166	163	153	167	171	191	190	172	170	175

Note: The total number of cases (N) includes a duplication of events on the part of some participants.

TABLE 78

THE PHYSIQUE CHANNELS OF OUTSTANDING HIGH SCHOOL AND COLLEGE TRACK AND FIELD ATHLETES*

Event	Number of Athletes: Physique Channels A_4	A_3	A_2	A_1	M	B_1	B_2	Total	Average Channel	Average Level
100 Yd Run	1	1	6	1	4			13	A_1A_2	170
220 Yd Run	1	2	5	3	3	1		15	A_1A_2	177
440 Yd Run		1	3	1	4	1		10	A_1	180
880 Yd Run				1	2	2		5	M	164
Mile Run					2	2	2	6	B_1	164
220 Yd. Low Hurdles			1	5	1	1		8	A_1	173
120 Yd. High Hurdles			1	4	1	3		9	M	174
High Jump				5	1	1		7	A_1M	177
Broad Jump			4	3	1	1		9	A_1	175
Pole Vault		1		1	1	1		4	A_1	182
Discus Throw		3	1	3				7	A_2	194
Shot Put	1	3	1	3	1			9	A_2	192
Total	3	11	22	30	21	13	2	102		

*Figures include 10 college athletes and 92 high school competitors.

TABLE 79

THE PHYSIQUE CHANNELS OF COLLEGE TENNIS PLAYERS

Levels	Number of Players: A_3	A_2	A_1	M	B_1	B_2	Total
190-199			1	1			2
180-189	1	1	1	3			6
170-179			2	1	2	1	6
Total	1	1	4	5	2	1	14
Percent of Total	7	7	28	35	14	7	
Average Level	185	185	182	185	175	175	

TABLE 80

THE PHYSIQUE CHANNELS OF WRESTLERS

Channel	Weight Classes (Lbs.) Over 180 %	170-179 %	160-169 %	150-159 %	140-1 149 %	130-139 %	120-129 %	110-119 %	100-109 %	All Weight Classes %
A_5 ...	25									4
A_4 ...	33	25	6							10
A_3 ...	..	..	12	18						6
A_2 ...	17	25	19	9	67	11	9			19
A_1 ...	25	37	38	64	..	45	9			33
M ...	..	13	..	9	33	44	46			18
B_1 ...	..	..	19	..	..	..	18			6
B_2 ...	..	..	6	..	..	..	18			4
No. Cases	12	8	16	11	6	9	11			73
Average Channel	A_3	A_1	A_1	A_1	A_1	MA_1	B_1M			A_1
High School Wrestlers										
A_5 ...	33									2
A_4 ...					10					1
A_3 ...	17		10		10	5				5
A_2 ...	50		30	12	20	28	6	11	14	20
A_1 ...			40	50	10	28	7	11	15	20
M ...			10	38	50	22	50	22	..	27
B_1 ...		100	10	..	..	6	31	45	71	20
B_2 ...		..	..	..	..	11	..	11	..	4
B_3 ...		..	..	..	..	..	6	..	..	1
No. Cases	6	1	10	8	10	18	16	9	7	85
Average Channel	A_3	A_1	A_1	MA_1	A_1	MA_1	B_1M	B_1	B_1	A_1

APPENDIX E

FREQUENCY DISTRIBUTION OF THE GRID RATINGS OF ATHLETES

TABLE 81

DISTRIBUTION OF PROFESSIONAL BASEBALL PLAYERS

Levels	Number of Players: Physique Channels A_6	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Total
Catchers											
210-214	1	2									3
200-209			3	4	2						9
190-199			10	19	16	8	3				56
180-189			2	4	14	4					24
170-179				1	4	3	4				12
150-159			1								1
Total	1	2	16	28	36	15	7				105
Pitchers											
210-219	1		5	1	1	1	1				10
200-209		6	8	12	13	8		1			48
190-199	1	2	15	32	45	38	21	1			155
180-189		1	6	6	22	31	24	4	1		95
170-179			2	2	1	13	4	4			26
160-169							1	1	1		3
Total	2	9	36	53	82	91	51	11	2		337
Infielders											
210-219				1							1
200-209			2	6	4	1	1				14
190-199			7	14	21	11	3				56
180-189		1	4	17	38	39	10	1			110
170-179				8	14	21	9	2	1		55
160-169				1	1	1	1				4
150-159					2						2
Total		1	13	47	80	73	24	3	1		242
Outfielders											
200-209		2	3	2	5						12
190-199		2	14	19	19	8	2				64
180-189	1	2	6	18	31	22	2		1		83
170-179			2	4	4	8	3				21
160-169					1			1			2
Total	1	6	25	43	60	38	7	1	1		182
Totals											
	4	18	90	171	258	217	89	15	4		866

TABLE 82

DISTRIBUTION OF HIGH SCHOOL BASEBALL PLAYERS

Levels	Number of Players								
	Physique Channels								
	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	Total
Catchers									
210-219	(1)			(1)					
190-199						(1)			
180-189				2 (1)	5	(1)			7
170-179	1	1	1	2 (1)	4	(1)			9
160-169			(1)	2	(1)	2(1)	(1)		4
150-159				(1)					
140-149							(1)		
Total	1	1	1	6	9	2			20
No. Unclassified	1		1	4	1	4	2		13

( ) Players whose positions were not specified by their coaches.

Levels	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	Total
Pitchers									
190-199		1			1				2
180-189		1		4	2	1			8
170-179		1		3	4	4	1	1	14
160-169				1	4	2	4	1	12
150-159						1	1		2
Total		3		8	11	8	6	2	38
Infielders									
190-199			1	2					3
180-189		1		5	6	2		1	15
170-179			3	3	10	8	1		25
160-169		1		3	4	7	3		18
150-159				1	6	4	2	2	15
140-149						1			1
Total		2	4	14	26	22	6	3	77

TABLE 82--Continued

Totals	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	Total
Outfielders									
190-199			1						1
180-189		1	4	2	5	2			14
170-179		1	3	6	3	4	3	1	21
160-169				1	4	8	6		19
150-159				1		3	1	1	6
140-149						1	1		2
Total		2	8	10	12	18	11	2	63
Totals									
	2	8	14	42	59	54	25	7	211

TABLE 83

DISTRIBUTION OF COLLEGE BASKETBALL PLAYERS

	Number of Players									
	Physique Channels									
Levels	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Total
Forwards										
210-219			1							1
200-209	1			2				1		4
190-199			2	7	11	6	1	1		28
180-189			1	6	22	13	6	1		49
170-179		1	2	3	17	12	5	1		41
160-169				2	1		1	1		5
Total	1	1	6	20	51	31	13	5		128
Guards										
210-219	1									1
200-209	1		1	1	1					4
190-199		2	5	15	13	3	1			39
180-189		1	5	12	24	12	3	1		58
170-179		1	1	4	12	6	1			25
160-169					1	2	1			4
150-159					1				1	2
Total	2	4	12	32	52	23	6	1	1	133
Centers										
210-219				1						1
200-209	2		1	4	5	3				15
190-199			1	1	7	11	7			27
180-189					3	10	7	3		23
170-179						1	1			2
Total	2		2	6	15	25	15	3		68
Unclassified Players										
220-229	1					1				2
210-219			2							2
200-209		1	2	1						4
190-199		1		1	2					4
180-189		2		2	7	6	2			19
170-179			1	1	4	4	1			11
Total	1	4	5	5	13	11	3			42
Totals										
	6	9	25	63	131	90	37	9	1	371

TABLE 84

DISTRIBUTION OF HIGH SCHOOL BASKETBALL PLAYERS

	Number of Players								
	Physique Channels								
Levels	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Total
Forwards									
190-199	1	1	2	1					5
180-189			1	4	2		1		8
170-179		1	2	10	6	2			21
160-169			4	2	5	3	1		15
150-159					1	3	1	1	6
Total	1	2	9	17	14	8	3	1	55
Guards									
190-199		2	2		1	1			6
180-189		1	2	4	2				9
170-179		2	1	11	1	3	1		19
160-169			2	3	3	1	1		10
150-159			1		1				2
Total		5	8	18	8	5	2		46
Centers									
190-199			1	1	5	2			9
180-189				3	3	1			7
170-179				2	1	4		1	8
160-169			1		1			1	3
150-159				1					1
Total			2	7	10	7		2	28
Totals									
	1	7	19	42	32	20	5	3	129

TABLE 85

DISTRIBUTION OF OUTSTANDING COLLEGE BASKETBALL PLAYERS

Levels	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	Total
				Number of Players — Physique Channels					
				Guards					
200-209	1				1				2
190-199				2	3				5
180-189				4	3	4	1		12
170-179				1	1				2
160-169					2				2
Total	1			7	10	4	1		23
				Forwards					
210-219			1						1
200-209									
190-199				4	2		1	1	8
180-189				1	4	2	1		8
170-179				1	2		1		4
160-169				2			1		3
Total			1	8	8	2	4	1	24
				Centers					
190-199					1	3			4
180-189						4		1	5
170-179		1	1	1			1		4
Total		1	1	1	1	7	1	1	13
				Totals					
	1	1	2	16	19	13	6	2	60

TABLE 86

DISTRIBUTION OF OUTSTANDING HIGH SCHOOL BASKETBALL PLAYERS

	NUMBER OF PLAYERS							
	PHYSIQUE CHANNELS							
Levels	A_3	A_2	A_1	M	B_1	B_2	B_3	Total
Guards								
190-199	1							1
180-189	1		2			1		4
170-179	1	1	1		1			4
160-169		1	1	1				3
Total	3	2	4	1	1	1		12
Forwards								
190-199		1	1					2
180-189			4					4
170-179			4		1			5
160-169				2	1	1		4
150-159					1			1
Total		1	9	2	3	1		16
Centers								
190-199		1			1			2
180-189				1				1
170-179			1					1
160-169				1		1		2
Total		1	1	2	1	1		2
Totals								
	3	4	14	5	5	3	0	34

TABLE 87

DISTRIBUTION OF COLLEGE BOXERS

Channel	Number of Boxers										
	Weight Classes (Lbs.)										
	Over 180	170-179	160-169	150-159	140-149	130-139	120-129	110-119	100-109	Under 100	All Classes
A_4	3			1							4
A_3	2	1		1							4
A_2	2	1	2	3							8
A_1			3	4	1	1					9
M		1	2	1	1	1	1				7
B_1				1	2	1			1		5
B_2							2			1	3
B_3									1		1
No. Cases	7	3	7	11	4	3	3		2	1	41

TABLE 88

DISTRIBUTION OF COLLEGE FOOTBALL PLAYERS

	Number of Players												
	Physique Channels												
Levels	Above A_8	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	No. Cases
Guards													
230-					1								1
210-219				1		1							2
200-209	1		1	2	5	10	4	2					25
190-199		1	1	10	11	48	53	41	6	1			172
180-189			1	3	14	37	33	40	25	6			159
170-179					1	2	6	15	14	2	1		41
160-169		2					1	2					5
No. Cases	1	3	3	16	32	98	97	100	45	9	1		405
Tackles													
230-	2												2
220-229	3	1	2	1	5								12
210-219		1	1	8	9	6	3						28
200-209			2	11	20	25	32	22	6				118
190-199			1	1	9	19	45	51	29	15	1		171
180-189							3	6	13	5	1		28
No. Cases	5	2	6	21	43	50	83	79	48	20	2		359
Centers													
210-219				1	1								2
200-209						2	5	3					10
190-199				2	5	21	16	37	19	4			104
180-189						5	13	10	22	9	3		62
170-179							1	2	4	2	3		12
160-169								1					1
No. Cases				3	6	28	35	53	45	15	6		191
Backs													
210-219				1	1								2
200-209	1			1	3	9	11	4	1				30
190-199				2	12	29	65	70	20	6			204
180-189					5	36	54	87	122	26	7		337
170-179					3	13	33	58	72	32	11		222
160-169							1	3	8	5	4	2	23
150-159										1	1		2
No. Cases	1			4	24	87	164	222	223	70	23	2	820

TABLE 88--Continued

Levels	Above A_8	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	No. Cases
Ends													
210-219						1	1						2
200-209						2	5	8	7	1			23
190-199					2	7	21	57	56	31	3		177
180-189						3	12	21	79	50	18	3	186
170-179							1	4	8	8	9	2	32
160-169									1	1	1		3
No. Cases					2	13	40	90	151	91	31	5	423
Totals													
	7	5	9	44	107	276	419	544	512	205	63	7	2198

TABLE 89

DISTRIBUTION OF OUTSTANDING COLLEGE FOOTBALL PLAYERS

	Number of Players									
	Physique Channels									
Levels	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	M	Total
Guards										
220-229								1		1
210-219			1							1
200-209				1	1					2
190-199	1			2	9	5	3	1		21
180-189				1	2	1	1			5
Total	1		1	4	12	6	4	2		30
Tackles										
220-229	1									1
210-219				1	1					2
200-209			1	1	4	5		1		12
190-199					2	3		1	1	7
180-189								2		2
Total	1		1	2	7	8		4	1	24
Centers										
200-209				1						1
190-199					5	3	2	1		11
180-189					1	1			1	3
Total				1	6	4	2	1	1	15
Backs										
200-209					2	1				3
190-199					7	5	10	3		25
180-189					3	3	7	14	2	29
170-179					1	2	1	5	3	12
160-169									1	1
Total					13	11	18	22	6	70

TABLE 89--Continued

Levels	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	M	Total
Ends										
200-209					1	2	3			6
190-199						4	4	5	1	14
180-189					1	1		5		7
170-179									1	1
Total					2	7	7	10	2	28
Totals										
	2		2	7	40	36	31	39	10	167

TABLE 90

DISTRIBUTION OF HIGH SCHOOL FOOTBALL PLAYERS

Levels	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	No. Cases
	Number of Players — Physique Channels											
Guards												
200-209		2										2
190-199					2	1	4	3				10
180-189			1	3	2	4	18	5		1		34
170-179				3	1	11	11	14	14	1		55
160-169		1				4	4	6	6	3		24
150-159							2					2
No. Cases		3	1	6	5	20	39	28	20	5		127
Tackles												
220-229	1											1
210-219	2	1			1							4
200-209		1	3	6	4	2	3	1				20
190-199			4	2	5	15	8	5	2			41
180-189					2	6	17	11	8			44
170-179						1	2	4	11	1	1	20
160-169							1	1	1			3
150-159									1			1
No. Cases	3	2	7	8	12	24	31	22	23	1	1	134
Centers												
200-219				2								2
190-199				2	1	2	4	2	1			12
180-189					2	3	7	8	4	1		25
170-179						4	3	6	5	2	1	21
160-169							3	2	3	2	1	11
150-159				1								1
No. Cases				5	3	9	17	18	13	5	2	72

TABLE 90--Continued

Levels	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	No. Cases
Ends												
200-209			1	1		1						3
190-199					1	3	1	4	1	1		11
180-189					1	2	5	27	13	1		49
170-179							3	21	20	5	5	54
160-169							3	5	4	2	1	15
150-159										1		1
No. Cases			1	1	2	6	12	57	38	10	6	133
Backs												
200-209			1									1
190-199			1		2	4	4	2				13
180-189				1	6	9	16	18	3			53
170-179				3	2	13	23	51	17	4	2	115
160-169				1	2	1	12	18	17	6	3	60
150-159						2	3	2	3	1		11
No. Cases			2	5	12	29	58	91	40	11	5	253
Totals												
	3	5	11	25	34	88	157	216	134	32	14	719

TABLE 91

DISTRIBUTION OF OUTSTANDING HIGH SCHOOL FOOTBALL PLAYERS

	Number of Players								
	Physique Channels								
Levels	A_6	A_5	A_4	A_3	A_2	A_1	M	B_1	Total
Guards									
190-199					1				1
180-189	1			1	2	3			7
170-179		1	1	2	2				6
160-169						1			1
Total	1	1	1	3	5	4			15
Tackles									
200-209	1	3							4
190-199			2	1	1				4
180-189					2	1			3
Total	1	3	2	1	3	1			11
Centers									
190-199				1	1				2
180-189			1	1	2				4
170-179						1			1
Total			1	2	3	1			7
Backs									
190-199					1				1
180-189			3	4	2	7			16
170-179		1	1	2	4	5	2	1	16
160-169					2	4	1		7
Total		1	4	6	9	16	3	1	40
Ends									
190-199						1		1	2
180-189				1	2	4		2	9
170-179						2	1	1	4
160-169					1				1
Total				1	3	7	1	4	16
Totals									
	2	5	8	13	23	29	4	5	89

TABLE 92

THE PHYSIQUES OF HOCKEY PLAYERS

	Number of Players									
	Physique Channels									
Levels	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	M	Total
Goal Keepers										
190-199						1				1
180-189					1	1	1			3
170-179					1	2				3
Total					2	4	1			7
Defense										
200-209							1			1
190-199					3	1	2	1	1	8
180-189		1			1	1	3	3		9
170-179					1	1			1	3
Total		1			5	3	6	4	2	21
Centers and Wings										
200-209						1				1
190-199				1		2		1		4
180-189					1		4	5		10
170-179						6	9	9	2	26
160-169						1		2	1	4
Total				1	1	10	13	17	3	45
Unclassified										
200-209	1			2	1					4
190-199			1		4	5	2			12
180-189				1	2	3	1			7
170-179					3		2	3		8
160-169							1	1	1	3
Total	1		1	3	10	8	6	4	1	34
Totals										
	1	1	1	4	18	25	26	25	6	107

TABLE 93

THE PHYSIQUES OF UNIVERSITY SWIMMERS

	Number of Swimmers								
	Physique Channels								
Levels	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	Total
Breast Stroke									
200-209		1							1
190-199		1	1	2	1				5
180-189				1	2		1		4
170-179					2	4	1		7
160-169						1			1
No. Cases		2	1	3	5	5	2		18
Back Stroke									
200-209						1			1
190-199									
180-189		1	1	1	1	1			5
170-179			1	2	2	1	2		8
No. Cases		1	2	3	3	3	2		14
Diving									
180-189			1	1		3			5
170-179			3	1		1			5
160-169				2	1	1			4
140-149								1	1
No. Cases			4	4	1	5		1	15
Free Style									
200-209			2	1					3
190-199			3	1	2				6
180-189		1	3	3	10	4			21
170-179			1	4	7	7	1	1	21
160-169					1	1			2
150-159					1				1
No. Cases		1	9	9	21	12	1	1	54

TABLE 93--Continued

Levels	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	Total
Relay									
180-189				1	1				2
160-169					1				1
No. Cases				1	2				3
Middle Distance									
200-209			1	1					2
190-199	1	1	2		1	1			5
180-189	1	1		2	2	1	1		8
170-179			1	3	3	1	1	1	10
160-169			1	1		1			3
No. Cases	2	2	5	7	6	4	2	1	28
Medley Relay									
190-199				1					1
No. Cases				1					1
Totals									
	2	5	21	28	38	29	7	3	133

TABLE 94

THE PHYSIQUES OF HIGH SCHOOL SWIMMERS

	Number of Swimmers											
	Physique Channels											
Levels	A_6	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	B_4	Total
Free Style												
190-200			1	2	2	3	1					9
180-189			3	2	4	12	9	5				35
170-179		2	1	2	10	18	15	16	3			67
160-169			1	1	5	11	21	15	2			56
150-159					2	3	2	10	4			21
140-149						1	1	1				3
130-139								1				1
120-129								1				1
No. Cases		2	6	7	23	48	49	49	9			193
Relay												
180-189						1						1
170-179		1				2	1					4
160-169							2	1				3
150-159							1					1
No. Cases		1				3	4	1				9
Middle Distance												
200-209		1										1
190-199				1	1	1						3
180-189	1		1		2	2	2	1				9
170-179				1	4	5	4	2	1			17
160-169				2		2	2	1				7
150-159						1	3					4
No. Cases	1	1	1	4	7	11	11	4	1			41
Breast Stroke												
190-199					1	2						3
180-189			1		1	5	1	1	1			10
170-179			1	2	2	3	8	2	1	1		20
160-169					2	4	7	4	2			19
150-159					1	1	5	2				9
140-149								1		1		2
130-139								1				1
No. Cases			2	2	7	15	21	11	4	2		64

TABLE 94--Continued

Levels	A_6	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	B_4	Total
Back Stroke												
190-199						2						2
180-189			1	1	3	4	2					11
170-179				2	5	2	7	7	3	1		27
160-169				1	4	2	4	4	2	1		18
150-159								1	3	2		6
140-149					1		2	1			1	5
No. Cases			1	4	13	10	15	13	8	4	1	69
Diving												
190-199				1								1
180-189					1	2						3
170-179				2	5	5	2	2				16
160-169					4	2	3	1				10
150-159				1		1	2	3				7
140-149							2			1		3
130-139							1					1
No. Cases				4	10	10	10	6		1		41
Medley Relay												
180-189	1											1
No. Cases	1											1
Medley Swim												
180-189					1							1
170-179					1							1
160-169						1						1
No. Cases					2	1						3
Totals												
	2	4	10	21	62	98	110	84	22	7	1	421

TABLE 95

DISTRIBUTION OF COLLEGE TRACK AND FIELD ATHLETES

	Number of Athletes											
	Physique Channels											
Levels	A_7	A_6	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Total
100 Yard Run												
200-209						1						1
190-199			1					1				2
180-189				1	2	1	2	1				7
170-179				1	1	1	3	1				7
160-169				1					1			2
150-159									1			1
No. Cases			1	3	3	3	5	3	2			20
220 Yard Run												
200-209						1						1
190-199					1			1				2
180-189				1	2	1	4	1	1			10
170-179				1	1	2	2	1				7
160-169				1					1			2
150-159									1			1
No. Cases				3	4	4	6	3	3			23
440 Yard Run												
200-209					1							1
190-199					1							1
180-189							2	5	3			10
170-179					1	1	1	6	1		1	11
160-169				1			2	4	2	1		10
150-159								1				1
No. Cases				1	3	1	5	16	6	1	1	34
880 Yard Run												
190-199					1	1						2
180-189								5				5
170-179								3	3	1		7
160-169							1	3		1		5
No. Cases					1	1	1	11	3	2		19

TABLE 95--Continued

Levels	A_7	A_6	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Total
Mile Run												
190-199					1							1
180-189								1	2			3
170-179					1		3	1	3	3		11
160-169							1	1				2
150-159								2				2
No. Cases					2		4	5	5	3		19
Two Mile Run												
180-189						1			1			2
170-179						2	2	2	3	2		11
160-169						1		1		1		3
150-159								1				1
No. Cases						4	2	4	4	3		17
Low Hurdles												
200-209				1								1
190-199			1			1						2
180-189					1		3	1				5
170-179							1	4	2	1		8
160-169				1			1		1			3
No. Cases			1	2	1	1	5	5	3	1		19
High Hurdles												
200-209				1								1
190-199						1						1
180-189					1		4	2				7
170-179						1	1	2	3	1		8
160-169								1	1			2
No. Cases				1	1	2	5	5	4	1		19
Shot Put												
230-	1											1
200-209				1	2	4						7
190-199			1	1	1	4	1					8
180-189					1		2	1				4
No. Cases	1		1	2	4	8	3	1				20

TABLE 95--Continued

Levels	A_7	A_6	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Total
Discus Throw												
230-	1											1
200-209				1	1	2						4
190-199			1		1	5	1					8
180-189				1	1		2	1				5
No. Cases	1		1	2	3	7	3	1				18
Javelin Throw												
190-199						2						2
180-189						1	3	1				5
170-179							1					1
No. Cases						3	4	1				8
Pole Vault												
180-189						1	3	1				5
170-179				1			4	1	1			7
160-169						1			1			2
No. Cases				1		2	7	2	2			14
High Jump												
180-189							2	1	1			4
170-179							1	1	5	1	1	9
160-169											1	1
No. Cases							3	2	6	1	2	14
Running Broad Jump												
180-189							4	1				5
170-179				1		2			1			4
160-169									1	1		2
No. Cases				1		2	4	1	2	1		11
Totals												
	2		4	16	22	38	57	60	40	13	3	255

TABLE 96

DISTRIBUTION OF HIGH SCHOOL TRACK AND FIELD ATHLETES

Levels	Number of Athletes: Physique Channels A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Total
100 Yard Run										
190-199					1					1
180-189			1		2					3
170-179	1	1	1	6	5	2	3			19
160-169				2	5	9	1			17
150-159						1				1
140-149						2				2
No. Cases	1	1	2	8	13	14	4			43
220 Yard Run										
180-189				1	4	1				6
170-179	1	1	1	6	6	2	2			19
160-169				2	6	10	2			20
150-159						2				2
140-149					1					1
No. Cases	1	1	1	9	17	15	4			48
440 Yard Run										
190-199				1						1
180-189					4	2				6
170-179				4	2	3				9
160-169					2	4	3	1		10
150-159						3				3
140-149						1	1			2
No. Cases				5	8	13	4	1		31
880 Yard Run										
180-189				1		2				3
170-179				1	2	2	1			6
160-169					3	4	3			10
150-159						6	1			7
140-149							1			1
No. Cases				2	5	14	6			27

TABLE 96--Continued

Levels	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Total
Mile Run										
180-189						2				2
170-179					2	2	1			5
160-169				1	2	6	3	2		14
150-159						2	2	1		5
140-149					1		1			2
130-139							1		1	2
No. Cases				1	5	12	8	3	1	30
Two Mile Run										
180-189									1	1
160-169							1			1
150-159								2		2
140-149					1					1
130-139							2			2
No. Cases					1		3	2	1	7
Mile Relay										
190-199				1						1
180-189		1			1					2
170-179					2	2	1			5
160-169					1	4	3	2		10
150-159					1	2	1			4
140-149							3			3
No. Cases		1		1	5	8	8	2		25
Low Hurdles										
180-189					3					3
170-179			2	2	4	2		1		11
160-169				1	4	5	1	2		13
150-159								1		1
140-149						1		1		2
130-139						1				1
No. Cases			2	3	11	9	1	5		31

TABLE 96--Continued

Levels	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Total
High Hurdles										
180-189				1	3		1			5
170-179			2	2	4	1	1	1		11
160-169				1	4	2		1		10
140-149								1		1
130-139						1				1
No. Cases			2	4	11	4	2	3		26
880 Yard Relay										
190-199				1						1
180-189					1					1
170-179					2	1	1			4
160-169						6	3	1		10
150-159					1	3				4
140-149						1	1			2
No. Cases				1	4	11	5	1		22
Shot Put										
210-219			1							1
200-209	1	3	1	3						8
190-199	1	2	1	5	3					12
180-189			1	2	1	1				5
170-179					1	2				3
160-169					2		1			3
No. Cases	2	5	4	10	7	3	1			32
Discus Throw										
210-219			1							1
200-209		3	1	1						5
190-199	1	1		1	3					6
180-189			1	1	2	2				6
170-179						1	1			1
160-169					1		1			2
No. Cases	1	4	3	3	6	3	2			22

TABLE 96--Continued

Levels	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	B_3	Total
Pole Vault										
200-209			1							1
180-189					3		1			4
170-179			1		7					8
160-169				1	2	1				4
150-159						1				1
140-149							1	1		2
No. Cases			2	1	12	2	2	1		20
High Jump										
180-189					3					3
170-179				1	6	2	1			10
160-169					3	3	1	1		8
140-149						1		1		2
No. Cases				1	12	6	2	2		23
Running Broad Jump										
190-199				1						1
180-189				1	3					4
170-179				3	2	1	1			7
160-169					3	1				4
150-159						1				1
No. Cases				5	8	3	1			17
Totals										
	5	12	16	54	125	117	53	20	2	404

TABLE 97

DISTRIBUTION OF OUTSTANDING TRACK AND FIELD ATHLETES IN HIGH SCHOOL AND COLLEGE*

Levels	Number of Athletes								
	Physique Channels								
	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	Total
				100 Yd. Dash					
180-189			1						1
170-179		2		4					6
160-169				1	1	3			5
150-159						1			1
No. Cases		2	1	5	1	4			13
				220 Yd. Run					
190-199			1						1
180-189			1		1	1	1		4
170-179		2		4					6
160-169				1	1	3			5
No. Cases		2	2	5	2	4	1		16
				440 Yd. Run					
190-199			1	1					2
180-189						1	1		2
170-179				2		1			3
160-169						1			1
150-159						1			1
No. Cases			1	3		4	1		9
				880 Yd. Run					
170-179						1			1
160-169							1		1
150-159					1	1			2
No. Cases					1	2	1		4

*Includes 10 college athletes.

TABLE 97--Continued

Levels	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	Total
Mile Run and Two Mile Run									
170-179						1			1
160-169							1	2 (1)	4
150-159						1	1 (1)		3
No. Cases						2	2 (1)	2 (1)	8

( ) Two Mile Run

Levels	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	Total
Running Broad Jump									
190-199				1					1
180-189					1				1
170-179		1		2	1		1		5
160-169				1	1	1			3
No. Cases		1		4	3	1	1		10
High Jump									
180-189					1		1		2
170-179					1	1			2
160-169					2				2
No. Cases					4	1	1		6
Pole Vault									
180-189					1		1		2
150-159						1			1
No. Cases					1	1	1		3
Discus									
200-209			2						2
190-199				1	1				2
180-189					1				1
170-179					1				1
No. Cases			2	1	3				6

TABLE 97--*Continued*

Levels	A_5	A_4	A_3	A_2	A_1	M	B_1	B_2	Total
Shot Put									
200-209			2						2
190-199	1			1	1				3
180-189					1				1
170-179					1	1			2
No. Cases	1		2	1	3	1			8
High and Low Hurdles									
180-189					1		1		2
170-179		1			2		1		4
160-169				1	2		1		4
No. Cases		1		1	5		3		10
Totals									
	1	6	8	20	23	20	12	3	93

TABLE 98

THE PHYSIQUES OF WRESTLERS

	Number of Wrestlers									
	Weight Classes (lbs.)									
Channel	Over 180	170-179	160-169	150-159	140-149	130-139	120-129	110-119	100-109	Total
High School Wrestlers										
A_5	2									2
A_4					1					1
A_3	1		1		1	1				4
A_2	3		3	1	2	5	1	1	1	17
A_1			4	4	1	5	1	1	1	17
M			1	3	5	4	8	2		23
B_1		1	1			1	5	4	5	17
B_2						2		1		3
B_3							1			1
Total	6	1	10	8	10	18	16	9	7	85
College Wrestlers										
A_5	3									3
A_4	4	2	1							7
A_3			2	2						4
A_2	2	2	3	1	4	1	1			14
A_1	3	3	6	7		4	1			24
M		1		1	2	4	5			13
B_1			3				2			5
B_2			1				2			3
Total	12	8	16	11	6	9	11			73

APPENDIX F

SOURCES OF ATHLETIC DATA

PROFESSIONAL BASEBALL TEAMS

Boston, (Braves), Mass.
Brooklyn, New York
Birmingham, Alabama
Buffalo, New York
Chicago, (Cubs), Illinois
Chicago, (White Sox), Ill.
Columbus, Ohio
Detroit, Michigan
Hartford, Connecticut
Hollywood, California
Hornell, New York
Indianapolis, Indiana
Kansas City, Missouri
Kingsport, Tennessee
Los Angeles, California
Mifflinberg, Pennsylvania

Milwaukee, Wisconsin
Minneapolis, Minnesota
Montreal, Quebec
Newark, New Jersey
New Orleans, Louisiana
New York, (Giants), New York
Philadelphia, (Athletics), Penna.
Philadelphia, (Phillies), Penna.
Pittsburgh, Pennsylvania
St. Louis, (Browns), Missouri
St. Louis, (Cardinals), Mo.
St. Paul, Minnesota
San Francisco, California
Syracuse, New York
Toledo, Ohio
Toronto, Ontario

HIGH SCHOOL BASEBALL TEAMS

Alliance, Ohio	Alliance High School
Bluffton, Ohio	Bluffton High School
Brecksville, Ohio	Brecksville High School
Chardon, Ohio	Chardon High School
Cleveland Heights, Ohio	Cleveland Heights High School
Garfield Heights, Ohio	Garfield Heights High School
Greenville, Ohio	Greenville High School
Warren, Ohio	Harding High School
Canton, Ohio	Lincoln High School
Perry, Ohio	Perry High School
Rocky River, Ohio	Rocky River High School
Conneaut, Ohio	Rowe High School
Youngstown, Ohio	South High School
Geneva, Ohio	Spencer High School
Wooster, Ohio	Wooster High School

COLLEGE AND MILITARY SERVICE BASKETBALL TEAMS

Albright College
Bowling Green University
Canisius College
Colgate University
College of the Pacific
Fort Hayes
Great Lakes Naval Training Station
Miami University
Michigan Normal College
Oklahoma A. & M. College
Oklahoma University
St. Mary's College, Pre-Flight School
Southwestern College
Western Reserve University
Willamette University
Wooster College
U. S. Naval Academy
University of California
University of California, Los Angeles Branch
University of North Carolina
University of Iowa
University of Missouri
University of Pennsylvania
University of Rochester
University of Texas
University of Washington

HIGH SCHOOL BASKETBALL TEAMS

Chicago, Illinois	Harper High School
Cleveland, Ohio	Cathedral Latin High School
"	Collinwood High School
"	John Hay High School
"	James Ford Rhodes High School
"	Lincoln High School
"	St. Ignatius High School
"	West High School
Columbiana, Ohio	Columbiana High School
Geneva, Ohio	Geneva High School
Middletown, Ohio	Middletown High School
Shaker Heights, Ohio	Shaker Heights High School

BOXING TEAMS

Bellvue High School	Bellvue, Ohio
Maryland University	College Park, Maryland
Willamette University	Salem, Oregon
Boxing Club, Western Reserve University	Cleveland, Ohio

VARSITY CREWS

Columbia University	New York, New York
Cornell University	Ithaca, New York
United States Naval Academy	Annapolis, Maryland

COLLEGE AND MILITARY SERVICE FOOTBALL TEAMS

Baldwin Wallace University
Bates College
Bowling Green State University
Brown University
Bucknell University
Case School of Applied Science
Colorado College
Columbia University
Cornell University
Dartmouth University
Duke University
Great Lakes Naval Training Station
Harvard University
Illinois State Normal College
Illinois Wesleyan University
Kansas State College of Agriculture
  and Applied Science
Lehigh University
Michigan Normal College
Michigan State College
Miami University
North Carolina State College
Northwestern University
Oberlin College
Oklahoma Agriculture and Mechanical
  College
Ohio State University
Ohio Wesleyan University
Princeton University
Purdue University
Rensselaer Polytechnic Institute
Rice Institute
Rutgers University
Southern Methodist University
Southwestern University
Temple University
Texas Christain University
University of Arkansas
University of California
University of Denver
University of Iowa State
University of Iowa, U. S. Navy Pre-Flight
  School
University of Kansas
University of Maryland
University of Michigan
University of Missouri
University of Notre Dame
University of Pennsylvania
University of South Carolina

College and Military Service Football Teams
(Continued)

University of Texas
University of Tulsa
University of Virginia
Texas Agriculture and Mechanical College
Villanova College
Wabash College
Western Michigan College
West Virginia University
Yale University

HIGH SCHOOL FOOTBALL TEAMS

Akron, Ohio	West Technical High School
Ashtabula, Ohio	Ashtabula High School
Ashland, Ohio	Ashland High School
Canton, Ohio	McKinley School
Cleveland, Ohio	Cathedral Latin High School
"	Cleveland Heights High School
"	Collinwood High School
"	East High School
"	East Technical High School
"	John Adams High School
"	John Hay High School
"	John Marshall High School
"	James Ford Rhodes High School
"	St. Ignatius High School
"	West High School
"	West Technical High School
Dayton, Ohio	Stivers High School
East Liverpool, Ohio	East Liverpool High School
Elyria, Ohio	Elyria High School
Euclid, Ohio	Euclid Shore High School
Findlay, Ohio	Findlay High School
Fremont, Ohio	Fremont High School
Geneva, Ohio	Geneva High School
Hershey, Pa.	Hershey High School
Hudson, Ohio	Western Reserve Academy
Kent, Ohio	Kent State High School
Lakewood, Ohio	Lakewood High School
Lima, Ohio	Central High School
Mt. Vernon, Ohio	Mt. Vernon High School
Parma, Ohio	Parma High School
Ravenna, Ohio	Ravenna High School

High School Football Teams
(Continued)

Rocky River, Ohio	Rocky River High School
Steubenville, Ohio	Steubenville High School
Tiffin, Ohio	Tiffin Columbian High School
Toledo, Ohio	De Vilbiss High School
University Heights, Ohio	University High School
Wapakoneta, Ohio	Wapakoneta High School
Warren, Ohio	Warren G. Harding High School
Youngstown, Ohio	South High School

FENCING TEAMS

United States Naval Academy	Annapolis, Maryland
United States Military Academy	West Point, New York

HOCKEY TEAMS

Cleveland Hockey Club	Cleveland, Ohio
Dartmouth University Hockey Team	Hanover, New Hampshire
United States Military Academy Hockey Team	West Point, New York
Hershey Hockey Club	Hershey, Pennsylvania
Le Club De Hockey Canadian	Montreal, Quebec
New York Rangers Hockey Club	New York, New York
Pittsburgh Hockey Club	Pittsburgh, Pennsylvania

COLLEGE SWIMMING TEAMS

Columbia University
Cornell University
Michigan University
Ohio State University
Pennsylvania State
Temple University
University of Pennsylvania
U. S. Military Academy
Yale University

HIGH SCHOOL SWIMMING TEAMS

Bay View High School	Milwaukee, Wisconsin
Brunswick High School	Brunswick, Maine
Central High School	Detroit, Michigan
Clinton High School	Clinton, Iowa
Culver Military Academy	Culver, Indiana
George Washington High School	New York City
Huntington Park High School	Los Angeles, California
Lakewood High School	Lakewood, Ohio
Lane Technical High School	Chicago, Illinoia
Los Angeles High School	Los Angeles, California
McKinley High School	Canton, Ohio
Mercersburg Academy	Mercersburg, Penna.
New Haven High School	New Haven, Connecticut
North High School	Des Moines, Iowa
Oak Park High School	Oak Park, Illinois
Rochester High School	Rochester, Minnesota
Schenley High School	Pittsburgh, Penna.
Staunton Military Academy	Staunton, Virginia
Shaker Heights High School	Shaker Heights, Ohio
Shaw High School	East Cleveland, Ohio
University School	Cleveland, Ohio
West Philadelphia High School	Philadelphia, Penna.
Western Reserve Academy	Hudson, Ohio
York High School	York, Pennsylvania

TENNIS TEAMS

University of Pennsylvania	Philadelphia, Pennsylvania

COLLEGE AND UNIVERSITY TRACK AND FIELD SQUADS

Baldwin Wallace College
Brown University
Marquette University
Miami University
Ohio State University
University of California
University of Illinois
University of Michigan

HIGH SCHOOL TRACK AND FIELD SQUADS

Akron, Ohio	Akron South High School
Berea, Ohio	Berea High School
Brecksville, Ohio	Brecksville High School
Boardman, Ohio	Boardman High School
Chardon, Ohio	Chardon High School
Columbiana, Ohio	Columbiana High School
Dover, Ohio	Dover High School
East Liverpool, Ohio	East Liverpool High School
Fremont, Ohio	Fremont High School
Geneva, Ohio	Geneva High School
Chicago, Illinois	Harper High School
Cleveland, Ohio	James Ford Rhodes High School
Mentor, Ohio	Mentor High School
Perry, Ohio	Perry High School
Shaker Heights, Ohio	Shaker Heights High School
Strongsville, Ohio	Strongsville High School
Willoughby, Ohio	Willoughby High School

COLLEGE AND UNIVERSITY WRESTLING TEAMS

Purdue University	Lafayette, Indiana
United States Naval Academy	Annapolis, Maryland
Tufts College	Medford, Massachusetts
University of Minnesota	Minneapolis, Minnesota
University of Pennsylvania	Philadelphia, Penna.
University of Wisconsin	Madison, Wisconsin

HIGH SCHOOL WRESTLING TEAMS

Cleveland, Ohio	James Ford Rhodes High School
Cleveland, Ohio	John Adams High School
Cleveland, Ohio	John Hay High School
Shaker Heights, Ohio	Shaker Heights High School
Euclid, Ohio	Shore High School
Cleveland, Ohio	Thomas Edison School
Shaker Heights, Ohio	University School
Cleveland, Ohio	West High School