DOCUMENT RESUME

ED 026 668 CG 003 467

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Contributions and Implications of the Medford, Oregon, Boys' Growth Study.

Oregon Univ., Eugene.

Pub Date 20 Apr 68

Note-40p.

EDRS Price MF-$0.25 HC-$2.10

Descriptors-*Child Development, Elementary School Students, *Growth Patterns, Longitudinal Studies, *Males, Maturation, Physical Fitness, *Psychomotor Skills, Secondary School Students, *Testing

The overall and long-range purposes of the Medford Boys' Growth Study are: (1) to construct physical and motor growth curves and growth acceleration curves of boys seven to 18 years old; (2) to relate these traits to physiological maturity, physique type, nutritional status, socio-personal adjustment, interests, and scholastic aptitude and achievement; (3) to trace, longitudinally, the development of all traits mentioned above for boys who become athletes, honor-roll students, and school and organizational leaders; (4) to contrast all these traits for boys who make and do not make interscholastic athletic teams, those who score high and low on strength tests and batteries, agility and running speed, reaction time, and muscular power; and (5) as concomitant studies, to revise and construct strength and other tests for boys of all ages, and to determine inter-relationships of various traits at various ages. The project permits three types of growth analyses (cross-sectional, longitudinal, and convergence), listed in eight categories: (1) maturity factors, (2) physique type, (3) body size measures, (4) strength elements and batteries, (5) motor tests, (6) scholastic aptitude and achievement, (7) psycho-personal adjustment, and (8) interests. Results, individual differences, and conclusions are discussed in detail for each of the specific test items. (BP)

CONTRIBUTIONS AND IMPLICATIONS OF

THE MEDFORD, OREGON, BOYS' GROWTH STUDY*

Fourth Edition

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Purposes and Scope

Purposes

The Medford, Oregon, Boys' Growth Study was initiated during the academic year of 1956-57; the last testing year of the project is 1967-68. The overall and long-range purposes of the Medford Boys' Growth Study are as follows:

1. To construct physical and motor growth curves and growth acceleration curves of boys seven to eighteen years of age for such traits as the following: body size, muscular strength, muscular endurance, and motor ability performances.

2. To relate these physical and motor traits to physiological maturity, physique type, nutritional status, socio-personal adjustment, interests, and scholastic aptitude and achievement.

3. To trace longitudinally the development of all traits mentioned above for boys who become athletes, honor-roll students, school and organization leaders, and the like.

4. To contrast all traits in the study for boys who make and who do not make interscholastic athletic teams; to make similar contrasts for boys who score high and low on strength tests and batteries, agility and running speed, reaction time, and muscular power.

5. As concomitant studies, to revise and construct strength and other tests for boys of all ages; and to determine the inter-relationships of the various traits included in the study at various ages.

Scope

The total project was designed to permit three types of growth analyses, as follows: cross-sectional with 40 boys at each age from 9 to 15 years inclusive; longitudinal series with approximately 100 boys at each age 7, 9, 12, and 12 years; and convergence at the end of four years, utilizing the boys in the longitudinal phase at over-lapping years.

To the date of this report, 61 graduate studies have been completed; forty have been doctoral dissertations and twenty-one have been master's theses. The greatest concentration of studies has been in the elementary school ages, since

*Terminal date, this report: April 20, 1968.

testing at these ages was completed first. The least number of studies completed has been at the senior high school level inasmuch as testing is still in progress at this level.

Subjects

The number of subjects tested each year at the different ages is shown on the following chart. The diagonals starting at ages seven, nine, twelve, and fifteen years are the same boys tested annually. At each of these ages (except seven years), additional subjects were included in 1959-60.

	7	8	9	10	11	12	13	14	15	16	17	18
1956-57	109		93	40	40	79	40	40	94			
1957-58		93		88			64			85		
1958-59			81		75			61			70	
1959-60				128		107			95			47
1960-61					108		83			84		
1961-62						104		78			77	
1962-63							93		69			56
1963-64								87		70		
1964-65									82		66	
1965-66										76		44
1966-67											69	
1967-68												42
TOTALS	109	93	174	256	223	290	280	266	340	315	282	189

In all instances, the Medford boys were tested within two months of their birthdays, in order to assure reasonable homogeneity as related to chronological age.

Tests

A listing of the test items included in the study follows:

1. Maturity factors: Chronological age, skeletal age, pubescent development.

2. Physique type: Somatotype components.

3. Body size measures: Body weight, standing and sitting heights, leg length, hip width, girths of upper arm, chest, abdominal, buttocks, thigh, and calf, lung capacity, Wetzel Grid, and skinfold measures over triceps, apex of scapula, and lateral abdomen.

4. Strength elements and batteries: Grip strength, back lift, ag lift, arm strength tests, Rogers' Strength and Physical Fitness Indices, eleven cable-tension strength tests of muscle groups throughout the body.

5. Motor tests: 60-yard shuttle run, standing broad jump, and total body reaction and movement times.

6. Scholastic aptitude and achievement: Grade point average and following tests depending on age and testing year: California Mental Maturity (Forms S and Secondary), Otis Quick-Scoring Beta (Forms A, B, Em, Fm), Otis Quick Scoring Gamma, Stanford Achievement (Elementary, Intermediate, and Advanced), Gates Reading (Primary and Advanced), Iowa Test of Educational Development.

7. Psycho-Personal Adjustment: The following tes... depend ng on age and year: Sociometric Questionnaire, Cowell Personal Distance Scale, Cowell Social Behavior Trend, Adjective Check List, California Psychological Inventory, Mental Health Analysis, and Level of Aspiration.

8. Interests: The following depending on age and testing year: Children's Interest Blank, Adjective Check List, Dreese and Mooney Interest Inventory, What I Like To Do, Kuder Preference Record (Forms D and Vocational), Garretson and Symonds Interest Form, Strong Vocational Interest Blank.

Understanding and Modification of Evaluative Instruments

Skeletal Age

The Greulich-Pyle method of evaluating skeletal age from wrist-hand x-rays consists of assessing some 30 bones and epiphyses. This process is quite time-consuming; considerable advantage would result from reducing the number of these assessments, provided there was no appreciable loss in the validity of the ratings. For boys 9 to 15 years inclusive, Hayman (26)* obtained a multiple correlation of .9989 between the skeletal age of all bones and four bones located longitudinally in the center of the hand: the capitate, metacarpal III, proximal phalanx III, and middle phalanx III. The difference between the skeletal age means by assessment of the total hand and by assessment of the four bones was .15 month (about five days); the *t* ratio was .03.

Pubescent Assessment

Degutis (13) compared the skeletal ages and various physical and motor factors with the pubescent development of 10, 13, and 16 year old boys. Pubescent assessments were based upon pubic hair and genital development according to Greulich's five-point categories. The conclusions which may be drawn from this study are as follows:

1. Of the three ages studied, physical maturation was differentiated by pubescent assessment most effectively at 13 years of age, although it was not so sensitive to maturational changes as was skeletal age. While the distribution by pubescent assessment of 13 year old boys disclosed some boys at this age in each of the five pubescent categories, most of them were equally distributed in Groups 2 and 3. At age 10 years, nearly all boys were classified in Group 1; at age 16 years, they were mostly in Group 5 but with some in Group 4. Considerable overlapping occurred in the skeletal age ranges of adjacent pubescent groups at each chronological age.

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*Numbers refer to "Graduate Theses" listed at end of this report.

2. With few exceptions, 13 and 16 year old boys who were advanced in pubescent development for their respective ages had higher mean scores on body size, strength, and motor tests. Mostly, the differences between the means were significant.

3. At 16 years of age, a significantly greater percentage of ectomorphs were found in Group 4 than in Group 5, thus indicating retarded maturation. Other comparisons of distributions by somatotype components were not significant.

General Maturity Indicators

Through factor a alysis by principal axes solution with varimax rotation, Burt (5) obtained a .961 loading with skeletal age on Principal Axes Factor I for 13 year old boys. Other high loadings on this factor were: .900 for the product of chest girth and height and .860 for body weight. The varimax rotations produced three factors, named as follows: Body Bulk, Strength Maturity Lag, and Linearity of Bone Structure. To designate a General Maturity Factor (GMF), a multiple correlation of .95 was obtained between the maturity factor and the chest girth-height product (CG x H) and leg length (LL). The following T-scale regression equation resulted:

$$GMF = 2.15(LL) + 7.59\left(\frac{CGxH}{240}\right) - 74.68$$

The standard error of estimate for this equation was 3.12 T-scale points.

A subsequent comparable factor analysis with a larger number of 13 year old boys was conducted by Medford project assistants; verification of Burt's findings did not result.

Willee (61) conducted a similar factor analysis with pre-pubescent 9 year old boys. However, he was unsuccessful in obtaining a general maturity factor, as skeletal age only loaded .611 on the first principal axes factor. From the varimax rotation, five factors were obtained; these factors were named Height, Ectomorphy-Endomorphy, Leg Strength, Relative Lung Capacity, and Grip Strength.

With advanced pubescent 16 year old boys, Torpey (55) obtained results similar to those by Willee. His rotated factors were named Ectomorphy-Endomorphy, Lower Body Strength, Body Bulk, Gross Arm and Shoulder Endurance, and Relative Sitting Strength.

Somatotyping

In a longitudinal somatotype study of the same boys from 9 to 12 years of age by Sinclair (50), multiple correlations of significant magnitude to warrant prediction were obtained between two of the components, mesomorphy and ectomorphy, and various other measures. These correlations and their regression equations follow.

Component	Age	R	Regression Equation	SE est
Endomorphy	9	.911	-.86 (mesomorphy) -.39 (ectomorphy) -.25 (height) + .09 (weight) + 15.58	.38
	10	.935	-.81 (mesomorphy) + .12 (upper arm girth) -2.17 (ponderal index) + 32.58	.35
	11	.947	-.80 (mesomorphy) -.46 (height) +.13 (weight) + 22.29	.36
	12	.945	-.76 (mesomorphy) -.42 (height) +.11 (weight) + 20.87	.35
Ectomorphy	9	.918	-.30 (endomorphy) -.54 (mesomorphy) +1.06 (ponderal index) -7.6	.38
	10	.926	2.10 (ponderal index) -24.54	.38
	11	.949	2.27 (ponderal index) -26.67	.34
	12	.943	2.40 (ponderal index) -28.36	.38

Munroe (40) computed similar multiple correlations with somatotype components for 13 year old boys. His multiple correlations were as follows:

Component	R	Regression Equation	σ est
Endomorphy	.887	-1.85 (ponderal index) +.17 (leg length) + 23.08	.48
Mesomorphy	.900	-2.15 (ponderal index) -.68 (Endomorphy) - 34.66	.28
Ectomorphy	.964	2.30 (ponderal index) - 27.02	.31

Sheldon's Trunk Index

A recent somatotype assessment proposed by Sheldon is based on the trunk index, the adult height, and the minimal index of height-over-cube-root-of-weight. The trunk index is the area of the thoracic trunk divided by the area of the abdominal trunk. According to Sheldon, this technique provides a quantitative differential between mesomorphy and endomorphy, appears to be constant from age three years to old age, and is derived objectively.

Morton (39) compared the trunk index* and anthroposcopic methods of somatotyping and their relationships to selected tests of maturity, structure, and

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*Acknowledgements are made to Dr. William H. Sheldon for making the somatotype assessments by the trunk-index method.

motor ability for the same 106 boys at ages nine through sixteen years. Among the results: (a) The correlations between somatotype components by the two assessment methods ranged from .394 to .758 for the various ages. (b) Generally, the trunk-index method produced higher somatotype designations of components for all ages than did the anthroposcopic method. (c) The trunk-index method identified more boys as endomorphs and endo-mesomorphs; the anthroposcopic method identified more boys as mid-types. (d) The highest correlation of a physical variable with the trunk index was .678 for chest girth/abdominal girth at age sixteen years. (e) The somatotype components by anthroposcopic assessment correlated higher with the experimental variables than did the trunk-index assessment for 91 per cent of the comparisons where a significant difference occurred. (f) Generally, the structural tests correlated best with somatotype components; none of the correlations with maturity was significant; standing broad jump, bar push-ups, and Physical Fitness Index consistently correlated significantly with ectomorphy.

Skinfold Measures

Geser (20) studied the relationship of skinfold measures of twelve year-old boys to various maturity, physique, strength and motor measures. Skinfold measurements were taken at the back of the upper arm, at the inferior angle of the scapula, and at the mid-axillary line at the level of the umbillicus (abdomen fat). As part of his study, Geser investigated the possibility of reducing the number of skinfold measurements necessary to adequately determine the relative amount of adipose tissue on the body. Using the composite of the scores of the three skinfold measures as the criterion, he obtained a multiple correlation of .995 with arm fat and abdomen fat as the independent variables.

The correlation of abdominal fat with skinfold total was .963.

Strength Index Simplification

Carter (6) simplified the administration of the Rogers Strength Index (SI) test for boys separately at upper elementary, junior high, and senior high school. Multiple correlations between .977 and .999 were obtained between the Strength Index, the dependent variable, and items of the test, the independent variables. Regression equations were computed for each of the multiple correlations so that predicted Physical Fitness Indices could be obtained from existing Strength Index norms. The multiple regression equations were as follows:

Upper Elementary School Boys: R = .977

SI = 1.05 (leg lift) + 1.35 (back lift) + 10.92 (push-ups) + 133

Junior High School Boys: A: R = .987

SI = 1.33 (leg lift) + 1.20 (arm strength) + 286

B: R = .998

SI = 1.12 (leg lift) + .99 (arm strength) + 5.19 (right grip) + 129

Senior High School Boys: A: R = .985

SI = 1.22 (leg lift) + 1.23 (arm strength) + 499

B: R = .996

SI = 1.07 (leg lift) + 1.06 (arm strength) + 1.42 (back lift) + 194

Boys' Elementary School Strength Tests

Utilizing 18 of Clarke's cable-tension strength tests, Schopf (48) constructed a strength test for boys in grades four, five, and six. By multiple correlation, four strength tests were selected to compose a Strength Composite battery: shoulder extension, trunk extension, knee extension, and ankle plantar flexion. Strength norms were developed based on the method used by Rogers in preparing Strength Index norms. A Strength Quotient was derived by dividing the normal into the achieved Strength Composites and multiplying by 100; thus a Strength Quotient of 100 is a median score.

Standing Broad Jump

With twelve year old boys as subjects, Flynn (18) studied four ways of scoring the standing broad jump as a muscular power test: distance jumped, distance jumped x body weight, body weight/distance jumped, and leg length/distance jumped. The highest intercorrelations among these criteria were -.848 and .753 between leg length/distance and distance jumped and weight/distance respectively. With one exception, the other intercorrelations were significant; the significant correlations ranged from .43 to -.55.

Each of the four standing broad jump criteria was intercorrelated with strength, speed, body size, and physique-type measures. For the experimental variable included in this study, the highest multiple correlations were obtained for distance x weight and weight/distance, .92 and .91. However, these criteria only correlated .43 with each other, thus indicating different implications when relating standing broad jump performances to various physical and motor traits. These implications are shown by the selection of tests in the multiple correlations as follows: for distance x weight; the tests were body weight, Strength Index, and skinfold total; for weight/distance, the tests were abdominal girth, Physical Fitness Index (negative), and skinfold total.

Test Scales

Based upon Hull-scale procedures (seven standard-deviation scale), a number of scales were constructed as follows: 12 cable-tension strength tests for boys 7, 9, 12 and 15 years by Harrison (24) and for boys 8, 10, 13 and 16 years by Stolsig (51); strength tests composing Rogers' Strength Index battery for boys 9 through 14 years by Clayton (8); and maturity and anthropometric tests for the same ages by Becker (2). A number of other Hull-scales are contained in a study by Shelley (49), to be mentioned later. Subsequently, T-scales for all maturity, physique type, body size, muscular strength and endurance, and motor ability tests and batteries were constructed by Medford project assistants for boys of all ages, 7 to 18 years.

Growth Curves

Cross-Sectional Analysis

Wickens (59) constructed growth curves from the cross-sectional data consisting of 40 boys at each age from 9 to 15 years inclusive for 34 maturity, structural, strength, and motor ability tests. In addition, he studied the variability of each test item at each age based on range, standard deviation, and coefficient of variation. In presenting mean growth curves for the various measures, an attempt was made to identify the differences in form which occurred. A single growth curve was not obtained, which was typical of all tests utilized; instead a number of variations to the upward trend as age increased was found. In a number of instances, more than one test followed a similar pattern. The mean growth curve descriptions by Wickens are as follows:

1. Skeletal age: straight-line rise.

2. Body weight, chest girth, and calf girth: straight-line to 13 years, some acceleration at 14 years and deceleration at 15 years.

3. Standing height, sitting height, and leg lift: nearly straight-line rise from 9 to 15 years with some acceleration at 14 years.

4. Lung capacity and hip width: convex from 9 to 13 years and linear from 13 to 15 years.

5. Upper arm girth: slight decrease from 9 to 10 years, followed by a steep rise to 15 years.

6. Right and left grips, back and leg lifts, and Strength Index: concave to 14 years.

7. Pull-ups and bar push-ups: erratic ups and downs until 13 years, steep rise to 14 years; the push-up curve continued to rise while the pull-up curve dropped off at 15 years.

8. Hip flexion and elbow flexion strengths: moderate rise from 9 to 12 years; elbow flexion rose steeply at 13 and 14 years and approached a plateau at 15 years, while hip flexion showed a slight dip at 13 and a sharp rise to 15 years.

9. Ankle plantar flexion, trunk flexion, knee extension, and cable-tension strength test average: moderately convex throughout.

10. Sixty-yard shuttle run: near plateau from 9 to 10 years, near straight-line rise to 13 years, a dip at 14 years, and a near plateau to 15 years.

11. Standing broad jump: nearly a straight-line rise with a slight dip at 13 and a hump at 14 years.

In Wickens' study, the Medford boys were found to be physically superior to normal populations, as reflected by above average scores on the Physical Fitness Index (PFI) test. Based on a large sample of boys, which provided the test scores for the norms, the median PFI is 100 and the first and third quartiles are 85 and 115. As determined by Wickens in the first year of the growth project, the mean scores of the Medford boys at each age were as follows:

Age	Mean PFI	Age	Mean PFI
9 years	106	13 years	116
10 years	119	14 years	125
11 years	108	15 years	113
12 years	117		

Convergence Analysis

Convergence growth analyses of maturity, structural, strength, and motor tests were made by Watt (57) for boys seven through seventeen years of age. Approximately 100 boys at each age 7, 9, 12, and 15 years were tested for four years; the convergence method was based on a three-year and three four-year sequences with each group overlapping the preceding age group; thus, the 7's overlapped the 9's, the 9's overlapped the 12's, and the 12's overlapped the 15's. Separate growth analyses were made based on the skeletal age of the subjects.

The differences between the means of the samples at each overlapping age 9, 12 and 15 years, were tested significance by application of the t ratio for each of the growth measures. Non-significant at all ages: skeletal age, body weight, standing height, lung capacity, Strength Index, and bar push-ups. Non-significant at 12 and 15 years: upper arm girth, pull-ups, 60-yard shuttle run, and standing broad jump. Significant at all ages: cable-tension strength tests. Convergence growth curves were constructed when non-significant differences between sample means were obtained. The convergence curves obtained were as follows:

1. Skeletal age, body weight, and standing height: approximately a straight-line rise from 7 to 17 years. However, body weight curve was slightly concave from 9 to 15 years and both body weight and standing height curves were convex from 15 to 17 years.

2. Lung capacity and Strength Index: generally concave curves, with some irregularities.

3. Bar push-ups: generally concave, but with distinct plateau from 8 to 12 years.

Velocity growth curves, in general, displayed patterns; these irregularities were most noticeable during the early years. Mostly, peak velocities appeared at either 15 or 16 years.

Longitudinal Analyses

Strength and Motor Tests: 7-12 years. Jordan (33) analyzed longitudinally the strength and motor development of the same boys for six years, from the age of 7 through 12 years. General conclusions from this study were as follows:

1. A moderate degree of consistency was found over the six-year period for the following variables: bar push-ups, standing broad jump, 60-yard shuttle run, cable-tension strength average, Strength Index, and Physical Fitness Index. For these variables, the inter-age correlations ranged from .38 to .89; the highest such correlations were .69 to .89 for bar push-ups, .54 to .83 for 60-yard shuttle run, and .45 to .81 for standing broad jump. The lowest inter-age correlations, generally, were for body reaction time, 10-ft. run, and shoulder inward rotation strength; 25 of the 35 correlations were not significant.

2. As the subjects advanced in age, their means generally increased on all tests. When the magnitudes of mean growth changes were expressed in standard deviation units, greater gains occurred for the strength tests than for the motor measures.

3. Comparisons of the strength and motor performance means for advanced and retarded maturity groups formed at 9 years revealed continuous significant differences until 12 years for the two gross strength batteries, Strength Index and cable-tension strength average.

4. For high and low cable-tension strength groups formed at 9 years, significant differences were obtained on other gross strength tests throughout the four-year period.

5. When growth patterns of high and low PFI groups, formed at 9 years, were compared, continuous significant differences were obtained for bar push-ups and Strength Index over the four-year period.

Somatotype: 9 to 12 years. Sinclair (51) studied physique-type stability of boys 9 through 12 years of age. Unlike Kurimoto's study of older boys, the somatotype component means of these boys did not differ significantly from age to age; the *t* ratios for the differences between the means ranged from .02 to .76. However, numerous variations occurred in the somatotypes of individual boys. The mean ranges of the components for the four years were: endomorphy, 3.4 to 3.6; mesomorphy, 4.1 to 4.2; ectomorphy, 2.8 to 3.2.

For the components the ranges of inter-age correlations were: endomorphy, .79 to .85; mesomorphy, .83 to .93; ectomorphy, .85 to .89. The ranges of correlations between components were: .03 to .25 between endomorphy and mesomorphy; -.64 to -.69 between mesomorphy and ectomorphy; -.64 and -.75 between endomorphy and ectomorphy. Zero-order correlations between somatotype components and measures of maturity, body size, muscular strength and endurance, and motor performances followed approximately the same pattern for the four years.

Structural Measures and Proportions: 7 to 12 Years. Day (10) analyzed longitudinally the structural measures and proportions of the same boys for six years, ages 7 through 12 years. Results from this study follow:

1. The structural measures with the exception of lung capacity, showed generally high levels of inter-age consistency. The inter-age correlations for seven body bulk and four linear measures ranged from .629 to .985. Standing height and body weight were the two most consistent measures. Skeletal age inter-age correlations ranged from .749 to .925. The inter-age correlations for body-form indices covered a wide range, from .452 to .964.

2. As the boys advanced in age, their means on fourteen of the eighteen measures in the study showed increases each year; the exceptions were four body-form indices which were ratios. The greatest mean annual increments expressed as a percentage of attained size were for lung capacity, body weight, and skeletal age.

3. Comparisons of the structural measure means for advanced and retarded maturity groups formed at 9 years revealed continuous significant differences for all measures. The index, chest girth x standing height, showed similar differences.

4. For high and low gross strength groups formed at 9 years, significant differences were obtained for 50 per cent of the comparisons in favor of the high strength group.

5. The comparisons of the maturity and structural measures and index means for heavy and light groups formed at 9 years of age resulted in continuous significant measures for all but 4 per cent of the comparisons. Similar results were obtained for the growth patterns of tall and short groups.

General: 15 to 18 years. Kurimoto (35) conducted the first longitudinal analyses of growth data from the Medford project. His subjects were 70 boys tested annually from 15 to 18 years. Among the conclusions reached as a consequence of this study are the following:

1. As the boys advanced in age from 15 to 18 years, their means increased on all tests. However, the amounts of increase became smaller with each yearly advance in age, as the subjects progressed toward and, in many instances, reached maturity.

2. The somatotype components of the boys changed significantly from one age to another. The amount of mesomorphy increased (4.05 to 4.65) and the amount of ectomorphy decreased (3.71 to 3.18).

3. As shown in Table I, the inter-age correlation coefficients were between .90 and .95 for skeletal age; for structural measures, they exceeded .80; for strength and motor ability tests, they were lower.

Table I

Illustrative Inter-Age Correlations

	Skeletal Age	Weight	Height	Mesomorphy	Leg Lift	PFI
15 vs. 16 years	.95	.87	.97	.91	.82	.77
16 vs. 17 years	.95	.84	.98	.83	.67	.72
17 vs. 18 years		.96	.99	.88	.77	.75
15 vs. 17 years	.90	.92	.91	.81	.73	.76
16 vs. 18 years		.81	.96	.86	.65	.72
15 vs. 18 years		.86	.86	.82	.64	.62

4. When advanced and retarded maturity groups were formed at 15 years of age, the advanced maturity group was larger and stronger than the retarded group. During the age period from 15 to 17 years, the retarded group registered significantly greater mean gains on various tests than did the advanced maturity group. For skeletal age, weight, lung capacity, and leg lift strength, the significantly higher means of the advanced maturity groups at 15 years were maintained at 16 and 17 years of age.

Growth Increment: 10 to 16 Years. Docherty (16) studied the characteristics of the rate and pattern of growth of maturity, structural, strength, endurance, and motor ability measures of the same 106 boys from ten to sixteen years of age. With very few exceptions, all variables showed a continuous improvement during the six years of the study. The yearly velocity rates for skeletal age and most functional variables were relatively consistent during this time span; the structural variables and bar push-ups showed less consistency in yearly growth increments.

The highest relationships between velocity rates of experimental variables were found for structural measures. The correlations between velocity rates of standing height and leg length increased from .44 at eleven years to .81 at sixteen years of age. The relationships between velocity rates of skeletal age and structural variables were generally significant but low in magnitude. For the velocity rates of structural and functional measures, the correlations were mostly insignificant.

Mental Health: 15 to 17 Years. Jordan (32) studied the Mental Health Analysis longitudinally for the same boys from age 15 to 17 years. Mostly, the inter-age correlations between the mental health scores indicated a consistency that ranged from moderate to high; the significant correlations ranged from .577 to .865; the highest correlations were between adjacent ages. Most of the significant correlations between Mental Health Analysis scores and body size, strength, motor ability, maturity, and physique tests were obtained at 15 years of age; the tests with highest correlations were cable-tension strength average and body weight.

Individual Differences

Nature and Extent

Space does not permit a detailed description of the nature and extent of the individual differences noted in the Medford Boys' Growth Study. Consequently, representative tests of each type only are presented here. The physical growth analyses made thus far in this project have been by Wickens (59), Watt (57), Kurimoto (35), Jordan (33), and Day (10). However, for purposes of a USOE Title III Grant, the maximum number of subjects available were included for a number of the variables, as reported here.

Maturity. Skeletal age is the main maturity measure utilized in the Medford study; this measure is the most commonly used scientific indicator of biological maturity. It evaluates how far the bones are in their course of development, as recorded by an X-ray of the wrist and hand; thus development continues from birth until maturity is reached. To illustrate the meaning of skeletal age: When a 12-year-old boy's "X-ray hand" conforms to the standard for 12-year-old boys in the Greulich-Pyle atlas his skeletal age is then 12 years; thus, his maturation is typical for his age.

Variability in skeletal age is pronounced, as shown in Table I. The skeletal age standard deviations for the six ages 7 through 12 years range from 11.9 to 15.0 months, over a year for all but age 7 years. The ranges were between 65.0 and 68.0 months for the youngest three years and then jumped to 74.0 to 77.0 months for the oldest three years. To illustrate what this means, take the 214 10-year-old boys: By testing restriction, their chronological ages could not vary by more than 4 months; yet, they varied in skeletal age by 77 months, 6 years 5 months; the most mature boy (153 months) had twice the skeletal age of the least mature boy (76 months) at this age.

Table I

Skeletal Age: Means and Variability

(Months)

Age	N	Mean	Low	High	Range	SD
7	107	75.4	42.0	110.0	68.0	11.9
8	93	88.3	54.0	120.0	66.0	14.6
9	176	109.3	75.0	140.0	65.0	12.7
10	214	120.5	76.0	153.0	77.0	15.0
11	176	131.6	89.0	163.0	74.0	13.8
12	298	144.9	104.0	180.0	76.0	12.9

Somatotype. By chi-square test, Irving (29) found that the Medford boys, classified into five categories, did not differ significantly from Sheldon's distribution of 46,000 men when formed into the same categories. As an indication of individual differences, the following percentages were obtained for 259 Medford boys, 9 through 15 years of age: 7 endomorphs, 21 mesomorphs, 24 ectomorphs, 10 endo-mesomorphs, and 38 mid-types.

Standing height: A consistent increase occurred in the range and standard deviation for the heights of 7 to 12 year old boys, as shown in Table II. The range of height scores at 7 years of age was 11 inches, whereas the range at 12 years was 19.2 inches. The standard deviations increased in a similarly consistent pattern; for ages 7 and 12 years, they were 1.97 and 2.75 inches, respectively. Except for 12 years of age, this same result was found for sitting height.

Table II

Standing Height: Means and Variability

(Inches)

Age	N	Mean	Low	High	Range	SD
7	113	48.1	42.0	53.0	11.0	2.0
8	94	50.5	43.3	54.8	11.5	2.1
9	178	52.3	44.9	57.3	12.4	2.2
10	223	54.6	46.7	61.0	14.3	2.3
11	190	56.6	48.4	63.4	15.0	2.4
12	298	58.9	49.8	69.0	19.2	2.8

Weight. Body weight demonstrated the same consistent increases in range and standard deviation that was evident for standing height, as shown in Table III. The range for weight was 33 pounds at age 7 years; at age 12 years, it was 88 pounds. At most ages, the heaviest boy was at least twice as heavy as the lightest boy. The standard deviations increased from 6.3 pounds at age 7 years to 16.6 pounds at age 12 years.

Table III

Body Weight: Means and Variability

(Pounds)

Age	N	Mean	Low	High	Range	SD
7	113	52.5	38.0	71.0	33.0	6.3
8	94	58.8	41.0	82.0	41.0	7.8
9	178	65.7	44.0	100.0	56.0	10.0
10	223	74.4	48.0	127.0	79.0	13.2
11	190	81.0	51.0	129.0	78.0	14.8
12	298	91.1	56.0	144.0	88.0	16.6

Fat. Fat caliper measures were taken on the elementary school boys at three ages only, 10, 11, and 12, years; actually, these measures were not included in the Medford Boys' Growth Study during the first three years. The cites for the fat-fold tests were: back of upper arm, inferior angle of scapula, and side of abdomen. The means and variability for the total of these three tests appear in Table IV. The fat totals show great variability with ranges from 108.0 mm. at age 10 years to 145.0 mm. at age 12 years. At these ages, the boys with most fat had 12 or more times as great a total as did the boys with least fat. The standard deviations were fairly constant for the three ages, 21.0 mm. to 23.5 mm.

Table IV

Fat Total: Means and Variability

(Millimeters)

Age	N	Mean	Low	High	Range	SD
10	130	29.0	10.0	118.0	108.0	21.1
11	108	32.3	10.0	126.0	116.0	23.5
12	217	36.8	12.0	157.0	145.0	21.0

Leg lift. Leg lift strength is tested with a dynamometer; a belt is used around the waist to clamp the lifting bar to the body. The subject is in a standing position with knees slightly bent; the lift is straight up. The leg lift means and variability for Medford boys 8 through 12 years of age are shown in Table V. The ranges increased from 370 to 930 pounds over this period (930 pounds, of course, nearly equals one-half ton). Consistently, the strongest boys at the various ages had leg lifts 3 to 5 times greater than for the weakest boys. The standard deviations increased from 84 pounds at age 8 years to 169 pounds at 12 years.

Table V

Leg Lift: Means and Variability

(Pounds)

Age	N	Mean	Low	High	Range	SD
7	0					
8	94	321	150	520	370	84
9	178	360	180	[illegible]0	530	106
10	223	435	165	855	690	125
11	186	505	300	900	600	138
12	298	621	250	1180	930	169

Physical Fitness Index. The Physical Fitness Index (PFI) is obtained by relating each boy's Strength Index to a norm based on his age and weight. The Strength Index to a norm based on his age and weight. The Strength Index is the sum of the following tests: lung capacity, right and left grips, back and leg lifts, and pull-ups and push-ups. A PFI of 100 is average according to the norms; scores of 85 and 115 are at the first and third quartiles.

The PFI means and variability of the Medford boys 8 through 12 years of age appear in Table VI. Mean increases on this test are not anticipated, as the norms keep pace with age. The mean PFI's of these boys are unusually high, ranging from 105 at 9 years to 117 at 11 years of age. The ranges varied from 79 to 132; the highest PFI boy at each age had a PFI two to three times higher than the lowest boy. The standard deviations clustered around 20 PFI points.

Table VI

Physical Fitness Index: Means and Variability

(Pounds)

Age	N	Mean	Low	High	Range	SD
8	94	109	74	153	79	17
9	178	105	71	170	99	20
10	223	115	57	179	122	21
11	185	117	65	178	113	20
12	297	115	52	184	132	21

Standing broad jump. The means and variabilities for the standing broad jump appear in Table VII. A steady increase in mean performances was found from ages 7 to 12 years. The standing broad jump ranges increased steadily from 27 and 26 inches at 7 and 8 years to 41 inches at 12 years of age. Generally, the best jumper in an age could jump twice as far as the poorest jumper. The standard deviations varied between 5.0 and 6.7 inches.

Table VII

Standing Broad Jump: Means and Variability

(Inches)

Age	N	Mean	Low	High	Range	SD
7	113	45.6	32.0	59.0	27.0	5.0
8	92	51.7	38.0	64.0	26.0	5.1
9	176	53.5	38.0	71.0	33.0	6.3
10	218	57.5	36.0	72.0	36.0	5.9
11	186	60.5	35.0	73.0	38.0	6.1
12	297	63.8	42.0	83.0	41.0	6.7

Significance

Maturity. In an analysis by Harrison (25), advanced, normal and retarded maturity groups were formed based on skeletal age at 9, 12, and 15 years of age. The boys in these three groups at each age were contrasted for structural, strength and muscular power characteristics, as illustrated in Table VIII. In all instances where the differences were significant, the more mature group had the highest mean. The most significant differences between the means were obtained at 15, 12, and 9 years of age in that order. Without exception, the differences between all body weight means were significant. Other test variables in which the differences between the means were relatively high in significance were hip width, grip strength, sitting height, upper arm girth, and calf girth; and, also, chest girth, mean of 12 cable-tension strength tests, Strength Index, standing height, and elbow flexion strength. The results of Degutis' study (13), utilizing pubescent assessments as the means of forming maturity groups, supported the findings by Harrison most consistently in the comparison between retarded and advanced maturity groups at 13 and 16 years of age.

Table VIII

Differences Between Advanced, Normal, and Retarded Maturity Groups

t Ratios for Differences Between Means

Test	Age	Advanced Normal	Advanced Retarded	Normal Retarded
Body Weight	9	2.30	3.92	2.32
	12	3.19	6.16	2.71
	15	2.82	6.41	4.54
Standing Height	9	1.39*	2.45	1.61*
	12	3.34	3.96	1.59*
	15	1.79*	3.99	2.82
Grip Strength	9	2.30	5.62	3.88
	12	1.09*	2.94	1.88*
	15	2.34	5.61	4.44
Standing Broad Jump	9	.70*	.58*	1.23*
	12	.53*	.04*	.60*
	15	1.22*	3.60	2.64

*Non-significant at .05 level

As mentioned earlier, Willee, Burt and Torpey conducted factor analysis studies of 9, 13, and 16 year old boys respectively. From 50 to 60 experimental tests, most of them the same in all studies, those measures that correlated significantly with skeletal age were selected for analysis. These correlations were highest at 13 years, next highest at 9 years, and lowest at 16 years of age. The highest correlations at these ages were: .73 for standing height and sitting height, 13 years; .59 for body weight, 9 years; and .49 for Rogers' arm strength score, 16 years.

Physique Type. In the somatotype analysis by Irving (29), the endomorphs and the endo-mesomorphs exceeded the other somatotype categories in the body-bulk measures of body weight, Wetzel physique channel, upper arm girth, chest girth, and hip width; in general, the mesomorphs had higher means on these measures than did the ectomorphs and midtypes. Due to their excessive weight, the endomorphs were at a great disadvantage in performing pull-ups and push-ups; their means for these tests were .06 and 2.1 times respectively. The mesomorphs showed superiority over the other categories in Strength Index and Physical Fitness Index, as well as pull-ups and push-ups. The ectomorphs and mid-types had higher Physical Fitness Index means than did the endomorphs and endo-mesomorphs.

Through partial and multiple correlation procedures, Munroe (40) studied relationships between somatotype components and maturity, structural, strength, muscular endurance, and motor ability measures of 12 year old boys. Among the findings of this study were the following:

1. Skeletal age was not highly related to somatotype components, but the direction of the zero-order and partial correlations indicated that endomorphy and, to a lesser extent, mesomorphy were associated with advanced skeletal age; ectomorphy was more likely associated with retarded skeletal development.

2. The ponderal index (height over cube root of weight) correlated .96 with ectomorphy and -.85 with endomorphy. The correlation with mesomorphy was lower (-.69).

3. Relationships between somatotype components and measures of body structure were significantly greater than corresponding zero-order correlations when contrasting structural measures were partialed out. Endomorphy was highly related to body bulk when linear measures were partialed; ectomorphy was highly related to linearity when body bulk measures were partialed; and mesomorphy seemed to relate to a combination of these factors, especially a large trunk and short legs. For example, the zero-order correlation between endomorphy and weight was .79; the partial correlation with height constant was .86. Much morepronounced, the zero-order correlation between ectomorphy and height was .19; the partial correlation with weight constant was .71.

4. Although the correlations were not high, endomorphy and mesomorphy were associated with gross strength, while ectomorphy was negatively so related. Endomorphy was associated with low relative (to weight) strength. Similar results were obtained with muscular endurance measures, except the endomorph was handicapped.

For 13 year old boys, Broekhoff (41) obtained few significant correlations between somatotype components and personality measures. When extreme somatotypes were compared, however, the meso-endomorphs and mesomorph groups had significantly higher means than the ectomorph group on a number of the California Psychological Inventory scales; they appeared more active, enterprising, and outgoing.

Wetzel Grid. Weinberg (56) presented relationships with various aspects of the Wetzel Grid for boys 9 to 15 years of age. A multiple correlation of .90 was obtained between the physique channels and upper arm girth, standing height, and body weight; this coefficient was increased to .96 with the addition of sitting height and leg length. Among the strength measures, only the Physical Fitness Index indicated a trend in body strength according to physique channels; the means of the borderline, fair, and good groups were significantly higher than the means of the stocky and obese groups. Wetzel's developmental level correlated .98 with body weight. The highest correlations with Wetzel's developmental ratio were .55 for calf girth, .51 for chest girth and for body weight, and .48 for upper arm girth.

Strength. Borms (3) investigated the relationship between selected maturity, physique, body size, and motor tests and gross and relative strength of boys 10, 13, and 16 years of age. The strength criteria utilized were Rogers' Strength Index and the average of eleven cable-tension strength tests as gross muscular strength measures, and the Rogers Physical Fitness Index as the relative muscular strength measure. Three strength groups, high, average and low, were arranged for each of the three strength criteria at each of the three ages. Results of the study were as follows:

1. Gross Strength Tests: Generally, the higher strength groups recorded significantly higher means than did the lower strength groups on maturity, body size measures, tests of motor ability elements, and mesomorphy. The low gross strength groups had significantly higher ectomorphy means. The high 10 and 13 year old groups on the Strength Index and the Cable-tension Tests Average recorded significantly higher mesomorphy and mesomorphy-endomorphy means, respectively.

2. Relative Strength: Generally, the body size means of the low PFI groups were significantly higher than the means of the high groups. In most cases, the low PFI groups recorded significantly higher endomorphy means than did the high group. The high-low and average-low groups differed significantly on ectomorphy means, favoring the higher strength groups. At all ages, with one exception, the high PFI groups realized significantly higher means on motor ability tests.

Body Size. From studies reported by Clarke involving nine anthropometric tests, four measures were particularly significant as structural indicators: upper arm girth, body weight, chest girth, and lung capacity. The intercorrelations of anthropometric variables were higher for junior high school than for upper elementary school boys. That structure is related to function is borne out by the following high correlations between anthropometric and strength tests for junior high school boys obtained by Tomaras (54): for lung capacity, .86 with mean of 12 cable-tension strength tests, .84 with McCloy's Athletic Strength Index, .81 with elbow flexion strength, and .80 with Strength Index; for body weight, .82 with McCloy's Athletic Strength Index, .75 with mean of 12 cable-tension strength tests, and .70 with grip strength and with elbow flexion strength; and for upper arm girth, .78 with McCloy's Athletic Strength Index, .74 with mean of 12 cable-tension strength tests, and .70 with elbow flexion strength.

Burt (5) obtained lower correlations between skeletal age and anthropometric and strength variables than did Tomaras, but his subjects were confined to a single chronological age, thirteen years; this restriction had the effect of partialing out chronological age. The highest correlations of skeletal age with anthropometric variables were .73 for sitting height and for chest girth times height, .72 for standing height, and .68 for weight. The highest correlations with strength measures were .75 for elbow flexion strength, .56 for left grip, .54 for leg lift, and .53 for right grip.

Geser (20) investigated the relationship of skinfold measures of 12 year old boys to various maturity, physique, strength, muscular endurance, and motor ability characteristics. When correlated with physique components, endomorphy had a high positive correlation of .824 with adipose tissue, while ectomorphy correlated negatively, -.657, with adipose tissue. The remainder of the correlations of adipose tissue with maturity, mesomorphy, strength, and motor measures were relatively low. However, the direction of the correlations were as follows: all maturity correlations were positive; gross strength correlations were positive; relative strength and muscular endurance correlations were negative; and correlations with motor ability elements of power and speed-agility were negative.

Growth Comparisons of Extreme Groups

Kurimoto (35) formed high and low maturity groups at 15 years of age and contrasted their growth characteristics to age 17 years. The advanced maturity group was larger and stronger than the retarded maturity group, and maintained this superiority to 17 years. Jordan (33) and Day (10) obtained similar results with advanced and retarded maturity groups formed at 9 years and followed to 12 years of age. The results obtained from comparing growth patterns of high and low height-attainment groups (i.e., groups formed on how nearly they had attained their 18-year-old height at 15 years of age) were similar to those observed when the advanced and retarded maturity groups were compared in Kurimoto's study.

When comparing growth patterns of high and low groups formed at age 9 years by use of cable-tension strength average, Jordan found that the strong group was superior and maintained their superiority to age 12 years on gross strength and motor ability tests. Day reported similar results for maturity and body size measures.

Eight Year Old Boys. Hindmarch (27) studied the significance of physique, maturational, body size, strength, motor ability, and reaction time characteristics of 8 year old boys. Among his conclusions were the following:

1. When skeletal age was used to determine physical maturity, the advanced maturity boys were larger in body weight, standing height, lung capacity, upper arm girth, abdominal girth, buttocks girth, and thigh girth and were stronger in gross strength than the retarded maturity boys.

2. When upper arm girth and lung capacity were used to indicate body size, larger boys had significantly greater gross strength than smaller boys.

3. Eight year old boys who had greater gross strength, as measured by the Strength Index and cable-tension strength average, are generally more mature and have better motor ability scores than boys of lesser gross strength.

4. Boys who had greater relative (to weight) strength, as measured by the Physical Fitness Index, are neither more mature nor faster in reaction time than boys of lesser relative strength. In tests of motor ability, however, the boys with greater relative strength were significantly faster in the 60-yard shuttle run and had greater standing broad jump distances than did boys who were lowest in relative strength.

Physical Education Election

Ragsdale (45) studied the differences in maturity, structural, strength, motor, and scholastic measures between boys who elected and those who did not elect physical education in grade eleven. For the same measures, he also contrasted those boys who participated in interscholastic athletics. Among his findings were the following:

1. No significant differences were obtained between skeletal age means of those boys who elected and did not elect physical education.

2. At grade ten, the boys who participated in athletics and who elected physical education at grade eleven had a significantly higher mesomorphy mean than the non-athletes who did not elect physical education.

3. When athletic participation was held constant, no significant difference was found between strength test means of those who elected and did not elect physical education. However, significant mean differences did result with muscular endurance measures when applied to non-athletes.

4. Boys who elected physical education were superior on all shuttle-run comparisons, and on the standing broad jump and reaction time for non-athletes.

5. Athletes who elected physical education had superior grade point averages.

6. Mean weight gains were consistently favorable to the groups which participated in eleventh grade physical education. For athletes, similar advantages were found for those participating in physical education in upper arm girth, skinfold tests, and Physical Fitness Index.

Personal-Social Relationships

The Mental Health Analysis, an inventory-type instrument, and a sociometric questionnaire, a peer-status device, were applied by Clarke (7) to boys 9 through 14 years of age. Positive relationships were obtained between the sociometric questionnaire and measures of body size and strength. However, when the inventory-type instrument was used, the results were conflicting and contrary to those with the sociometric questionnaire. In fact, with the inventory, only one difference between the means of those who were well adjusted and poorly adjusted was significant at the .05 level; this was for the Physical Fitness Index with the better adjusted having the lowest mean.

Devine (14) studied the interrelationships of the five categories of the sociometric questionnaire for boys at ages 9 and 11 years; the categories were those they would like for friends, those with whom they would like to go to the movies, to play games, and to study homework, and those they would like to invite to a birthday party. The intercorrelations at 9 years were relatively low ranging from .62 to .75; thus, each category contributed some unique element to peer-status assessment. At 11 years, the boys chosen as friends were also generally chosen in the party, movies, and sports categories (<u>r</u>'s from .91 to .97); the lowest correlations were with the homework category (.59 to .76). Thus, at this age, the sociometric questionnaire could well be limited to two categories, friends and homework.

Greene (22) administered the following five personal-social tests to the same 78 boys 10 years of age: sociometric questionnaire, friends and homework categories only; Cowell Personal Distance Ballot, a second peer-status instrument, Cowell Social Behavior Trend Index, based on the ratings of teachers; level of aspiration test, as noted below; and SRA Junior Inventory, in which each boy answered questions about himself. The highest intercorrelations among these instruments were: .73 between friends and homework categories on the sociometric questionnaire, -.74 between the friends category and Cowell Personal Distance Ballot (a low score on the ballot is a good score), and -.52 between the homework category and Cowell's ballot. All of these instruments correlated low with various physical tests; the highest correlation was -.30 between the friends category and degree of ectomorphy (with mesomorphy, the correlation was .22).

In a second study, Greene (23) longitudinally related peer status and level of aspiration measures to the maturity, physique, structural, strength, and motor ability characteristics of the same boys from 7 to 12 years of age. The highest multiple correlation obtained was .485 between the Sports category at age 12 years and standing broad jump, mesomorphy, Physical Fitness Index, and cable-tension strength average. Mean differences in favor of high sociometric groups (boys highly chosen at least three of four years) were found for the standing broad jump, cable-tension strength average, mesomorphy, Physical Fitness Index, and 60-yard shuttle run; in some instances, high endomorphy means were found with low socio-metric groups. Based on a level of aspiration test, such tests as the following differentiated between high and low groups: body weight, upper arm girth, cable-tension strength average, Wetzel physique channel, standing height, mesomorphy, ectomorphy, and standing broad jump.

The results of administering the following level of aspiration test to 9 year old boys were analyzed by Stratton (52): three grip strength tests were given; after each test, the subject was told his score and was asked what he thought he could do on the next test (his aspirations). The second aspiration discrepancy (difference between the first aspiration and the second grip strength score) was the most representative of the various performances, aspirations, and discrepancies studied. Utilizing two aspiration discrepancy scores obtained from 9 year old boys, Clarke and Clarke reported that those who expressed higher levels of aspiration were physically superior in size and strength to those who expressed neither an increase nor a decrease in their assessments.

Subsequently, Stratton (53) studied the reliability of level of aspiration scores and their relationship to measures of the growth and development of 11 year old boys. The reliability coefficients with the tests taken one week apart ranged from .44 to .68; the most reliable measure was the difference between the second grip strength test and the second aspiration (AD-2). Other findings related to this form of level of aspiration testing were: no age effect was found; previous annual experience in grip strength testing did not affect level of aspiration testing of 9 year old boys; experience in level of aspiration and grip strength tended to cause 11 year old boys to be more consistent in setting their grip strength levels and the setting of aspirations closer to their actual abilities. Among the relationships found with level of aspiration measures were: for the Dreese-Mooney Interest Inventory, a significant difference was obtained between high and low First Aspiration Discrepancy means; the high Average Magnitude of Discrepancy and Average Variability of Discrepancy groups had significantly higher standing broad jump means than did the low groups; the high Average Variability of Discrepancy group had a higher grip strength mean than did the low group.

In Jordan's longitudinal study with the Mental Health Analysis (32), the physical test with most significant correlations with mental health scores was cable-tension strength; of nine significant correlations, seven were negatively related to the liabilities section and components. Body weight correlated significantly with four mental health measures.

Reynolds (46) formed groups of 13 year old boys who checked and who did not check each of the 50 adjectives on the Davidson Adjective Check List; the differences between the means on sixteen physical and motor tests for the groups thus formed were tested for significance. The adjectives showing greatest differentation in descending order (numbeals indicate number of variables with significant differences): 8, cry-baby; 7, stupid; 5, bossy, leader, mean, nervous, sissy; 4, brat, generous, unhappy; 3, bad careless, clumsy, dependable, kind, smart. The physical and motor tests showing greatest differentiation were: 8, skeletal age, endomorphy, ectomorphy, standing broad jump; 7, 60-yard shuttle run; 6, mesomorphy, arm strength, PFI, 10-ft. speed; 5, chest girth, height x chest girth, reaction time; 4, cable-tension strength average.

Flynn (19) conducted a study similar to the one above by Reynolds, but his subjects were 205 boys 16 years of age. The adjectives showing greatest differentiation in descending order were: 10, clumsy; 9, leader; 8, good sport; 7, sissy (mostly negative); and 5, silly (mostly negative) and clever (mostly positive). The physical and motor tests showing greatest differentiation were skeletal age, endomorphy, cable-tension strength mean, Strength Index, total-body completion time, and standing broad jump.

Broekhoff (4) studied the relationships between physical characteristics and measures of personality, social status and adjustment, interest, self-image, intelligence, and scholastic achievement of 13 year old boys. Among his conclusions were the following:

1. The taller boys with high gross muscular strength, who were most likely advanced in skeletal age, tended to be defensive, rebellious, and inhibited.

2. Boys with high PFI tended to be outgoing, enterprising, and competitive, and performed well in their school work; they showed interest in academic subjects and were favorably rated by their teachers. High arm strength boys tended to be active, sociable, and popular with teachers and peers. Generally, boys with high gross muscular strength appeared to be aloof and showed signs of adjustment problems.

3. Boys with high motor ability tended to be active, ambitious, confident, and alert; they were popular among teachers and peers and performed well in school.

4. These boys appeared to have a definite image of an ideal physique: the great majority selected a well-balanced mesomorphic physique as the ideal body type.

5. Boys who performed well on objective physical tests tended to underestimate their superiority, where as poor performers "over-corrected" toward the age group average.

Miller (37) studied the relationship between measures of self-differentiation, social-interaction, and physical characteristics of the same boys from 12 to 17 years of age. The instruments used were: Davidson Adjective Check List for self-differentiation and California Psychological Inventory for social-interaction; for background information in profile analysis: Cowell Personal Distance Ballot and Cowell Behavior Trend Index for social status and adjustment, Garretson-Symonds Interest Questionnaire for interest, and Medford Information Questionnaire for social information. Fifteen measures of maturity, physique type, body size and proportion, gross and relative strength, and motor ability elements. Among his results are the following:

1. Positive Adjective Check List responses were significantly related to physical variables at age 12 years; none was significant at ages 14 and 16 years. Four of the five significant correlations at age 12 years involved relative performance measures and the fifth was a gross strength test. At age 16 years, endomorphy and abdominal girth had significant negative correlations with the negative Adjective Check List responses.

2. The general pattern of relationships between the California Psychological Inventory and the physical variables is: At age 13 years, standing height and right grip strength were associated with unfavorable personal-social adjustment; at age 17 years, these same variables had favorable associations. At age 15 years, 60-yard shuttle run, standing broad jump, and 10-foot speed were connected with favorable personal-social adjustment; at age 17 years, the favorable relationships were with standing height, abdominal girth, grip strength, 60-yard shuttle run, standing broad jump, and 10-foot speed. At age 17 years, the tall boy with high motor ability, high relative strength, high grip strength, and little excess adipose tissue was favorably adjusted to his social environment.

3. The general profile patterns of high positive self-differentiation boys suggested that high positive self-differentiation at age 12 years is associated with above average relative physical performances; is relatively unaffected by maturity level; and tends to be associated with a mesomorphic physique. Although these profiles were not maintained at ages 14 and 16 years, fluctuations in relative strength and motor ability elements tended to be related in a positive manner to fluctuations in both positive and negative self-differentiation. Negative self-differentiation was associated with retarded physiological development and was relatively stable over the age period investigated.

Scholastic Achievement

Jarman (30) investigated the scholastic achievement of boys 9, 12, and 15 years of age as related to various strength and growth measures. High and low scoring groups of 20 boys each were formed separately on the basis of three strength and two growth measures at each of the three ages; each pair of high and low groups was equated by use of intelligence quotients. The scholastic achievement of the groups was then contrasted. A consistent tendency for the high groups to have higher means on both standard achievement tests and grade point averages was noted. There were more and greater significant differences in scholastic achievement between the high and low Physical Fitness Index groups than for the other measures. The Strength Index was especially effective at nine years of age. For each of the other experimental variables, Rogers' arm strength score, McCloy's Classification Index, and Wetzel's developmental level, significance between means on academic measures was achieved once only.

Page (42) conducted a study similar to Jarman's investigation. The ages of his boys were 10, 13, and 16 years; high and low groups on 20 maturity, physique type, strength, motor, and personal-social tests were formed, each equated by intelligence quotients. Although no general pattern was evident, the following significant results were obtained: (a) The low skeletal age group had higher means (.05 level) on both the standard achievement test and grade point averages at sixteen years of age. (b) No consistent relationships between linear body measurements and academic achievement were observed. The six significant differences were divided between the high and low academic achievement groups.

(c) Sixteen year old boys in the low physique channel of the Wetzel Grid had significantly higher mean grade point averages than did those in the high physique channel. (d) Little relationship between motor ability and academic achievement was revealed. However, significant relationships were observed between reaction time and academic achievement at ages 13 and 16 years. (e) Differences in academic achievement between boys who scored high and low on peer status and mental health measures which reached the .05 level of significance were as follows: The high sociogram group had higher grade point averages than did the low group at age 10 years; at 16 years of age the high Mental Health Analysis group had higher standard achievement scores and grade point averages than did the low group.

By correlational methods, Coefield (9) and Jarman (31) studied the relationships between academic achievement and maturity, physique, strength, motor, and personality measures of boys 12 years of age in the sixth grade and boys 15 years of age, respectively. In Coefield's study, the highest correlations obtained with scholastic achievement criteria were with the Mental Health Analysis; the correlations were .46 for grade point average and .40 for Stanford Achievement Test. Listings of other variables that correlated significantly or nearly so at the .05 level and above follow (positive correlations unless otherwise indicated): Both scholastic criteria: endomorphy (negative), mesomorphy (negative), ectomorphy, Wetzel Physique Channels, and Rogers' General Learning Capacity. Grade point average only: standing broad jump and Rogers' General Learning Potential.

In Jarman's study of 15 year old boys, significant correlations were obtained between scholastic achievement criteria and some experimental variables. All significant correlations, except ectomorphy and total and mathematics grade point averages, however, were negative in direction. For the Iowa Test of Educational Development, the experimental variables were muscular strength and endurance tests and the standing broad jump. For the grade point averages, the experiment variables were mesomorphy, ectomorphy, Wetzel Physique Channels, arm girth, cable-tension strength average, and standing broad jump.

Moutis (39) followed academic achievement relationships for the same 90 boys over a three-year period from 10 through 12 years of age. At age 10 years, skeletal age and standing height correlated significantly with a number of scholastic measures; sitting height and Strength Index had significant correlations with term grade point average. These relationships were maintained at age 11 years. At age 12 years, skeletal age, standing height, sitting height, Strength Index, and standing broad jump were all significantly correlated with intelligence quotient, Stanford Achievement Test score, and term and final grade point averages. Generally, the effect of partialling intelligence quotients reduced the magnitude of the corresponding zero-order correlations. Forty-four significant multiple correlations were obtained; the highest was .401 at 12 years between final grade point average and skeletal age, standing height, sitting height, and standing broad jump.

Further, in Moutis' study, the 30 boys who scored highest and the 30 boys who scored lowest over a three-year period were formed into high and low groups for each of 15 experimental variables. The experimental measures which produced mean scholastic differences favoring the high group were skeletal age, ectomorphy, standing height, sitting height, upper arm girth, Strength Index, cable-tension strength average, 60-yard shuttle run, standing broad jump, and total-body reaction time. The evidence suggests that boys 10 through 12 years of age who are superior in standing height and maturity (skeletal age) score consistently and significantly higher in scholastic achievement tests, academic grades, and grade point averages.

A longitudinal analysis of the academic achievement and intelligence of 55 boys from nine to 17 years of age as related to physical variables was made by DiNucci (15). Among his results were: (a) With the exception of somatotype components, the means of all measures increased or improved with age. When the magnitudes of the mean growth changes were expressed in standard deviation units, greater gains were observed between ages 9 and 12 years for the academic achievement criteria; similar gains were obtained for standing height, cable-tension strength average, skeletal age, chest girth x height, and weight. (b) A consistent pattern of significant positive correlations was obtained between academic achievement and intelligence criteria and the physical variables of skeletal age, endomorphy, weight, standing height, and chest girth x height; a consistent negative relationship was found for mesomorphy and Physical Fitness Index. (c) A greater number of significant partial correlations with academic achievement criteria than for corresponding zero-order correlations were recorded for skeletal age, mesomorphy, ectomorphy, weight, skinfold total, cable-tension strength average, Rogers' arm strength score, bar push-ups, standing broad jump, and 60-yard shuttle run. (d) The highest multiple correlation obtained was .698 for "Reading in Natural Science" at age 15 years, with skeletal age, hand-arm reaction time, and standing broad jump as the independent variables. The physical variables that appeared in the greatest number of multiple correlations were: standing height in 25, skeletal age and mesomorphy in 17 each, Physical Fitness Index in 13, endomorphy in 12, and standing broad jump in 10.

Day (11) investigated the relationships between intelligence and physical, motor, and strength measures of boys 9, 13, and 17 years of age. At each age level, linear and curvilinear correlations were computed among the physical measures and the intelligence quotients. Although the results of the study indicated that intelligence and the physical measures used were not significantly related, the following observations were made: At 9 years of age none of the linear or curvilinear correlation coefficients involving intelligence was large enough to be significant. However, a tendency toward positive correlations was apparent. At 13 years, a significant linear correlation of .17 was recorded between IQ and the sixty-yard shuttle run and significant eta of .31 was obtained between IQ and weight. At 17 years of age, the only correlation reaching significance at the .05 level was -.17 between IQ and arm girth.

Drowatsky (17) compared the intelligence, scholastic achievement, interests, aspirations, peer status, maturity, body size, physique type, strength, and motor ability of boys 7 to 12 years of age who were underaged and normal-aged in their respective grades and who were the same age but in different grades in school.

For boys in the same grade who were underaged and normal-aged, differences reaching significance at the .05 level or above were as follows:

1. Underaged boys recorded higher means on: (a) upper arm girth measurements at ages 7 and 8 years; (b) interest in art, music, active play and quiet play interests in the sixth grade; (c) Physical Fitness Index scores in the third grade.

2. Normal-aged boys recorded higher means on: (a) approximately 25 per cent of the scholastic achievement measures; (b) the home arts and science interest elements; (c) the athletic rating form in fifth grade; (d) skeletal age; (e) approximately 75 per cent of the elements of body size; (f) the average score of eleven cable-tension tests; (g) approximately 60 per cent of motor ability elements.

For boys who were the same age but who were in different grades, the differences which were significant at the .05 level were as follows:

1. Boys in the lower of the two grades recorded higher means on: (a) grade point average at age 10; (b) approximately 15 per cent of peer status measures; (c) interest in school subjects and people.

2. Boys of the same age but in the higher of the two grades recorded higher means on: (a) approximately 28 per cent of the scholastic achievement measures; (b) approximately 10 per cent of the physical measures; (c) occupational interests at age 11.

Interests

McNally (36) analyzed data from the application of the Dreese-Mooney Interest Inventory for 220 Medford boys 9 through 14 years of age; the interests thus expressed were related to 12 maturity, structure, and strength measures. In the 9 through 11 year old group, there was no significant inclination for small, weak, and immature boys to indicate sedentary interests, such as reading, movies, and school subjects. However, for the 12 through 14 year old boys, a tendency was found for those with low Physical Fitness Indices to indicate more interests in reading and radio. In addition, the boys with most interests in occupations, in activities, and with highest interest scores on the total Dreese-Mooney inventory had significantly lower Physical Fitness Indices than did boys with low scores in these interest categories. In the school subjects category, the more mature boys indicated greater interest than did the immature boys. In this age group, too, the boys with high Physical Fitness Indices had less interest in things to own than did boys with low indices.

Utilizing a Children's Interest Blank, Kozacioghi (34) studied the relationship between various interest and physical traits of the same boys at 7 and 8 years of age. As in the McNally analysis, these relationships were low. No significant changes in the subjects' interests in outdoor play, indoor play with toys, and paper-pencil-crayon activity were found as they grew from age 7 to age 8 years. However, they did show a significant increase in the interest of "helping adults with work."

Olson (41) studied the characteristics of 15 year old boys classified as outstanding athletes, scientists, fine artists, leaders, scholars, or as poor students or delinquents as determined when high school seniors. Among his conclusions were the following: (a) The only trait common to all outstanding groups was their higher intelligence as compared with the 15 year old boys not in the respective categories. (b) Outstanding junior high school athletes were superior to other boys their age in maturity, mesomorphic physique, chest girth, explosive power, strength, speed, and agility. Seven of the ten leaders were active in athletics when they were in junior high school. (c) As expressed on the Kuder Preference Record-Vocational, Form CH, vocational interests of boys in the special accomplishment groups did not differ from other boys of their age. Also, vocational interests on this form were not highly related to maturity, physique, strength, motor ability, intelligence, and academic achievement; the highest correlation was .28 between the outdoor interest and chest girth.

Motor Ability Elements

Standing Broad Jump

By correlational analysis, Degutis (12) studied the relationship between the standing broad jump and various maturity, structural and strength measures of 12 year old boys. His multiple correlations were: (a) Anthropometry: .41 with body weight, leg length and lung capacity. (b) Cable-tension strength: .52 with elbow flexion and hip extension. (c) Combined variables: .69 with elbow flexion strength, body weight, hip extension strength, ankle plantar flexion strength, and leg length.

In Flynn's study (18) of various methods of scoring the standing broad jump performances of 12 year old boys, the following zero-order (in parenthesis) and multiple correlations with physical and motor traits were obtained:

R	S B J Scoring	Physical and Motor Tests
.917	Distance x Weight	Weight (.84), Strength Index (.64), skin-fold total (.44), abdominal girth (.63).
.908	Weight/Distance	Abdominal girth (.87), Physical Fitness Index (-.44), skinfold total (.79).
.717	Leg Length/Distance	Physical Fitness Index (.50), leg length (.45), 10-ft. run (.33), skinfold total (.44).
.690	Distance	Physical Fitness Index (.47), 10-ft. run (-.42) sitting height (.22), skinfold total (-.33), cable-tension strength average (.35).

In a follow-up of Flynn's study, Ward (56) determined the relationship between various physical variables and the following three standing broad jump criteria for 141 boys 12 years of age and 174 boys 15 years of age: distance jumped, distance times body weight, and distance/body weight. The multiple correlations obtained were as follows:

SBJ Scoring	R	Age	Physical Tests
Distance	.756	12	60-yd. shuttle run, Rogers' arm strength score, skinfold total (neg.), cable-tension strength
	.768	15	Physical Fitness Index, 60-yd. shuttle run, weight, cable-tension strength
Distance x Weight	.924	12	Weight, Rogers' arm strength score, 60-yd. shuttle run
	.920	15	Weight, Physical Fitness Index, skinfold total
Distance/Weight	.916	12	Weight (neg.), Rogers' arm strength score, total-body reaction time
	.878	15	Weight (neg.), Physical Fitness Index

In Ward's study, too, distance jumped and distance x weight both differentiated between athletes and nonparticipants at 12 and 15 years of age; the distance jumped was the best such differentiator.

Shuttle Run

Radcliffe (44) examined the relationship between maturity, physique type, structural, strength, and motor ability items and the 60-yard shuttle run performance of 14 year old boys. Seventy-eight per cent of the correlations between the shuttle run and the experimental variables were significant at or beyond the .05 level. The highest correlation with the time element of the shuttle run was -.57 for standing broad jump. The highest coefficient of five multiple correlations computed with the 60-yard shuttle run was .65; the independent variables were standing broad jump, Physical Fitness Index, and total body reaction time.

Reaction Time

Glines (21) related reaction, movement, and completion (reaction plus movement) times to various physical measures of 13 year old boys. Both total-body and arm-shoulder reaction times proved to be independent variables; not one of the correlations with these measures was significant. The correlation between the two reaction times was a low .44. The highest multiple correlation obtained was .76 between body completion time as criterion and 60-yard shuttle run and standing broad jump.

The differences in total-body reaction time and 10-foot speed (less reaction time) associated with age, maturity, physique type, and athletic ability was studied longitudinally by Sandstrom (47) for 165 junior high school boys from age 13 to 15 years. Various groups were formed at age 13 years, as follows: advanced, normal, and retarded in maturity; somatotype categories; and athletes and nonparticipants. Among his findings were: (a) The mean reaction time of all groups decreased slightly with age; the only significant difference, however, was between ages 13 and 15 years for the entire sample. (b) Changes in mean 10-ft. run time were more marked; significant improvement occurred from age 13 to 15 years for the normal and advanced skeletal age groups, for the mesomorph and mid-type somatotype groups, and for the athletes and nonparticipants. (c) Differences in 10-foot speed time were more diffuse but some significant differences were found among the maturity and somatotype groups. (d) The following significant differences between mean reaction times were obtained: advanced maturity groups slower than normal and retarded groups, endomorphs and endomesomorphs slower than other somatotype categories, and athletes faster than nonathletes. (e) Generally low correlations were obtained between reaction and 10-foot speed times. However, significant correlations of .625 and .609 (negative connotations) were obtained for the endomorphs at ages 13 and 15 years.

Inter-School Athletic Ability

Cross-Sectional

Peterson (43) contrasted the maturational, structural, strength, and motor traits of upper elementary and junior high school boys with different levels of athletic ability and contrasted the same traits of boys in these athletic groups with nonparticipants. Levels of athletic ability were differentiated according to success on interschool competitive teams. Such results as the following were obtained: (a) The outstanding athletes at both school levels had significantly higher mean skeletal ages than did the other groups; in studying maturity relative to chronological age, the outstanding elementary school athletes only were found to be advanced. (b) In general, the size of athletes as compared with non-participants was more significant at the junior high school than at the elementary school level; this was particularly true for the outstanding athletes. (c) A higher proportion of mesomorphs was also found among the junior high school athletes. (d) Strength was a consistent differentiator of athletic ability; this was particularly true for the gross measures such as the Strength Index and the mean of 12 cable-tension strength tests, although the Physical Fitness Index means of the outstanding athletes were exceptionally high. (e) In the standing broad jump, the means of the outstanding athletes and the regular players were significantly higher than the means of the non-participants at both school levels.

This study did not attempt to determine the effects of participation on inter-school athletic teams upon the boys, as the subjects were tested only once. It does demonstrate, however, that boys who make and are successful on such teams are definitely superior in maturity, body size and build, both absolute and relative (to weight and age) muscular strength, and explosive power. Thus, the decision as to whether boys are physically ready for such participation should be determined on factors other than chronological age (or grade in school), as is commonly done today. Actually, within age limitations, natural selection takes place, based in part at least on those factors included in this study.

Anderson (1) investigated the personal adjustment and social status of elementary and junior high school boys who possessed different levels of athletic ability. Successful athletes tended to achieve higher levels of peer status and social adjustment than did boys who had less success or no experience in inter-school athletic competition. The means of outstanding athletes and regular players combined at the elementary school level were significantly higher than the means of non-participants for all five categories of the sociometric questionnaire; in addition, they were superior to the substitutes in the movies, sports, and party categories. Few significant differences were revealed between the two groups on their Mental Health Analysis results. Where significant results appeared, they were mostly in the Social Participation section of the Mental Health Analysis Test.

Longitudinal

Wiley (60) studied the maturity, physique, structural, and motor traits of 12 year old elementary school boys who made and were successful on elementary school interscholastic athletic teams; in addition, he studied the unique characteristics of boys participating in different sports. Further, he studied a number of these boys longitudinally over a period of four years, from the ages of 9 to 12 years. Among his findings were the following:

1. The best tests that differentiated athletic ability in the different sports, listed according to rank, were as follows:

Football: Strength Index, lower-body strength, 60-yard shuttle run, arm strength, skeletal age, upper-body strength, standing broad jump, and Physical Fitness Index.

Basketball: 60-yard shuttle run, standing broad jump, arm strength, Physical Fitness Index, total-body reaction time, Strength Index, and Ectomorphy.

Baseball: Standing broad jump, Physical Fitness Index, and Strength Index.

Track and Field: Arm strength, 60-yard shuttle run, standing broad jump, Physical Fitness Index, upper-body strength, Strength Index, and skeletal age.

2. The tests that were the best differentiators of athletic ability, when the boys were grouped according to their highest athletic ratings, were rated as follows: standing broad jump, arm strength, 60-yard shuttle run, total-body reaction time, Strength Index, and Physical Fitness Index.

3. At the four longitudinal ages, 12 traced back to 9 years, the best and most consistent differentiators of athletic ability in the different sports were ranked in the following order:

Football: Strength Index, 60-yard shuttle run, standing broad jump, body weight, and calf girth.

Basketball, Baseball and Track: Standing broad jump, 60-yard shuttle run, and Physical Fitness Index.

4. The tests that were the most consistent differentiators of athletic ability at all ages (back to 9 years), when the boys were grouped according to their highest athletic ratings, were ranked as follows: 60-yard shuttle run, Physical Fitness Index, arm strength, standing broad jump, and total-body reaction time.

5. The tests with the least value as differentiators of athletic ability at this age were the three somatotype components, the various structural measures, and pull-ups.

6. Certain tests did not appear as significant differentiators of athletic ability until the years when the boys began their inter-school athletic participation, generally at 11 and 12 years. Whether improvement in these measures is associated with or caused by their sports participation at this level is speculative. The tests thus identified were as follows: football, skeletal age; asketball, arm strength; baseball and track, Strength Index and skeletal age.

Profiles

Shelley (49) constructed age Hull-scale profile charts based upon 22 maturity, structure, strength, motor ability, and intelligence tests; these were utilized to contrast the characteristics of 38 outstanding elementary school and junior high school athletes. Due to the small number of cases in some of the subdivisions of this analysis, generalizations must remain tentative. With this understanding, the following observations may be made: (a) On all tests, the H-score means of the outstanding athletes were above the means for boys of their respective ages. (b) The most distinctive characteristics of these athletes were their high scores on the standing broad jump, 60-yard shuttle run, Strength Index, and Rogers' arm strength score; of less importance, but still with high means were skeletal age, weight, height, Physical Fitness Index, and all other strength tests but back lift. (c) Superiority by contrasting sports: football athletes, maturity and all structural and strength measures; basketball players, height (also, tall for their weight), 60-yard shuttle run, and intelligence; track athletes, 60-yard shuttle run, height (also tall for weight), and standing broad jump; baseball athletes, standing broad jump; wrestling athletes, Physical Fitness Index, standing broad jump, heavy for height.

Howe (28) contrasted T-scale test profiles based on physical and mental tests for 20 elementary school boys 12 years of age and junior high school boys 15 years of age who were rated by their coaches as outstanding athletes. Each athlete's profile chart contained three profiles, when he was 9, 12, and 15 years old. Three groups of outstanding athletes were identified as follows: (a) Athletes who were outstanding at both 12 and 15 years, 5 athletes or 25%; (b) Athletes who were outstanding at 12 but not at 15 years, 9 athletes or 45%; and (c) Athletes who were outstanding at 15 but not at 12 years, 6 athletes or 30%.

A summarization of the distinctive longitudinal profile patterns of the three groups of outstanding elementary and junior high school athletes follows.

1. The test profiles of athletes rated outstanding at both 12 and 15 years showed increases in nearly every profile position at 15 years. These increases were especially marked for strength tests, arm-shoulder endurance, and standing broad jump; small increases occurred for skeletal age, body size, and mental tests. The mean profiles were average or above average on all tests for the three years.

2. The test profiles of athletes who were outstanding at 12 but not at 15 years were similar at 9 and 12 years, generally average or below in skeletal age and body size measures and above average on the other tests. At 15 years, losses in profile position occurred on nearly all tests.

3. The test profiles of athletes who were outstanding at 15 but not at 12 years improved markedly in strength and arm-shoulder endurance tests at 15 years. They were mostly above average on the profile tests at the three ages.

<u>Conclusions</u>

Conclusions that may be drawn from the study of Medford elementary and junior high school athletes have been stated by Clarke (9) as follows:

<u>First</u>: Boys who make and are successful on interscholastic athletic teams in both elementary and junior high schools are definitely superior to their peers in maturity, body size, and muscular strength, endurance, and power. The decision as to whether boys are physically ready for such participation should be determined by factors other than chronological age or grade in school.

<u>Two</u>: Successful elementary school athletes enjoy greater peer status than do boys who are less successful or have no interscholastic athletic experience.

Three: Some fundamental physical characteristics of 12-year-old elementary school athletes are clearly evident at younger ages, at least as early as nine years, well before their interscholastic competition began.

Four: The longitudinal significance of the physical characteristics of young athletes may be extended to specific sports and some variations in these characteristics exist for the different sports.

Five: The general physical fitness of all boys in a school is an indirect contributing factor to a higher physical fitness level of the athletes.

Six: Although successful young athletes generally have common characteristics the pattern of these characteristics varies from athlete to athlete; where a successful athlete is lacking in such a trait, he compensates by strength in another.

Seven: Outstanding elementary school athletes may not be outstanding in junior high school athletics and outstanding junior high school athletes may not have been outstanding in elementary school athletics; longitudinal test profiles reveal distinguishing differences between athletes in these categories.

Acknowledgments

Many acknowledgments should be made for assistance rendered in the conduct of the Medford Boys' Growth Study to date. Among these are the following:

Supporting Agencies: Medford Public Schools, Southern Oregon College, Athletic Institute, Curriculum Development Fund of the Oregon State Department of Education, and the Office of Scientific and Scholarly Research and the School of Education's In-Service Program of the University of Oregon.

Research Instructors and Graduate Assistants: Kay H. Petersen and David H. Clarke (1956-58), Arne L. Olson (1958-60), Morgan E. Shelley (1958-59), Norman S. Watt (1959-61), Richard Munroe (1960-1966), Jan Broekhoff (1961-1967), Laine' Santa Maria (1966-1968), and L. Richard Geser (1967-68).

Medford Educators and Others: The late Dr. Leonard Mayfield, former Superintendent of Schools; Dr. Elliott Becken, present Superintendent; Lee Ragsdale, former Director of Physical Education; Louise Basford and Henry De Voss, Testing Service Directors; Wilson Slater, Clerk of the School District; Russell Acheson, Ralph Mathews, and R. E. Wicks, physical plant officials; the principals and classroom teachers of the various Medford schools; the senior and junior high school physical education staffs; the boys who served as subjects and their parents.

Southern Oregon College: Dr. Theodore G. Schopf, Southern Oregon representative and his students who served as testers throughout the project.

University of Oregon: (in addition to the research assistants) Dr. Arthur A. Esslinger, Dean, School of Health, Physical Education, and Recreation; Mrs. Ethel Cooper, Mrs. Betsy Lynch, and Mrs. Doris Maurer, secretaries; Dr. Leona Tyler, Professor of Psychology and Dean of Graduate School, consultant; the many graduate students from the United States and throughout the world who served as project testers.

Others: Mrs. Barbara Honeyman Heath, Monterey, California, Somatotype consultant and assessor; Dr. Bhim Savara, Director, Child Study Clinic, University of Oregon Dental School, consultant; William C. Applegate, Chief Industrial Engineer, Oregon State Board of Health; and Earl Lawson, M.D., Medford radiologist, for evaluating X-ray operation (skeletal age).

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