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A cardio-Vascular Test as a Reliable Measurement of Physical Fitness

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A CARDIO-VASCULAR TEST AS A RELIABLE MEASUREMENT OF PHYSICAL FITNESS

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TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
	The Problem	2
	Statement of the problem	2
	Limitations of the Study	3
	Definitions of Terms Used	3
II.	REVIEW OF LITERATURE	5
	Pulse-ratio tests	5
	Rogers Physical Fitness Index	9
III.	PROCEDURE	14
IV.	SUMMARY AND CONCLUSIONS	18
BIBLIOGRAPHY		21
APPENDIX		23

CHAPTER I

INTRODUCTION

Studies have been conducted over the past twenty years to determine if physical fitness can be measured by a cardio-vascular test. There has been varied support of this test as a measure of physical fitness. Some studies have shown that a pulse-ratio is a valid and reliable test of physical condition. Other studies have concluded that the reliability of the pulse-ratio is not sufficient for rating condition. If evidence can be brought forth and is accepted there would be a quick and simple measurement for physical fitness. Most of the physical fitness tests used in our schools are either too long and involved or need too much equipment. There are also many different thoughts on what items should be used to test physical fitness.

In reviewing the literature, it was apparent that much work in relation to the cardio-vascular system has been done between the early 1920's and the middle 1940's. From the middle 1940's until now, little has been done in this area.

The reason for this study is to determine a relatively simple and effective means of evaluating physical fitness. This may lead to a simple yet effective means of rating the fitness level of persons prior to intensive training in

either athletics or physical education. Many physical fitness tests, such as the Rogers Physical Fitness Index, involve expensive equipment. Most school districts cannot afford to purchase this equipment thereby making this battery of tests of less value. Another poor feature of physical fitness testing is that many of the items in a test can be improved to some extent by test familiarization whereas in a cardio-vascular test, which is mainly a body function test, it is more difficult to influence, by practice, the results to any extent. The only equipment needed for a cardio-vascular test is a bench, a stop watch and a chair. A qualified physical education instructor can give the test in a few minutes as compared with a few hours or days with some of the others.

There is a possibility that a correlation might be found between the Tuttle Pulse Ratio Test and the scores on the Rogers Physical Fitness Index. If this is true then it should be possible to substitute the Tuttle Pulse Ratio Test for the Rogers Physical Fitness Test as an effective measure of general physical fitness.

I. THE PROBLEM

Statement of the problem. It will be the purpose of this study to determine the relationship between scores on a standard physical fitness test and scores on a standard cardio-vascular test to determine if the cardio-vascular test

will give a valid measure of physical fitness.

II. LIMITATIONS OF THE STUDY

a. A group of thirty boys will be used for this study.

b. Ninth grade boys were used from Olympic Junior High School at Auburn, Washington, which will further limit the study as to level of subject.

III. DEFINITIONS OF TERMS USED

Cardio-Vascular. Pertaining to the heart and circulatory functions.

Physical Fitness. A test of muscular strength, muscular endurance and circulo-endurance.

P.F.I. Physical Fitness Index.

Ninth Grader. Boy in the ninth grade.

Strength Index. The gross score obtained from the seven tests contained in the P.F.I.

Grip-Dynometer or Manuometer. An instrument used to measure grip strength.

Back Dynometer. An instrument used to mechanically measure the strength of back muscles.

Leg Dynometer. An instrument used to mechanically measure the strength of the leg muscles.

Oregon Simplification. A simplification of the Rogers P.F.I. conducted by Clarke and Carter using the leg lift,

arm strength and right grip.

Muscular Endurance. The ability of a muscle to continue exerting force.

Muscular Strength. The maximum force that can be voluntarily applied in a single muscular contraction.

CHAPTER II

REVIEW OF LITERATURE

I. PULSE-RATIO TESTS

The pulse-ratio for rating physical efficiency.

Tuttle tells the procedure for selecting 2.5 as a point and some of the tests he gave such as (11:5-7):

1. A test on the parallel bars.
2. A test on the horizontal bar.
3. A test of pulse ratio and swimming.

After studying many methods he came up with a formula.

$$\text{Efficiency Rating} = 100 \quad \frac{\text{Number of steps to get 2.5 pulse ratio}}{50}$$

Tuttle finally concluded:

> Evidence is submitted which supports the validity of the use of the test as a means of pointing out differences in physical efficiency.

The reliability of the pulse-ratio test.

Gathering data Henry and Farmer found reliability coefficients ranging from .53 to .90. They decided (4:86):

> A brief discussion of these results in connection with theoretical considerations, led to the conclusion that the test in its present form is not as reliable as is desirable if it is to be used for predicting individual scores.

A study of the post-exercise heart rate.

> .....In general, where the exercises are used to differentiate individuals on the basis of the post-exercise pulse-rate, the pulse-ratio, and the recovery time, they must be strenuous in order to give reliable results (6:9).

Further data on the pulse-ratio test.

This study was given to college women between the ages of 17 and 23 for the purpose of determining the validity and reliability of the pulse-ratio. Their conclusions were (7:429):

> 2. The reliability correlation of .774 for the pulse-ratio test is too low to make the test valuable for individual measurement, although it could be used for group comparisons.
>
> 4. The reliability correlation is too low to justify the expenditure of time needed to validate the test for college women.

A pulse-ratio simplification.

Fifty-four male subjects were tested on 20, 30 and 40 standardized stool steps. On the basis of their data (12:79):

> 1. Physical efficiency ratings based on the pulse-ratios obtained after 20 stool steps are unreliable.
>
> 2. Physical efficiency ratings based on the pulse-ratios obtained after 30 and 40 steps of exercise are reliable as those obtained on the basis of the amount of exercise required to produce and arbitrarily set pulse ratio.
>
> 3. Due to the unreliability of the ratios after 20 steps of exercise, the composite score was less reliable than that obtained after either 30 or 40 steps of exercise.
>
> 4. The pulse-ratio technique for measuring physical efficiency may be materially simplified without destroying its reliability.

The pulse-ratio on high school boys.

In this study a pulse rate is taken to establish a pulse ratio between a known amount of physical exercise in

order to establish a ratio between the resting heart rate and the increase after work. The work was stepping on and off a bench thirteen inches high. A pulse rate of 2.5 was empirically taken as the goal. A stepping rate of eighty steps per minute was taken as 100% physically fit. It was found by investigation that the most agile could only attain sixty steps per minute. Seventy-six high school boys were tested from University High School at Iowa City, Iowa. The boys were from grade 9-12 inclusive. Their ages ranged from 12 to 20. They were given one practice period before the test day. A stepping that would produce a pulse rate of below 2.5 was given; then another stepping that would produce a pulse rate of over 2.5 was given. A straight line graph was drawn (13:33).

The pulse rate was determined by auscultation. The data were recorded on record sheets designed especially for this purpose. The following were the conclusions that were drawn from the data:

1. The mean efficiency rating by the test used in this investigation of seventy-six high school boys was found to be 34.51, with a range of 19-48.
2. The mean standing pulse rate of seventy-six high school boys was found to be 79.84 per minute with a range of 60-112.
3. When classified according to efficiency rating, the group studied fell into the following division:

GROUP	PER CENT
Excellent	3.95
Above average	35.52
Average	35.52
Below average	15.80
Poor	9.21

4. When compared on the basis of age, it is found that there are no significant differences in efficiency.

5. The data show that there is a slightly higher heart rate and a slightly lower efficiency on the part of the heaviest students as compared to a similar group of the lightest.
6. There is a slightly lower pulse rate and a considerably lower efficiency rating on the part of the students who smoke as compared to the ones who do not.
7. The data show a high degree of relationship between the recovery ability of the heart and the efficiency rating.
8. The data with reference to the variability of the efficiency rating of athletes during the season of competition show that:

    a. The normal standing pulse rate was higher during the season of competition than before.
    b. The efficiency rating of athletes during the season of competition is materially increased.
    c. The most common occurance is a fall in the rating after athletic competition. There are a number of factors such as the severity of the game, whether at home or away, amount of rest, etc., which must be considered.

9. The pulse-ratio test must be limited to individuals with a pulse rate well within the normal range.

A comparison of physical fitness ratings.

Rifenberick gave the Rogers test and a pulse-ratio to seventh and eighth grade boys. He gave the test once in the fall and once in the spring (9:98).

> The P.F.I.'s of the eighth grade boys correlated .80 with their pulse ratios in the fall tests as computed by the use of Spearman's rank-difference method. On the second test, six months later, the same group correlated .83
>
> The seventh grade results were somewhat higher with .94 on the first tests and .90 on the second.

II. ROGERS PHYSICAL FITNESS INDEX

Testing for grip strength (2:186):

1. The tester should take the right hand corner of the manuometer between the thumb and the forefinger of the right hand and place it in the palm of the subject's hand while holding the hand to be tested with his left hand in such a manner that the convex edge of the manuometer is between the first and second joints of the fingers and the rounded edge is against the base of the hand. The thumb should touch, or overlap, the first finger. The dial of the manuometer should be placed face down in the hand.

2. In taking the test, the subject's elbow should be slightly bent and his hand should describe a sweeping arc downward as he squeezes the manuometer. The hands should not be allowed to touch the body, or any object, while the test is being administered. If they do, the score should not be read at all, and a retest should be given after a short rest of 30 seconds.

3. The right hand should be tested first and then the left. Scores should be read to the nearest pound.

4. A cake of magnesium carbonate should be available for dusting the hands if they become moist or slippery.

5. The indicator should be returned to zero after each test.

Testing for leg strength (2:190):

1. The subject should hold the bar with both hands together in the center, both palms down, so that it rests at the junction of the thighs and trunk. Care should be taken to maintain this position after the belt has been put in place and during the lift.

2. The loop end of the belt is slipped over one end of the handle or crossbar: the free end of the belt should be looped over the other end of the bar, tucking it in under so that it rests next to the body. In this position the pressure of the belt against the body and the resultant friction of the free end against the standing part holds the bar securely. The belt should be placed as low as possible over the hips and gluteal muscles.

3. The subject should stand with his feet in the same position as for the back lift. The knees should be slightly bent. Maximum lift occur when the subject's legs are nearly straight at the end of the lifting effort. Experienced testers become adept at estimating the potential lift by noting the degree of muscularity of the subject's legs; as a consequence, they will start stronger subjects at a lower chain link, so as to allow the extra distention in the dynamometer. If too high a link is used, the subject's knees may snap into hyper-extension during the lift, although an alert tester can always anticipate such an occurrence and interrupt the performance.

4. Before the subject is instructed to lift, the tester should be sure that the arms and back are straight, the head erect, and the chest up. These details are of great importance to accurate testing. Beginners will err in results by from 100 to 300 or more pounds if the single detail of leg angle is wrong. Therefore, even experienced testers repeat leg-lift tests for most subjects immediately, changing the length of chain, even by twisting, if a link seems too great.

5. Record the best of two to three tests.

The pull ups and the push ups (dips) should be administered in the following manner (2:190-193):

1. In taking the pull-up test, the subject hangs from the rings by his hands, and chins himself as many times as he can. In executing the movement, he should pull himself up until his chin is even with his hands, then lower himself until his arms are straight. He should not be permitted to kick, jerk, or use a kip motion. (Without the rings, use forward hand grip.)

2. Half-counts are recorded if the subject does not pull all the way up, if he does not straighten his arms completely when lowering the body, or if he kicks, jerks, or kips in performing the movement. Only four half-counts are permitted.

<u>Push-ups</u>.

1. The bar should be adjusted at approximately shoulder height.

2. The subject should stand at the end of the parallel bars, grasping one bar in each hand. He jumps to the front support with arms straight (this counts one). He lowers his body until the angle of the upper arm and forearm is less than a right angle, then pushes up to the straight-arm position (this counts two). This movement is repeated as many times as possible. The subject should not be permitted to jerk or kick when executing push-ups.

3. At the first dip for each subject, the tester should guage the proper distance the body should be lowered by observing the elbow angle. He should then hold his fist so that the subject's shoulder just touches it on repeated tests.

4. If the subject does not go down to the proper bent-arm angle or all the way up to a straight-arm position, half-credit only is given, up to four half-credits.

Tests of strength.

Frederick Rand Rogers presented a revised strength test for his doctorial dissertation in 1925. The Rogers revision was approximately the same test as the old intercollegiate strength test. The intercollegiate test consisted of the following items (15:19-23):

1. Lung strength.
2. Right and left grips.
3. The back lift.
4. The leg lift.
5. Arm strength (chins and dips).

Rogers changed this test by (15:22):

1. Using English units of measure instead of the metric system.
2. Lung capacity was scored in cubic inches.
3. Chinning and dipping were scored by the formula, number of chins plus the number of dips, times, weight divided by ten plus height minus sixty.
4. Rogers presented an excellent routine for administering the test to large groups.
5. In 1927 he published norms for these tests.
6. In 1927 Rogers proposed a modification of the chinning and dipping procedure for girls.

Simplifications of the Rogers strength tests.

This study was conducted to see if a more simplified version of the Roger's battery of tests would be effective. The subjects were separated into three groups:

1. Elementary, ages 9, 10, and 11.
2. Junior High, ages 12, 13, and 14.
3. Senior High, ages 15, 16, and 17.

There were forty boys in each of the groups except the seventeen year olds group. In this group there were only thirty-six. On the junior high level a correlation of .998 was obtained between the Strength Index and the following tests:

1. Leg lift.
2. Arm strength (Rogers).
3. Right grip.

The conclusions of this study were (3:9):

> The Oregon simplications of the Strength and Physical Fitness Indexes are presented in an effort to secure more strength testing of this sort in the public schools. Obviously, the simplified versions do not require as many pieces of testing apparatus as does the full test, although a back and leg dynomometer is still necessary. Also, the simplifications can be given more rapidly with fewer testers than the complete test. Testing skill is still a requisite, especially for the dynamometer tests. For those who are dissatisfied with approximation, however, the full test should be given.

Oregon simplification of P.F.I.

Clarke and Carter used a product-moment intercorrelation among the various tests and found a .998 correlation at the junior high school level using three tests:

1. Leg lift.
2. Arm strength (Rogers).
3. Right grip.

With a high correlation of .998 the Oregon simplification will be a much faster reward.

CHAPTER III

PROCEDURE

This study will be concerned with ninth grade boys who are without major physical problems that could hinder their performance. The study will be conducted in required physical education classes at Olympic Junior High School in Auburn, Washington. The tests will be given to boys that volunteer to take part and it will be clearly stated that these tests will not relate to their physical education grade.

Each class period five boys will be excused from calisthenics and will sit on a bench. While the remainder of the physical education class will do calisthenics and prepare for class; the five boys excused from exercise will be given their Tuttle Pulse Ratio Test. They are excluded from exercise in order to begin the test with a resting pulse. The Tuttle Pulse Ratio will be given in five steps that are as follows (2:103):

Step I. Subject will suit up and go directly to a bench in the gym and sit for a period of 10 minutes. This will allow the pulse to become steady.

Step II. Take the pulse at the radial artery for a period of one minute while subject is in a sitting position.

Step III. Subject stands in front of stepping box ready for exercise. The elbows are held close to the sides and the forearms are at right angles and parallel to each other.

Step IV. Hands and arms are kept in the starting positions and the left foot is placed on the stepping box, then the right foot is placed on stepping box. The left foot is then placed on the floor and the right foot is placed back on the floor. The sequence is then repeated. A rate of stepping should be followed. A rate of thirty to forty steps will be used.

Step V. The subject sits down and the pulse is taken for a two minute period immediately following the exercise. The subject is then allowed to rest and aids the tester in counting the number of steps on the next subject.

It has been found by Tuttle and Dickenson (12:74) that the ratio from a single stepping of 30 steps has a correlation of .930 to the original test and that a stepping of 40 steps has a ratio of .957 with the original test. The pulse rate is found by dividing the pulse for two minutes by the sitting pulse (7:426). The equipment needed to conduct the Tuttle Pulse Ratio will be:

1. A bench.
2. A stopwatch.
3. A stepping box or bench thirteen inches high.

Any standard stopwatch will do. The stepping box must be thirteen inches high and of sufficient stability as to not hinder the performance of the subject. Following the administration of the Tuttle Pulse Ratio Test the subjects

will have one week of no testing before the administration of the Rogers P.F.I. The equipment for this test will be borrowed from the Seattle Y.M.C.A. for one week. During this time the tester can obtain the height, weight and age of all the subjects. The Rogers P.F.I. will be given in the organized physical education class after a light warmup consisting of twenty-five jumping jacks. The leg lift will be given first, then the right and left grip test. A block of magnesium carbonate or chalk will be supplied for the purpose of dusting moist and slippery hands.

The Rogers P.F.I. will be given as explained in Chapter II, the Review of Literature.

There will be a correlation drawn between these tests. Correlation coefficients range from a +1.00 to a -1.00 with .00 being the mid-point. A +1.00 shows a perfect positive relationship and a -1.00 shows a perfect inverse relationship. .00 shows an absence of any relationship whatsoever (8:192).

CHAPTER IV

ANALYSIS OF DATA

The formula used to find a simple correlation between both the P.F.I. and the S.I. and the Tuttle Pulse-Ratio was:

$$r = \frac{N\Sigma xy - \Sigma x \cdot \Sigma y}{\sqrt{\left[N\Sigma x^2 - (\Sigma x)^2\right]\left[N\Sigma y^2 - (\Sigma y)^2\right]}}$$

The formula used to find arm strength was (2:195):

$$(\text{Push-ups} + \text{pull-ups})\left(\frac{W}{10} + \text{H-60}\right)$$

The formula $\text{P.F.I.} = \frac{\text{Achieved S. I.}}{\text{Normal S. I.}} \times 100$ was used to arrive at the Physical Fitness Index (2:195).

The variables to be correlated were Tuttle Pulse-Ratio, Rogers Strength Index and Rogers Physical Fitness Index. The Tuttle Pulse-Ratio was correlated with the Rogers Strength Index. The correlation was .26. The Rogers Physical Fitness Index was then correlated to the Tuttle Pulse-Ratio. This correlation came out -.25.

CHAPTER V

SUMMARY AND CONCLUSIONS

It was the purpose of this paper to determine if there was a relationship between the Tuttle Pulse-Ratio Test and the Oregon Simplification of the Rogers Physical Fitness Index. The subjects for the study were thirty ninth grade boys from the required physical education classes at Olympic Junior High School in Auburn, Washington.

The subjects were tested on the one step variation of the Tuttle Pulse-Ratio Test over the period of one week. The following week they were tested on the Oregon Simplification of the Rogers P.F.I. From this data a zero order correlation was drawn. First, a correlation between the Pulse-Ratio and the Strength Index was taken. The results showed a very low correlation of .26. Second, the correlation between the Pulse-Ratio and the Physical Fitness Index as a -.25.

Conclusions:

1. Since the correlation of .26 is low, this study shows that there is almost no relationship between a cardio-vascular test (as measured by the Tuttle Pulse-Ratio) and a strength test (as measured by the Rogers Strength Index).

2. A -.25 shows a very low inverse relationship between a cardio-vascular test and the Rogers P.F.I. Therefore,

if the Rogers P.F.I. is a good measure of physical fitness as we have claimed in this study, the pulse-ratio cannot be used as a measure of physical fitness.

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APPENDIX

APPENDIX A

Subject	Height	Weight	Age	Chins	Dips	Leg Lift	Right Grip
1	67	143	14.7	14	18	1100	106
2	61.5	158	14.2	0	5	190	52
3	64.5	108	14.5	10	30	700	68
4	66	124	14.7	5	11	460	60
5	66	124	16	17	24	1320	110
6	70	158	14.8	4	10	780	90
7	68	142	14.4	3	4	600	40
8	67	114.5	15.1	7	12	650	60
9	64	99.5	14.9	6	7	500	56
10	66.5	125	14.10	12	19	540	80
11	68	138	15.2	12	20	900	90
12	66	168.5	15.10	7	12	960	110
13	60	94	14.7	1	3	290	24
14	66.5	136.5	15.1	14	17	840	112
15	69	131	15	10	14	520	86
16	55.5	78.5	14.2	10	17	380	30
17	68	113.5	14.9	5	6	540	50
18	67	143	15.8	15	22	1160	92
19	68.5	136	14.5	8	16	860	86
20	65	160	14.7	14	24	1480	106
21	66	121.5	14.6	9	15	940	86
22	63	134	15.3	17	31	1300	80
23	63	107	14.9	22	49	400	68
24	64.5	127	14.8	10	18	820	76

Subject	Height	Weight	Age	Chins	Dips	Leg Lift	Right Grip
25	65.5	129	14.2	12	20	560	90
26	63.5	128.5	14.2	4	10	600	66
27	73.5	187	14.10	7	20	1340	118
28	65.5	149.5	14.8	4	9	740	70
29	64.5	160	14.3	0	2	680	66
30	DROPPED FROM SCHOOL						
31.	69.5	129.5	14.7	4	6	540	68

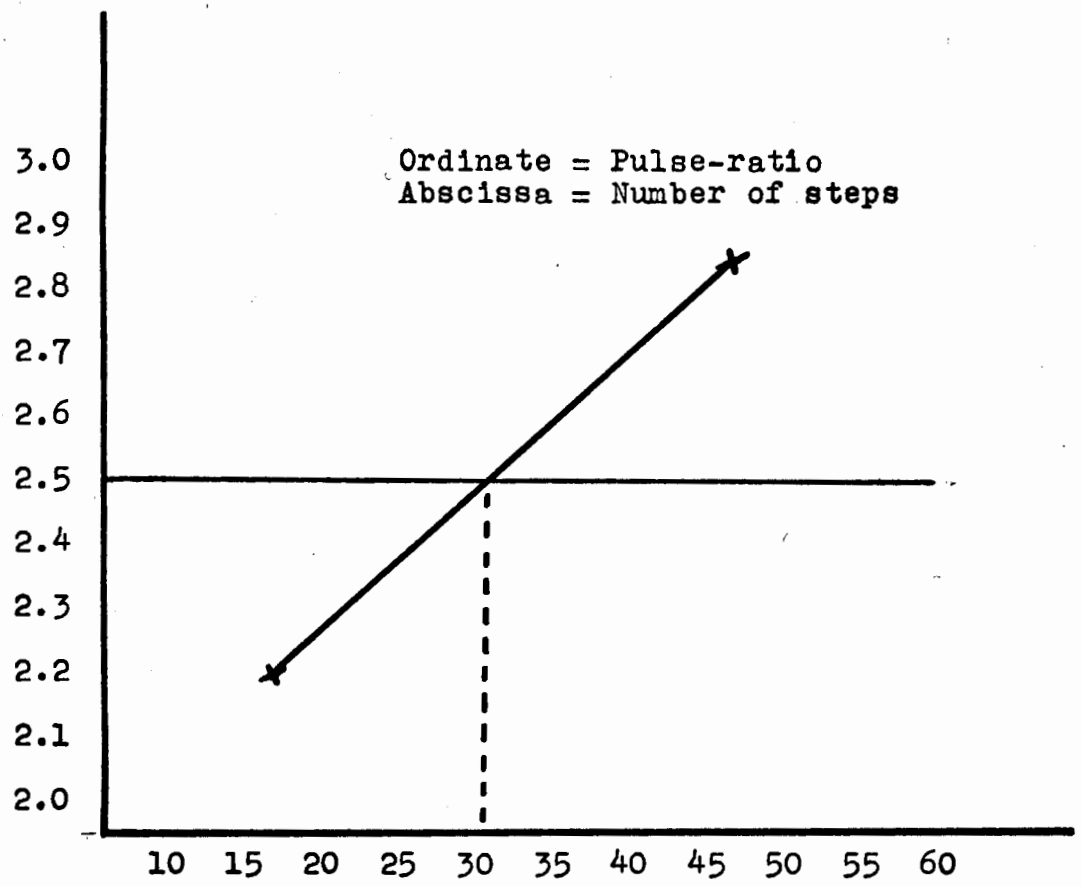
Subject	Pulse Ratio	Achieved S.I.	Norm. S.I.	P.F.I.
1	2.18	2576	1935	133
2	2.35	701	1972	36
3	2.71	1900	1452	131
4	2.41	1241	1673	74
5	2.10	2909	1879	155
6	2.70	1830	2142	85
7	2.70	1161	1922	60
8	2.36	1526	1615	94
9	2.35	1160	1342	86
10	2.11	1763	1774	99
11	3.08	2172	1997	109
12	2.56	2208	2694	82
13	2.45	614	1259	49
14	2.76	2296	1965	117
15	2.05	1680	1870	90
16	2.38	924	1028	90
17	2.36	1200	1535	78
18	2.15	2654	2231	119
19	2.08	2085	1839	113
20	2.66	3127	2170	144
21	2.55	2056	1646	125
22	2.13	2761	1967	140
23	2.47	1914	1488	129
24	2.44	1941	1728	112

Subject	Pulse Ratio	Achieved S.I.	Norm. S.I.	P.F.I.
25	2.69	1825	1642	111
26	2.79	1379	1618	85
27	3.45	3124	2775	113
28	2.97	1591	2032	78
29	2.47	1275	2083	61
30	CASE DROPPED FROM SCHOOL			
31	2.03	1314	1756	75

RANK ORDER

P.F.I. Subject No.	Pulse-Ratio Subject No.	Achieved Strength Index
5	27	20
20	11	27
22	28	5
1	26	22
3	14	18
23	3	1
21	6 and 7	14
18	25	12
14	20	11
19 and 27	12	19
24	21	21
25	23 and 29	24
11	13	23

P.F.I. Subject No.	Pulse-Ratio Subject No.	Achieved Strength Index
8	4	6
15 and 16	16	25
9	8 and 17	10
6 and 26	2 and 9	15
12	1	28
17 and 28	18	8
31	22	26
4	10	31
29	5	29
7	19	4
13	15	17
2	31	7
		9
		16
		2
		13


Ordinate = Pulse-ratio
Abscissa = Number of steps
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
10
15
20
25
30
35
40
45
50
55
60