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Condition of Football Players During and After the Season as Indicated by Cardiovascular and Strength Tests

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CONDITION OF FOOTBALL PLAYERS DURING AND AFTER THE SEASON AS INDICATED BY CARDIOVASCULAR AND STRENGTH TESTS

BY

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in the Department of Physical Education in the Division of Science and Applied Arts of South Dakota State College

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This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and acceptable as meeting the thesis requirements for this degree; but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Advisor

Head of the Major Department

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CHAPTER I

INTRODUCTION

Previous studies of the physiological condition of athletes have furnished evidence indicating that strenuous and persistent activity modifies cardiovascular function and increases body strength. The modifications in cardiovascular function which come as a result of activity remain only as long as the activity continues.[1]

Further investigation was conducted in this study with specific attention given to the cardiovascular and strength modifications of football players during, immediately following, and several weeks after the season. This study utilized two previously validated cardiovascular tests: namely, the Harvard Step Test and the Carlson Fatigue Test. Roger's strength test, which also has been previously validated, was utilized to measure the strength of the subjects. Data were obtained from the results of these tests which were administered to nine freshmen football players who volunteered to participate in this study. Utilization of these data will appear in the ensuing chapters.

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[1]Leonard A. Larson, and Rachel D. Yocum, Measurement and Evaluation in Physical Health, and Recreation Education, p. 49.

CHAPTER II

RELATED LITERATURE

To determine the condition of circulatory and respiratory systems of an individual, it is necessary to measure certain functions of these systems before, during, and after exercise. Reactions prior to activity together with modifications and reactions after activity indicate the temporary and permanent effects of exercise.

Larson and Yocum[2] say in this regard:

> The measurements which are used to estimate the nature and efficiency of circulation and respiration are blood pressures (systolic, diastolic, pulse and venous), pulse rate, vital capacity, breath holding oxygen consumption, basal metabolic rate, respiratory quotient, cardiac output, and blood analysis for hemoglobin, red cells, pH, glucose, and lactate. The criterion test of the efficiency of circulatory-respiratory function is the degree of external stress which can be applied with a minimum loss of physiologic energy.

Pulse rates (at rest, after exercise, and after rest following exercise), systolic and diastolic blood pressures, and venous pressures are the variables which can easily be measured in cardiovascular testing. According to McCloy[3], these may be taken reclining,

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[2]Larson and Yocum, op. cit., p. 41.

[3]C. H. McCloy, "A Study of Cardiovascular Variables by the Method of Factor Analysis", quoted in C. H. McCloy, Tests in Measurements in Health, and Physical Education, p. 238.

sitting, or standing and are subject to modification due to a number of physiological mechanisms. The tonus of blood vessels is an important factor in many cardiovascular responses; this may be influenced by the parasympathetic and sympathetic nervous systems and by other mechanical and chemical factors.

McCloy[4] lists, in general, the following factors which may be considered as accompanying good and poor condition:

Good Condition

Slow pulse.
Little rise in rate of pulse upon rising from reclining position.
Normal systolic pressure.
Rise of systolic pressure upon rising from reclining position.
Fairly high diastolic pressure.
Relatively high venous pressure.
Relatively small increase in pulse rate after exercise.
Rapid recovery of pulse rate after ceasing exercise.

Poor Condition

Fast pulse.
Relatively great change in rate of pulse upon arising from reclining position.
Relatively low systolic pressure.
Drop in systolic pressure upon arising from reclining position.
Fairly low diastolic pressure.
Fairly low pulse pressure.
Low venous pressure.
Great increase in pulse rate after exercise.
Slow recovery of pulse rate after ceasing exercise.

Upon these factors, a large number of cardiovascular tests have been constructed. A review will be made of only those tests which are closely related and useful in interpreting this study.

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[4]C. H. McCloy, Tests and Measurements in Health and Physical Education, p. 239.

CARDIOVASCULAR TESTING

Foster[5] published and proposed a test of physical efficiency which was designed to determine an individual's physical efficiency according to a pre-determined rating scale. The subject's pulse rate is recorded by an examiner immediately before, following, and forty-five seconds after the moderate exercise; the faster the pulse rate returns to normal the higher the score. A high score indicates physical efficiency. The Foster Test was adapted to mass testing by the Michigan Test,[6] which requires the subjects to count and record their own pulse rates.

In an investigation by Klyver[7] the customary immediate rise in the heart rate was noted after a short period of strenuous exercise. Nelson,[8] in his unpublished thesis, summarizes a study using stool-stepping as an exercise as follows:

> After one minute of stool-stepping at the rate of six per minute, the mean rise in pulse frequency for a group of subjects was five beats. After increasing the exercise to 12 steps for one minute, the mean rise was found to be 20 beats for the first minute, but only five for the second. After 18 steps for one minute the average rise was 35 beats during the second. When this exercise was increased to 24 steps for one minute, the rise was 50 beats for the first minute after the exercise and 20 beats for the second. It was therefore concluded from studying the response of the heart to stool-stepping, that pulse frequency after a measured amount of exercise was a useful index of physical fitness. The assumption was that the pulse frequency following a standard exercise was less for the physically conditioned than the physically unconditioned individuals.

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[5]W. L. Foster, A Test of Physical Efficiency, American Physical Education Review, XIX: 632, December, 1914.

[6]McCloy, op. cit., p. 241.

[7]Fred Klyver, Jr., J. Haung, and George D. Schafer, "The First Secondary Change in Pulse Rate Following a Very Brief Violent Exercise," American Journal of Physiology, 81: pp. 765-773, 1927.

[8]N. Nelson, Thesis, University of Iowa, 1939.

Schneider[9] using a bicycle ergometer, on which resistance could be increased or decreased, discovered a direct relationship between graded exercise and heart rate. However, this did not hold true for mild exercise. Schneider's experiment led him to believe that the heart does not work efficiently at a slow rate. He also points out that between 160-180 beats of the heart per minute there is a loss of cardiac efficiency which is continuous.

Riedman[10] makes the following statements in regard to the effects of exercise on pulse rate:

> Exercise increases the heart rate to the greatest extent. The rise is proportional to the severity of the task.
>
> The rise caused by exercise, especially by speed exercises, is immediate, beginning with the first cardiac cycle after work has begun. After a secondary rise, undoubtedly due to delayed adjustments not operating initially, a plateau is maintained throughout the work period, as soon as the work ceases, the return to normal begins. In fact, the post-exercise rate, even during the first 30 seconds, is an unreliable measure of the pulse during activity. Accurate measurements of the pulse rate can be made only when the recording is simultaneous with the exercise.
>
> Speed exercises, such as running, increase the pulse rate more than heavy work load. Experiments with a stationary bicycle show that increasing the speed of "riding" heightens the pulse rate more than increasing the resistance against which the feet work.

Tuttle[11] developed a Pulse Ratio Test designed to indicate the ability of the heart to compensate for muscular exercise. The ratio of the heart beat before and after exercise, "is determined by dividing the pulse rate for two minutes, after a known amount of exercise, by the normal pulse for one minute." The number of steps onto a 13 inch stool per minute

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[9]E. C. Schneider, "The Cardiovascular Response of Pre-adolescent Boys to Muscular Activity", American Journal of Physiology, 114: 403, 1935-1936.

[10]Sarah Riedman, The Physiology of Work and Play, pp. 264-265.

[11]W. W. Tuttle, "The Use of the Pulse Ratio Test for Rating Physical Efficiency," Research Quarterly, 11: 5-17, May 1931.

necessary to obtain a 2.50 ratio determines the subject's score. The test has been found to be a valuable index of athletic condition because it measures the ability of the heart to counteract the effects of exercise.

The Carlson Fatigue Test[12] uses the pulse rate of the subject after exercise. The exercise consists of spot-running as fast as possible for ten innings of ten seconds of running and ten seconds of rest. The subject counts the number of right foot contacts for each inning. Five pulse rates are taken: (1) before exercise; (2) ten seconds after exercise; (3) two minutes after exercise; (4) four minutes after exercise; (5) six minutes after exercise. The subject counts his own pulse. Production is measured by the number of right foot contacts with the floor in ten innings. The fast return of the pulse rate to normal after exercise is an indication of good condition. A high rate of production with a rapid return of pulse rate after exercise indicates a high level of condition.

The Harvard Step Test[13] was developed to measure the "general capacity of the body, in particular the cardiovascular system, to adapt itself to hard work and to recover from what it has done." The subject steps up and down a 20-inch platform for five minutes at the rate of 30 times per minute. If the subject cannot continue for five minutes at that rate, he stops and the number of minutes of exercise is recorded. The pulse is counted and recorded from one to one and one-half, two to two and

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[12]H. C. Carlson, "Fatigue Curve Test," Research Quarterly, 16: 169-175, October, 1945.

[13]L. Brouha, "The Step Test: A Simple Method of Measuring Physical Fitness for Work in Young Men," Research Quarterly, 14: 31-36, March, 1943.

one-half, and three to three and one-half minutes after the exercise. The subject's score is determined by dividing the duration of the exercise by the sum of the pulses in recovery. This test is highly reliable, and even though it is relatively simple to administer, the results are comparable to those obtained from more complicated testing techniques.

Brouha, Fradd and Savage[14] in their study of physical efficiency of athletic and non-athletic college students found that the Step-Test technique gives a suitable indication of physical efficiency. They conclude in their study that "each man has a maximum efficiency which he can develop progressively through regular and adequate training; but no matter how hard and assiduous the training, superior scores can only be attained by men who constitutionally possess the potential physical efficiency".

STRENGTH TESTING

About 1900, a search was begun for a test with greater functional value than the anthropometric tests, which at the time consisted of only gross exterior body measurements. This need led to the development of strength tests which give a higher relationship to physical performance. Sargent and Martin[15] developed the first strength tests which were used to measure physical ability. Rogers[16] later presented tests of

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[14] L. Brouha, H. Fradd, and B. Savage, "Studies in Physical Efficiency of College Students", Research Quarterly, 15: 211-224, October, 1944.

[15] Larson and Yocum, op. cit., p. 77.

[16] Larson and Yocum, loc. cit.

motor ability and tests of physical fitness. Additional studies have recognized that strength is only one element in physical fitness. Its importance depends upon the type of the physical performance to be made by an individual and the degree to which success in the performance is contingent upon muscular strength.

Rogers[17] states that "practically every change in the condition of functioning of the vital organs has a corresponding change in the condition or functioning of the voluntary muscles."

McCloy[18] summarizes reports on the significance of muscular strength as follows

> Individuals who are 25 percent overweight, or individuals who have only four-fifths of the normal amount of muscle for given weights suffer certain hardships. The undermuscled individuals tire easily, and this fatigue is cumulative to complete exhaustion. The overweight individuals carry too great a load for the muscle structure of their bodies. Thus muscle efficiency is lessened, because the efficiency of the muscle contraction is related to the muscle load. A muscle with a light load operates more effectively than one that is overloaded. This overload also leads to fatigue, and constant fatigue becomes a health handicap, in that fatigued individuals are more liable to colds.

According to Steinhaus,[19] an individual's muscles become larger and, therefore, stronger as a result of exercise. Only exercise which is heavy enough to tax a muscle to its limit will stimulate muscles to grow larger and correspondingly stronger.

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[17] F. R. Rogers, "The Significance of Strength Tests in Revealing Physical Condition", Research Quarterly, 5: 43-46, October, 1934.

[18] C. H. McCloy, "How About Some Muscle", Journal of Health and Physical Education, 7: 302-303, May, 1936.

[19] A. H. Steinhaus, "Why Exercise," Journal of Health and Physical Education, 5: 5-7, May, 1934.

MacCurdy's Strength Test[20] is based on the formula: Power = Force X Velocity. The sum of the strength of the legs, back and arms is multiplied by height of the vertical jump and divided by 100 to give the Physical Capacity Index. The reliability and validity of the test is .93.

Roger's Strength Index (S. I.) and Physical Fitness Index (P. F. I.)[21] is obtained by first administering the following seven tests: (1) lung capacity, (2) back strength, (3) leg strength, (4 and 5) right and left grips, and (6 and 7) pull-ups and push-ups. The Strength Index (S. I.) is the sum of the subject's score in these tests. By dividing the achieved S. I. by the normal S. I. for the age and weight, the Physical Fitness Index (P. F. I.) is obtained. The strength of the large voluntary muscles of the body is indicated by the Strength Index (S. I.). Also, the S. I. may be used to classify individuals into homogeneous groups and as one measure of general athletic ability. Fitness changes resulting from exercise are measured by the Physical Fitness Index (P. F. I.).

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[20] Larson and Yocum, loc. cit., pp. 84-85.

[21] Larson and Yocum, op. cit., p. 84.

CHAPTER III

PROCEDURE

The subjects used in this study were volunteers from the freshmen football team. Twelve men volunteered but later this number was reduced to nine. The author, after witnessing the performance of three of the subjects, decided the results would be distorted since these three subjects were inconsistent in their performances. The scores of the initial tests are not utilized in the results of this study. The initial tests were conducted as a practice in order to eliminate erratic scores which might result from improper testing procedures and techniques.

The tests used for the study consisted of Harvard Step Test,[22] Carlson Fatigue Test[23] and test items two, three, four, and five of Rogers Strength Test[24]. They were administered on seven separate occasions as follows:

1. Two weeks prior to the end of the football season.
2. One week prior to the end of the football season.
3. The week following the football season.
4. Two weeks prior to Christmas vacation.
5. The last week prior to Christmas vacation.
6. The week following Christmas vacation.
7. Two weeks after Christmas vacation.

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[22]Brouha, op. cit., pp. 31-35.

[23]Larson and Yocum, op. cit., pp. 58, 73.

[24]Larson and Yocum, op. cit., pp. 84, 92-93.

The Harvard Step Test consists of stepping up-and-down on a platform 20 inches high for five minutes at the rate of 30 times per minute. After the exercise, the subject sits down for one minute and then counts his pulse rate for 30 seconds. Following the first counting, he sits for 30 additional seconds before counting his pulse again for 30 seconds. This process is repeated after 30 more seconds of rest. After each count, the subject recorded his pulse rate.

The formula used for determining the results of this test is as follows:

$$\frac{\text{Duration of Exercise in Seconds X 100}}{\text{2 X Sum of Pulse Counts in Recovery}}$$

The derived quotient constitutes a score of cardiovascular efficiency. The less the total pulse rate the higher the score.

The Carlson Fatigue Test consists of spot-running as fast as possible for ten innings of ten seconds each and alternating these with ten seconds of rest. The subject counts the number of right foot contacts for each inning and records the results. Five pulse rates are taken: (1) before exercise; (2) immediately following exercise; (3) two minutes after exercise; (4) four minutes after exercise; (5) six minutes after exercise. The subject counts and records each pulse rate. Production is measured by the number of right foot contacts in ten innings. The quick return of pulse rate to normal after exercise is an index of good condition. A high level of condition is a high rate of production with a rapid return to normal after exercise.

The strength of the subjects was determined by the following four items taken from the Roger's Strength Test:

1. Left grip - hand dynameter
2. Right grip - hand dynameter
3. Back lift - back and leg dynameter
4. Leg lift - back and leg dynameter

It has been found that strength can be reasonably well measured by these four tests. The score resulting from these four items correlates very highly with the Strength Index.

Graphs were then made of the scores: first, of each individual performance and second, of the average or composite scores of the groups. Graphs were made showing the results of the Harvard Step Test, the Carlson Fatigue Test, and the tests of gripping and lifting strength.

CHAPTER IV

INTERPRETATION OF DATA

GROUP RESULTS

The test results for each subject are included in the appendix. Graphs showing group averages are interpreted in this chapter. The group results of each test will be analyzed in an attempt to determine the physical condition of the group during, immediately following and several weeks after the close of the football season.

A comparison of Harvard Step Test and Carlson Fatigue Test was made in an attempt to obtain additional significant information. The Harvard Step Test (Figure 1) best indicated the condition of the subjects. Results of this test showed a steady progression in cardiovascular efficiency even after the football season had ended with the exception of the testing periods following the Christmas vacation. A sharp decrease followed by a slight increase occurred after this period of inactivity. There was a one-point increase in the score between the last two tests. The increase in the group score from the first test to the last test was five points with the highest degree of condition being attained just prior to the Christmas vacation.

One of the limitations of the Carlson Fatigue Test (Figure 2) was that it was so dependent on a consistently maximum effort. If erratic

HARVARD STEP TEST

CLASSIFICATION SCORES

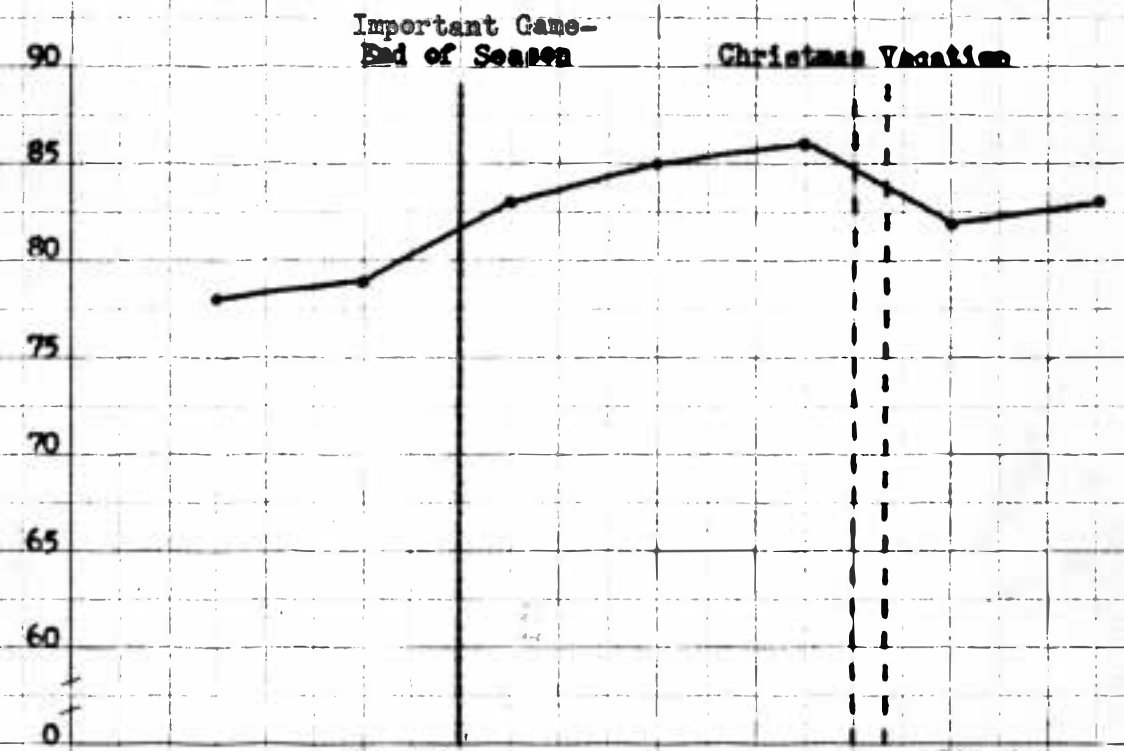

Fig. 1. Classification score averages indicating the cardio-vascular condition of nine freshmen football players.

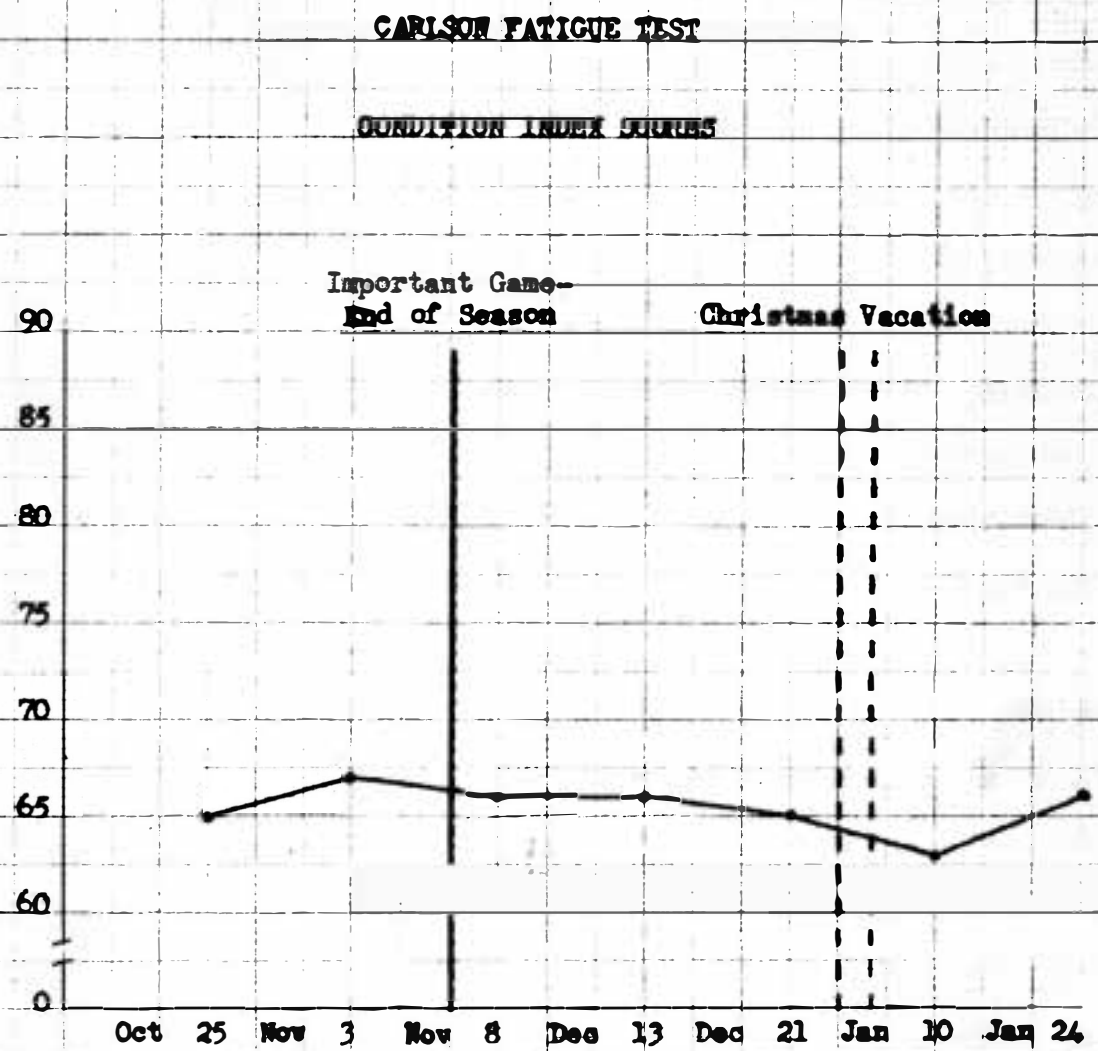

Fig. 2. Condition index score averages indicating the car io-vascular condition of nine freshmen football players.

results are to be eliminated in this test, it would be necessary that subjects exert themselves to the limit each time they take the test. A fluctuation in foot contacts or pulse rates causes a variation in the condition index scores. This fluctuation is shown in the graph of the average foot contacts (Figure 3) and the graph of the average pulse rates (Figure 4). It will be noted that these fluctuations occurred prior to the important game of the season and following Christmas vacation. With the exception of the period prior to and immediately following Christmas vacation, the Carlson Fatigue Test indicated that the cardiovascular condition of the subjects did not decrease.

Christmas vacation caused a decrease of two points in the group condition index. However, the condition index curve then returned to the same level maintained following the cessation of football. The difference between the lowest and the highest score as shown by the condition index was four points. The high score was just prior to the last game of the season and the low score immediately following the Christmas vacation. The increase of the group index score from the first to the last test was one point.

The curve of the combined average scores of the subjects gripping and lifting strength (Figure 5) indicated the adverse effects of football practice sessions during the testing period. Following the cessation of practice sessions, the average scores increased greatly and then declined again just before the Christmas vacation.

It is difficult to note any significant trends in strength results during the entire investigation. However, there are indications that

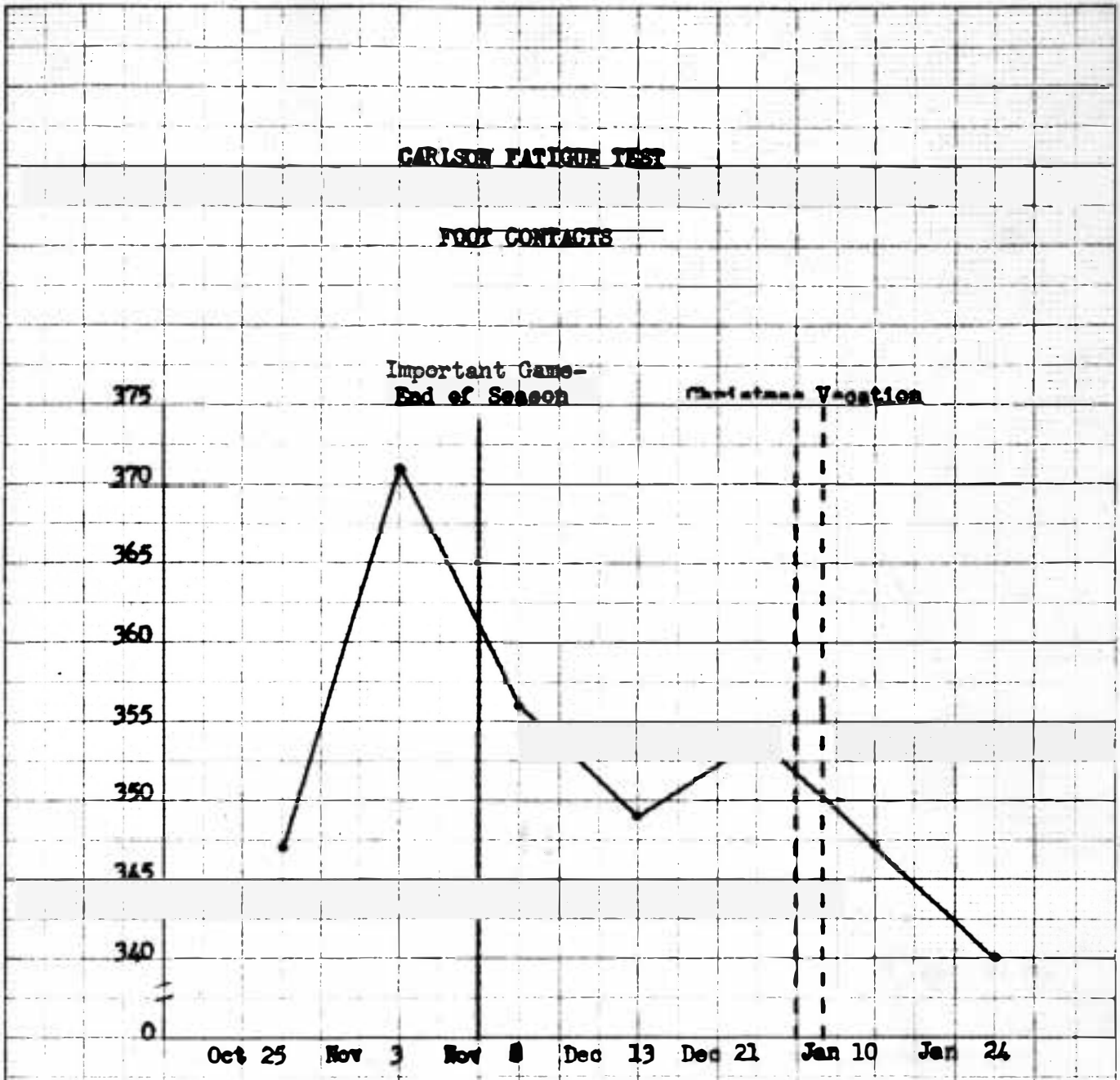

Fig. 3. Total daily foot contact averages of the nine freshman football players.

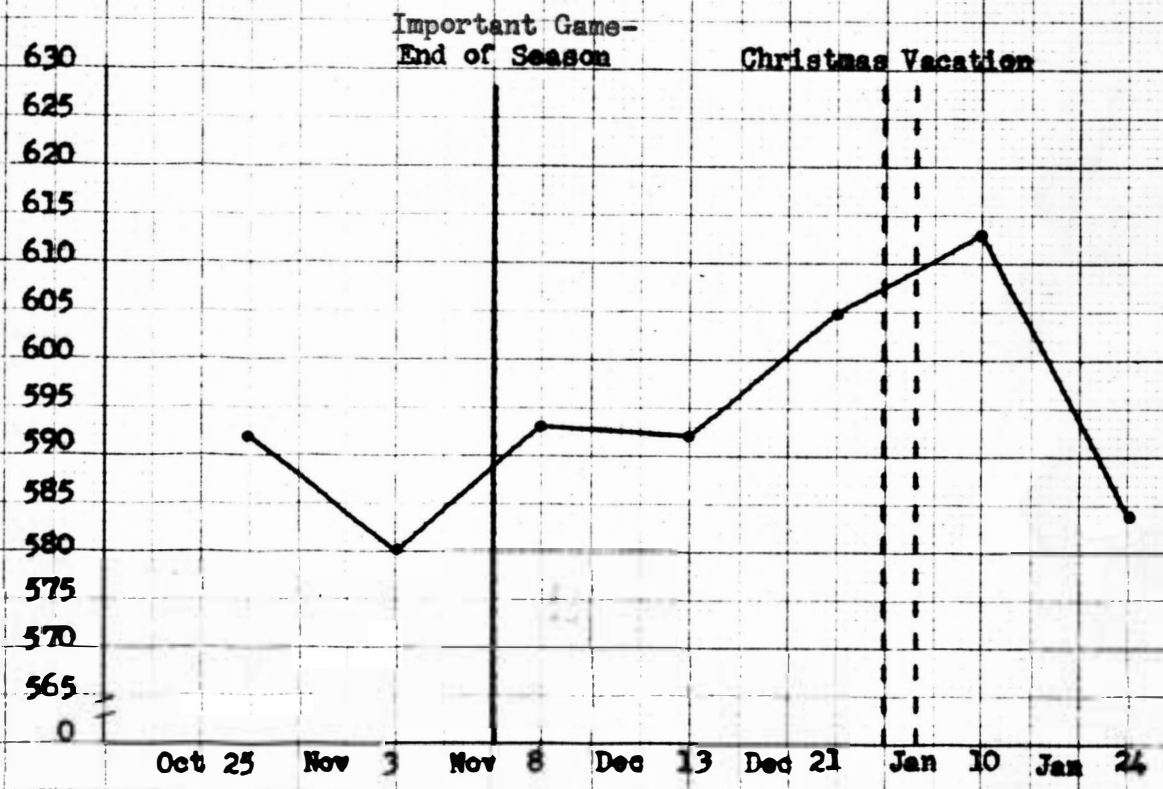

Fig. 4. Pulse rate averages of the nine freshmen football players.

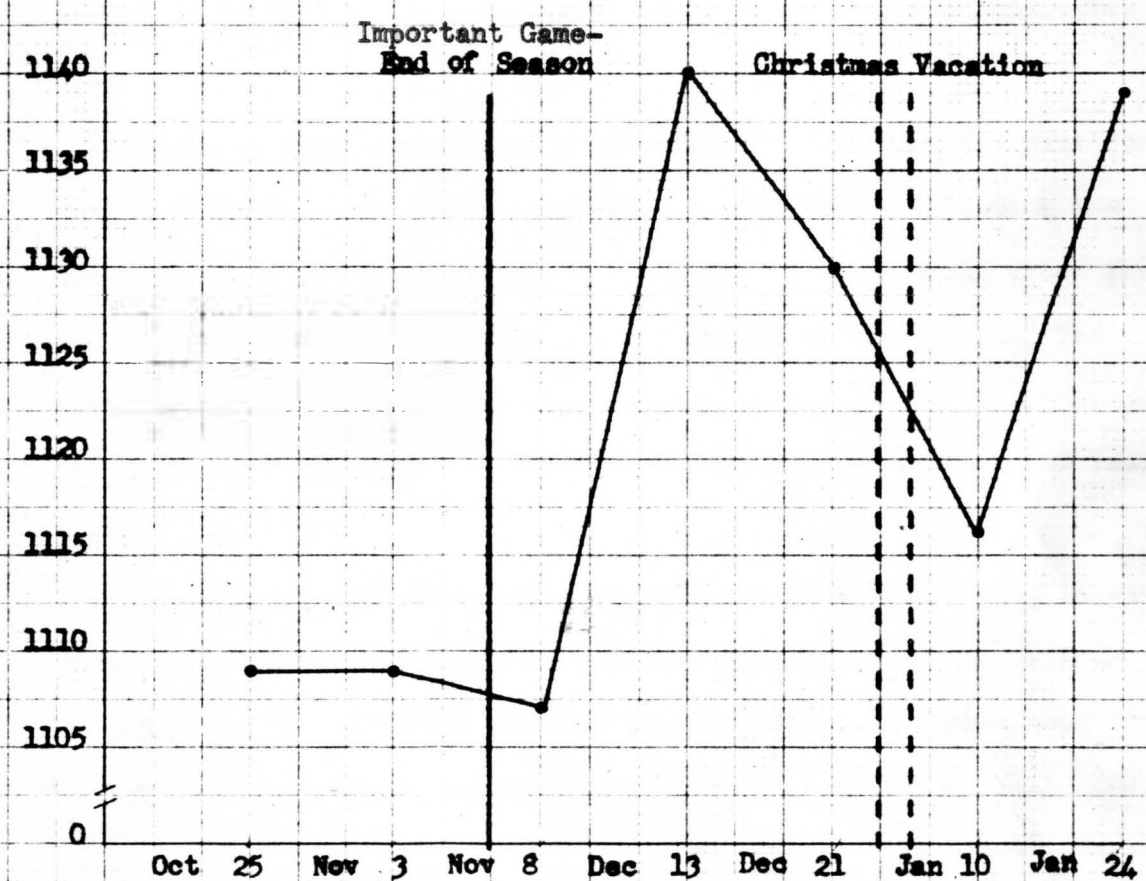

Fig. 5. Combined lifting(back and leg) and gripping strength (right and left hand) averages of the nine football players.

the results were influenced by fatigue. Following the football sessions and during the week of final examinations, scores tended to drop. After periods of rest, such as the one that followed the end of the football season, there was a sharp rise in the scores. These results were not consistent enough, however, to show any conclusive trends.

The curve reached a low point immediately following the vacation period and the lowest point was recorded immediately following the most important and last game of the season. Several weeks after the end of the football season the highest scores were obtained. The difference between the first test and the last test was 30 points with the greatest difference being 33 points between the highest and lowest scores.

In analyzing the group grip strength averages (Figure 6), it was shown that the results were much more consistent than the combined gripping and lifting group score averages. Rogers[25] states that "grip strength alone responds remarkably well to changes in physical condition". The results of the group gripping strength (Figure 6) showed a sharp decrease in strength immediately following the important game of the season. Another sharp decline was noted immediately following Christmas vacation. With the exception of the vacation period, it was shown that the scores maintained a steady level which tends to support previous conclusions that strength does not greatly decrease immediately following the cessation of periods of persistent exercise.

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[25]F. R. Rogers, "The Significance of Strength Tests in Revealing Physical Conditioning", Research Quarterly, V. 3: 43-46, October, 1934.

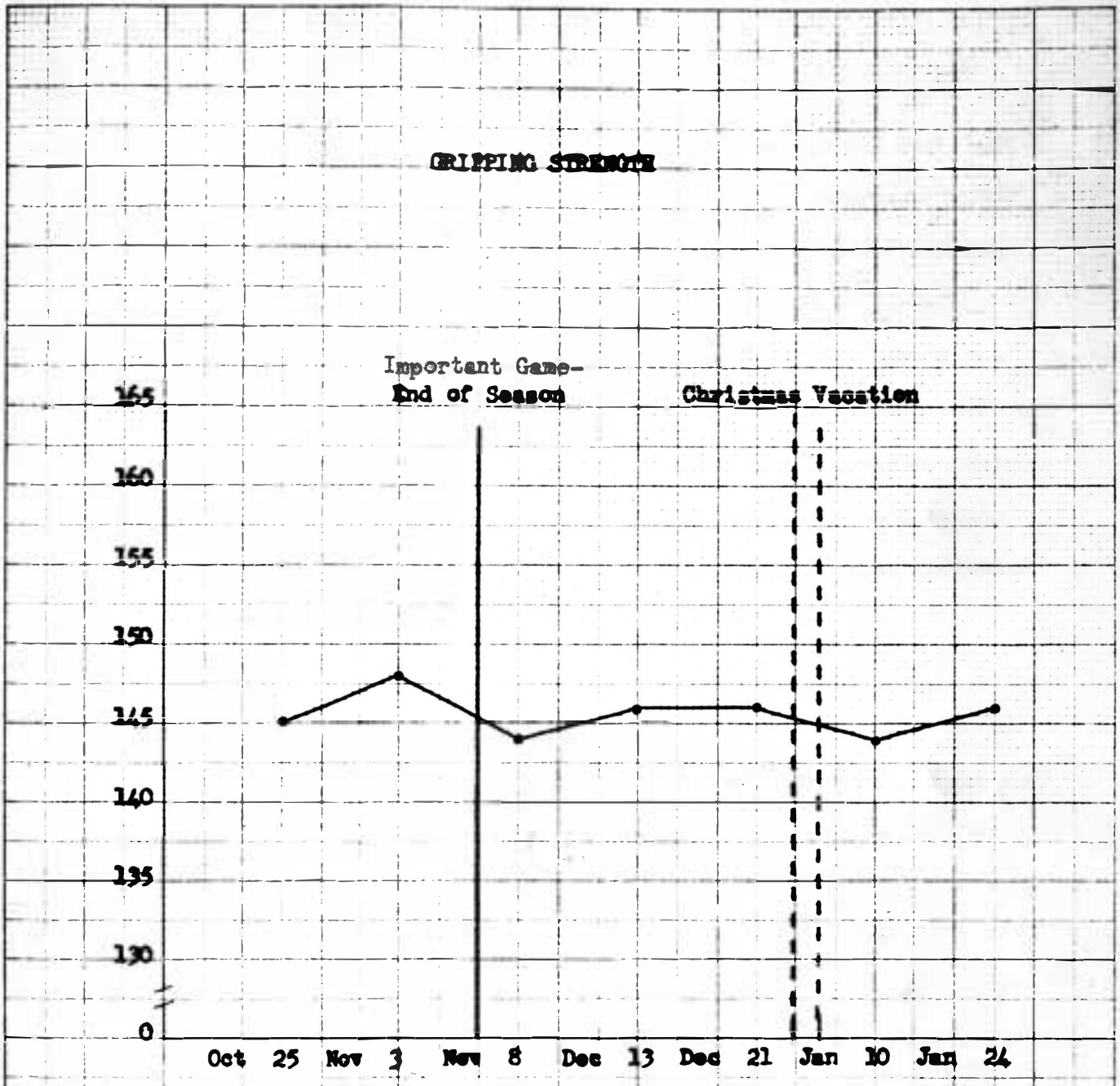

Fig. 6. Right and left hand gripping strength averages of the nine freshmen football players.

It is apparent in comparing the results of the Harvard Step Test and Carlson Fatigue Test (Figure 7) that they do not measure the same thing. The cardiovascular condition as measured by the Harvard Step Test increased steadily from November 3, 1954 through four testing periods ending with December 21, 1954. During this same period the Carlson Fatigue Test scores decreased steadily. It indicated that as cardiovascular condition increased, fatigue also increased. Both tests indicated a decrease in cardiovascular efficiency as a result of the Christmas vacation with the most pronounced decrease indicated by the Harvard Step Test.

INDIVIDUAL RESULTS

The individual classification scores (Harvard Step Test, Appendix) dropped sharply after the Christmas vacation (December 23, 1954 to January 3, 1955) with the exception of subjects J.N. and J.S. J.N.'s classification score remained at the same level throughout the last three testing periods. C.N.'s classification score increased sharply after Christmas vacation. J.N. was the only one to show a decrease in his classification score immediately after cessation of the football season (November 6, 1954).

The individual index scores (Carlson Fatigue Test, Appendix) tend to vary a great deal. Only J.S.'s scores approached the index scores of the group average (Figure 2). The individual foot contacts (Chart I, Appendix) and pulse rates (Chart II, Appendix) show an even greater variation than the condition index scores, and do not approximate the averages of the group shown in figures 3 and 4.

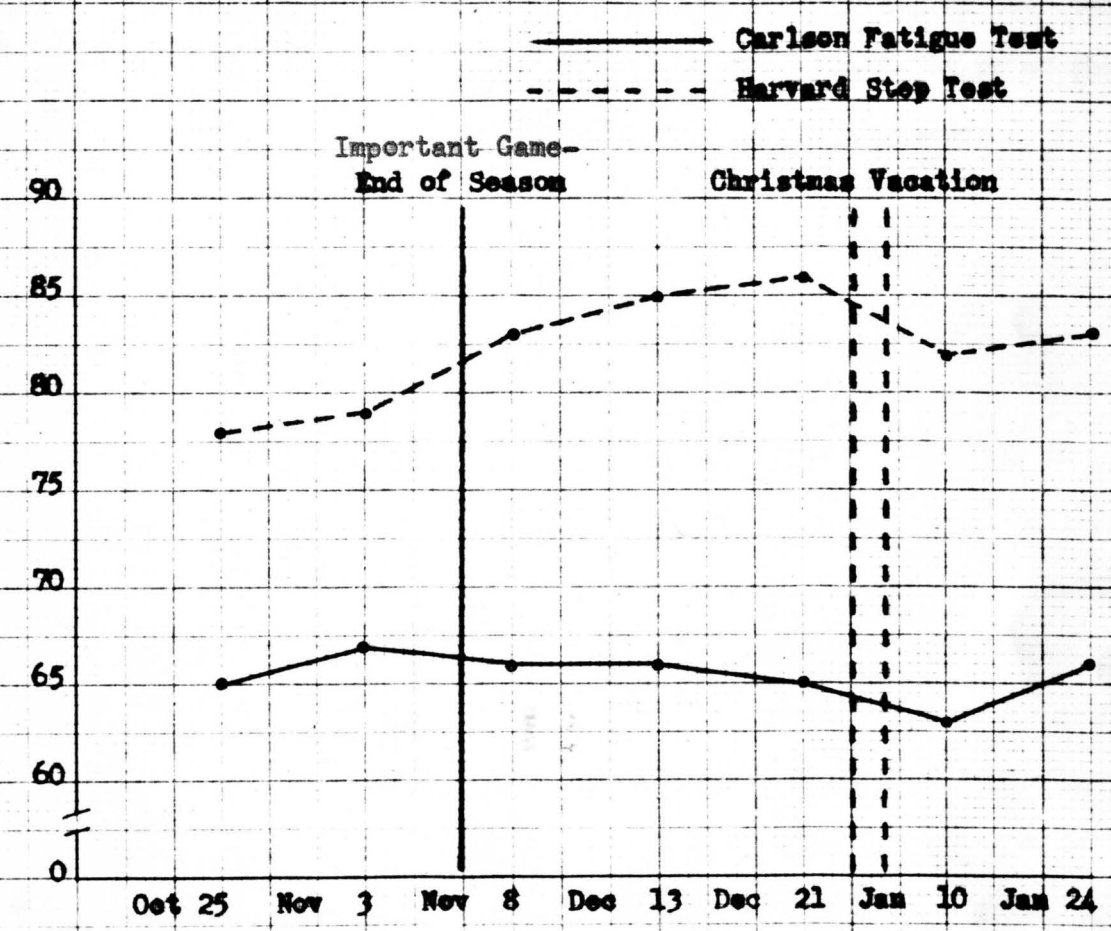

Fig. 7. Composite graph of cardiovascular test score averages of the nine football players as determined by the Harvard step test and Carlson fatigue test.

The subject's strength scores (Chart III and Chart IV, Appendix) vary greatly from test to test which tends to show the effect which disturbing influences and physical condition changes may exert. We may assume then, that this is an indication of the capability of these test items to denote the physical condition of the subjects.

CHAPTER V

SUMMARY OF RESULTS

1. The Harvard Step Test indicated a steady increase in cardiovascular condition of the subjects. This increase continued after cessation of the football season up until the beginning of the Christmas vacation period. It seems therefore, that the cessation of a period of training does not bring about an immediate decrease in cardiovascular condition but rather the body continues to adjust for sometime afterward.

2. Christmas vacation caused a sharp decline in the cardiovascular condition and strength of the group.

3. The Carlson Fatigue Test suggests that the "fatigue-condition" of the group decreased after the close of the football season and then remained at an even level with the exception of the period prior to and immediately following the Christmas vacation. Apparently then, the individuals become progressively more tired as strenuous practice sessions continue.

4. Football practice sessions tended to adversely affect the combined lifting and gripping strength of the group. This is substantiated by the extremely sharp increase which appeared during the period of decreased activity following the football season. Apparently the fatigue

brought on by the strenuous practice caused a decrease in both the desire and the physical ability to perform well in this test.

5. The groups gripping strength variations closely paralleled the variations in the "fatigue-condition" suggested by the Carlson Fatigue Test. Rest and absence of fatigue seem to be important in top performances in strength tests.

6. The Harvard Step Test and Carlson Fatigue Test scores tended to disclose variations in condition due to changes in the amount and the strenuousness of physical activity in which the group participated. However, the Harvard Step Test indicated an increase and the Carlson Fatigue Test indicated a decrease in the groups condition during the period between the end of the football season and Christmas vacation. This would seem to signify that while cardiovascular condition is increasing during the practice season the individuals are at the same time becoming more tired so that their fatigue scores decrease during this period.

7. The Carlson Fatigue Test, because of its strenuousness, would itself tend to develop good cardiovascular condition. This was indicated by the continuing rise in the scores of the Harvard Step Test even after football practice ended.

8. Individuals did very a good deal in the scores obtained on all the tests. This would seem to substantiate the theory of individual differences and to show that it applies very definitely to the individual's reactions to training routines and to testing techniques and procedures.

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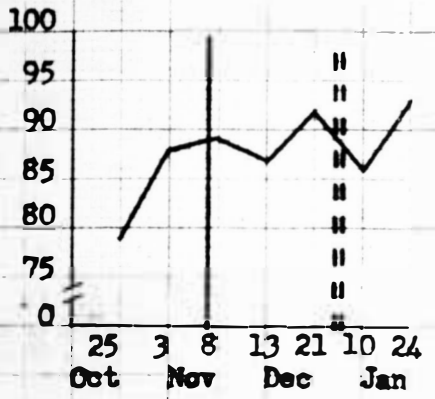
APPENDIX

Individual Data

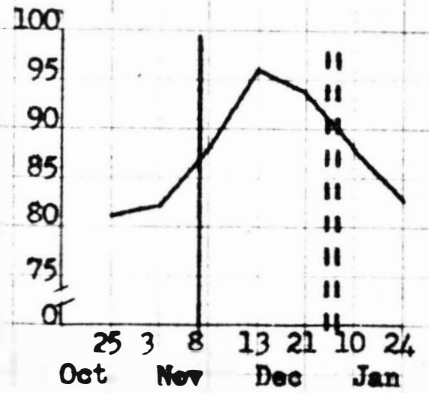
HARVARD STEP TEST

INDIVIDUAL CLASSIFICATION SCORES

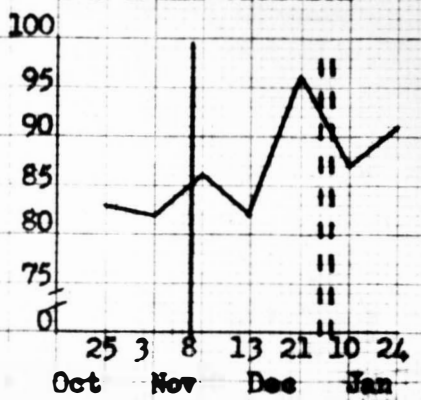
—— End of Season
= = X-mas Vacation



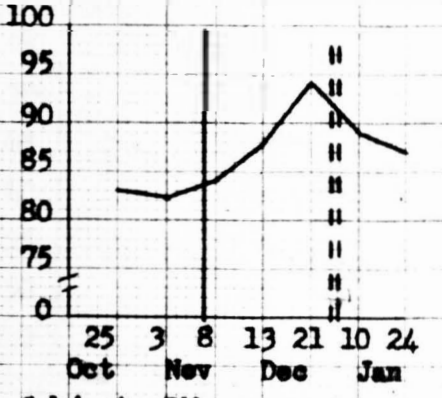
Subject: MD
Age: 19
Height: 6'0
Weight: 190



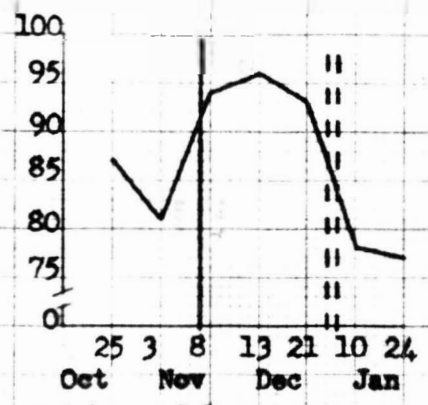
Subject: JS
Age: 19
Height: 5'11
Weight: 173



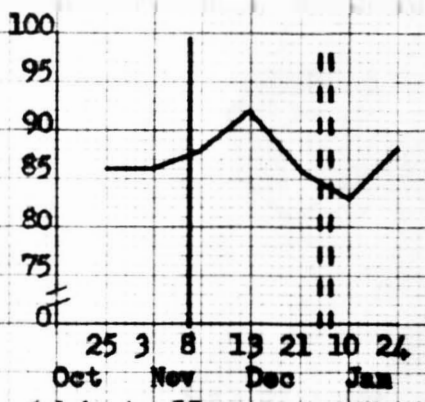
Subject: AZ
Age: 19
Height: 6'0
Weight: 160



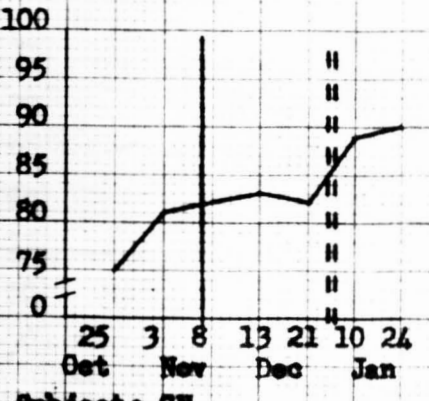
Subject: DM
Age: 18
Height: 6'0
Weight: 176



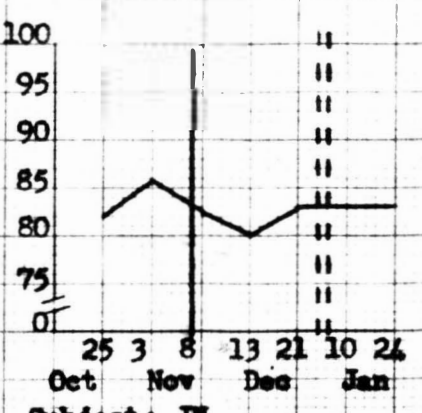
Subject: BJ
Age: 18
Height: 5'9
Weight: 165



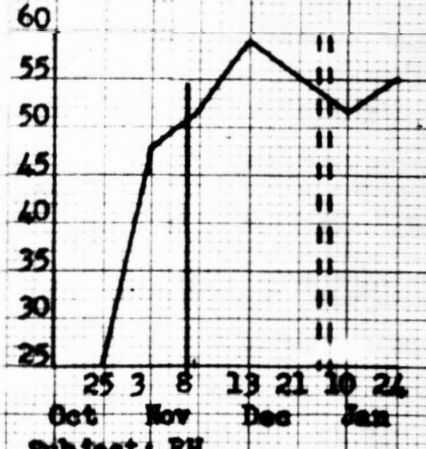
Subject: GS
Age: 18
Height: 6'1
Weight: 165



Subject: CM
Age: 18
Height: 5'9
Weight: 166



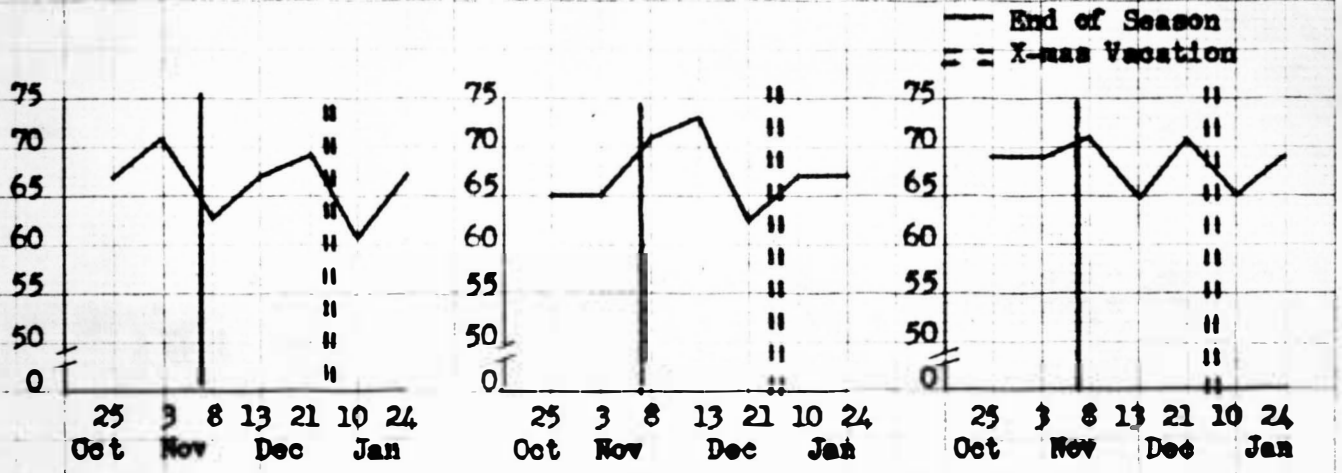
Subject: JM
Age: 18
Height: 5'9
Weight: 161



Subject: RH
Age: 18
Height: 6'0
Weight: 267

CARLSON FATIGUE TEST

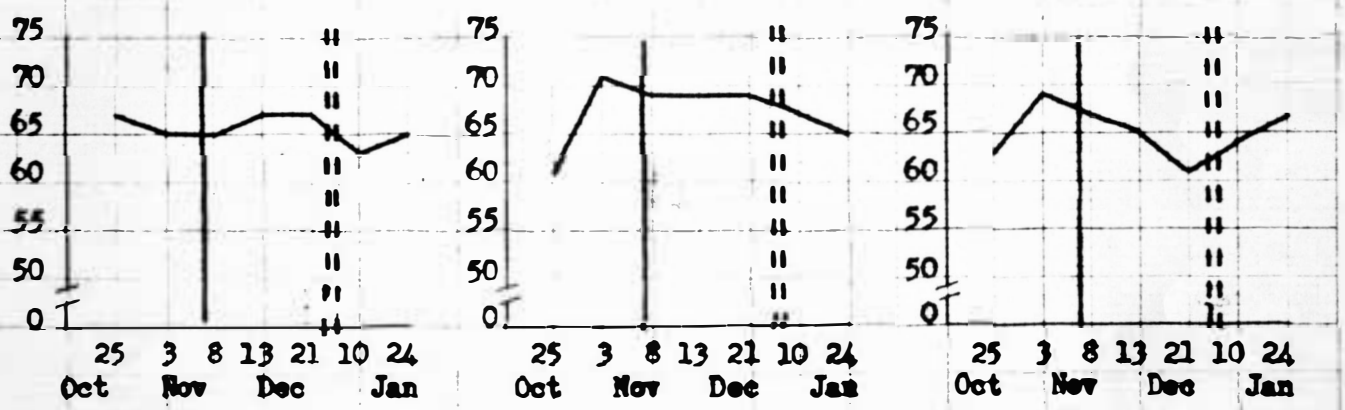
INDIVIDUAL CONDITION INDEX SCORES



Subject: ND
Age: 19
Height: 6'0
Weight: 190

Subject: JS
Age: 19
Height: 5'11
Weight: 173

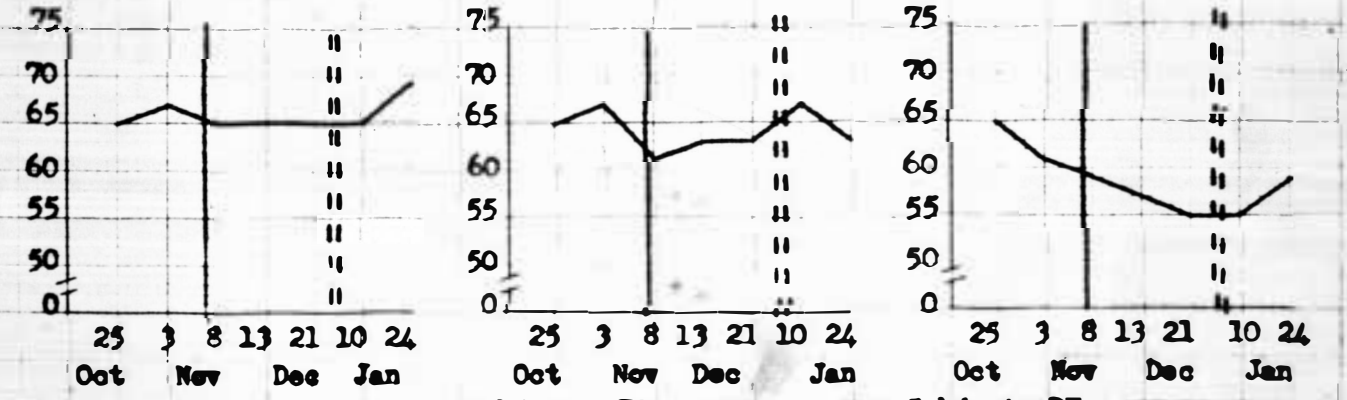
Subject: AZ
Age: 19
Height: 6'0
Weight: 160



Subject: DM
Age: 18
Height: 6'0
Weight: 176

Subject: BJ
Age: 18
Height: 5'9
Weight: 165

Subject: GS
Age: 18
Height: 6'1
Weight: 165



Subject: CN
Age: 18
Height: 5'9
Weight: 166

Subject: JN
Age: 18
Height: 5'9
Weight: 161

Subject: RH
Age: 18
Height: 6'0
Weight: 267

INDIVIDUAL TEST SCORES

TEST - CARLSON FATIGUE TEST (CHART I)

	Sum of Foot Contacts						
Subject	Oct. 25	Nov. 3	Nov. 8	Dec. 13	Dec. 21	Jan. 10	Jan. 24
ND	326	390	401	351	361	350	363
BH	325	292	284	289	280	282	285
BJ	374	389	372	391	394	398	368
DM	351	334	369	338	378	335	331
CN	340	364	367	341	352	309	341
JN	348	357	348	352	373	380	363
GS	372	365	343	356	349	343	336
JS	323	340	347	355	339	383	337
AZ	363	366	358	366	364	344	340
Average	347	371	356	349	354	347	340

TEST - CARLSON FATIGUE TEST (CHART II)

	Sum of Pulse Rates						
Subject	Oct. 25	Nov. 3	Nov. 8	Dec. 13	Dec. 21	Jan. 10	Jan. 24
ND	564	570	654	582	570	648	576
BH	594	612	618	630	690	654	612
BJ	660	564	564	588	576	600	630
DM	582	582	600	570	558	600	576
CN	584	594	618	594	600	558	546
JN	582	588	630	648	648	606	642
GS	624	564	564	600	648	666	564
JS	576	594	546	510	618	606	570
AZ	564	552	546	606	534	582	540
Average	592	580	593	592	605	613	584

INDIVIDUAL TEST SCORES (CONTINUED)

TEST - ROGERS STRENGTH TEST (CHART III)

	Combined Back and Leg Lifting Strength						
Subject	Oct. 25	Nov. 3	Nov. 8	Dec. 13	Dec. 21	Jan. 10	Jan. 24
ND	1170	1140	1050	1030	1220	1140	1230
BH	1300	1130	1110	1130	1130	1160	1110
BJ	1135	1125	1050	995	980	1075	1000
DM	1010	1090	1145	1070	1180	1100	1165
CN	950	900	910	1080	920	895	970
JN	750	745	830	740	710	710	880
GS	810	870	910	950	910	920	860
JS	800	860	915	985	972	915	870
AZ	750	785	750	870	830	830	860
Average	964	961	963	994	984	972	993

TEST - ROGERS STRENGTH TEST (CHART IV)

	Right and Left Hand Gripping Strength						
Subject	Oct. 25	Nov. 3	Nov. 8	Dec. 13	Dec. 21	Jan. 10	Jan. 24
DN	160	170	169	173	170	162	175
BH	180	190	175	189	189	183	189
BJ	140	139	138	138	145	133	135
DM	147	166	152	154	152	171	161
CN	142	149	135	133	138	121	136
JN	137	124	128	133	125	126	126
GS	133	126	133	136	131	136	126
JS	132	134	125	120	118	124	123
AZ	137	135	137	135	145	140	143
Average	145	148	144	146	146	144	146
*	964	961	963	994	984	972	993
**	1109	1109	1107	1140	1130	1116	1138

* Combined Back and Leg Lifting Strength Averages.
** Combined Lifting and Gripping Strength Averages (Figure 5).