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A STUDY OF THE GROWTH PATTERN OF FIFTEEN YEAR OLD BOYS DURING AND AFTER A PERIOD OF STRENUOUS ACTIVITY

Thesis for the Degree of M. A.

MICHIGAN STATE UNIVERSITY

Frank L. Sudac

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A STUDY OF THE GROWTH PATTERN OF FIFTEEN YEAR OLD BOYS DURING AND AFTER A PERIOD OF STRENUOUS ACTIVITY

by

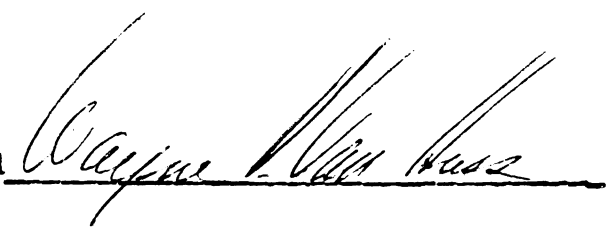
Frank L. Sudac

AN ABSTRACT

Submitted to the College of Education of Michigan State University of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of MASTER OF ARTS

Department of Health, Physical Education and Recreation

1960

Approved 

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ABSTRACT

TITLE

A Study of the Growth Pattern of Fifteen Year Old Boys During and after a Period of Strenuous Activity.

METHODOLOGY

Twenty pairs of boys were carefully matched on height --and as closely as was possible--weight, and body type. The pairs were then randomly divided into two groups: experimental and control. The subjects in the experimental group were placed on a schedule of training for distance running. The control group received no activity other than the usual school chores. The experimental period lasted fourteen (14) weeks; the follow-up period extended another twenty-seven (27) weeks. During the experimental and follow-up periods, the subjects were permitted no rigorous activity--other than that prescribed by the study.

Fourteen (14) weeks were used in the experimental period because that is the natural break in the school year and about the length of the usual competitive sports season. The experiment was conducted at Eastern High School (Lansing, Michigan).

The data were statistically analyzed using the analysis of variance and "t" techniques.

CONCLUSIONS

The differences found in the growth of the experimental and control groups were statistically insignificant.

ACKNOWLEDGEMENTS

The writer is most grateful to Dr. Wayne D. VanHuss whose guidance and cooperation made this study possible.

To the boys who unselfishly gave their time and effort to this study, the author wishes to express his gratitude.

The writer also wishes to thank his wife, Adeleen, for her patience and understanding, which were so necessary to the completion of this study.

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CHAPTER I

INTRODUCTION TO THE PROBLEM

Most persons would agree that exercise for growing children is essential. There are, however, many persons who are concerned with the amount of exercise a growing child should have, and also, the kind of activity to which these children should be exposed.

Parents, physicians, and educators, have, for many years, been arguing the question as to the value of strenuous activity for boys during their growing years. Some of these people argue for--others against--this type of activity.

Scientific evidence on the subject is quite inadequate. Some criticize strenuous activity as being harmful to the normal growth of the child. Studies by Fait[23] and Rowe[20] have indicated that there may be some slowing down of growth in the height of a boy. Others criticize strenuous activity because of possible damage to certain organs of the body, such as the heart or the liver. Animal studies indicate, on the other hand, that as a result of activity during the growth period, the vital organs are stronger and heavier.[12,2] But, regardless of the position taken, more evidence is needed to substantiate such claims. Too many assumptions are based on personal biases, general observa-

tions, or experiences which have little scientific basis.

This study will approach two parts of this problem.

In the first part, we will determine whether a fifteen year old boy's growth will be slowed down as a result of strenuous exercise.

The second part will attempt to discover those changes, if any, which occur in the growth pattern of the boys after the strenuous exercise period has been terminated.

STATEMENT OF THE PROBLEM

To determine the effect of endurance running on the growth of fifteen year old boys and to determine what effects this running had on the growth of the boys after the running period was ended.

JUSTIFICATION OF THE STUDY

Studies show that a boy's growth is slowed down during a period of stressful activity.[23,20] No evidence seems to be available as to whether this slow-down is permanent or will be corrected after a period of rest. This study has been made to determine whether--after a reasonable length of time--a boy's growth will accelerate enough to correct the influence of the inhibitor.

LIMITATIONS OF THE PROBLEM

This study is limited because of two factors: the small sample used; and, the limited control of the group (we had control of the group only at school; we had to trust them to carry out the plan of the study while they were away).

DEFINITION OF TERMS

Selye[7] defines stress as a:

> ". . .state manifested by a specific syndrome which consists of all the nonspecifically induced changes within a biologic system. Thus, stress has its own characteristic form and composition but no particular cause. The elements of its form are visible changes due to stress whatever its cause. They are additive indicators which can express the sum of all the different adjustments that are going on in the body at any time. When in experimental animals or humans, organs are induced to function intensely (for instance, if a large part of the musculature is forced to work) there is positive evidence of an increased secretion of ACTH, the adrenal-stimulating pituitary hormone."

CHAPTER II

REVIEW OF LITERATURE

Much of the literature dealing with the effects of strenuous activities for the young is concerned with matters of psychology or body organs. In many instances, this literature consists merely of observations on the part of the author, rather than true scientific evidence. There are a few studies which have been made in reference to the growth of height in young boys.

To commence this review, mention of some authors, in regards to their observations and arguments against strenuous activities for growing boys, will be made.

Kirkpatric and Huettner[5] infer that the heart of a growing boy may suffer injury because the mass of the body increases faster than the circulatory system, thus causing a greater burden on the heart.

Besides injury to the heart, Berg[10] says that strenuous activities can cause emotional distress, maladjustment, physical exhaustion, and injury to bones which have not yet ossified.

In another study, Keen[16] states that the kidney may be overworked because of the increase of end products of fatigue. In a statement by Nixon and Cozens[6], strenuous activity is considered dangerous because of the rapid growth

of bone and muscle.

Steinhaus[22] and Lowman[17] both indicate the possibility of injury to the joints of a growing boy. Such injuries could be caused by too much pounding, such as that associated with the more strenuous sports.

Two authors, Barr[9] and MacKinzie[18], claim that, before the heart could be in danger of overtaxation, the other effects of fatigue on the body would create enough discomfort in the individual so as to induce a cessation or reduction of the activity.

Running--distance running in particular--is frowned on as an activity for the young growing boy. The State of Michigan[19] has a policy which limits the age at which a boy may run any distance over one hundred-ten (110) yards. In a study on the effects of distance running, Jokl[14] says that the reaction of the body, to stressful exercise which causes discomfort and possibly blacking-out, is harmless and lasts only a short period.

In a study on the duration of the three pubescence periods: pre-puberty, puberty, and post-puberty, Dimock[1] found that the ages of the boys in all three stages varied greatly. He also found that growth was most rapid between the periods of puberty and post-puberty.

In studies with animals, Hatai[12], and Donaldson[2], found that organs in rats increased in growth as a result

of exercise.

In reference to the kidney, Steinhaus[22] recorded no evidence of harm, due to exercise, in the function of that organ.

A child is considered still growing through the age of sixteen (16) and, in many cases, until the age of seventeen (17) years. His bones are not completely ossified and his muscles are still developing.

The effects of strenuous exercise on height are discussed by Steindler[8] from a study by Mark Jansen.[13] In his theory, Jansen indicates that pressure or stress will slow down the growth of new cells in the bone. In another study, Jores[15] has stated that this stress is also a stimulating agent; once the stress is released, the growth of the bone is increased so that no harm to growth occurs.

Courtes[11] states that, if growth is retarded by disease or other physical stress, once the cause of the retardation of growth has been eliminated, the growth is accelerated and will soon be at that point where it should have been--had the rate of growth not been affected.

A fine study by Rowe[21] using junior high school boys, found that participants in interscholastic athletic competition did not grow as rapidly as non-participants. This difference was also compared in the weight of the two groups; the results were the same; the participating group

did not gain as much weight as did those enrolled in physical education classes.

Rowe[21] also compared the boys enrolled in the physical education classes with those excused from physical education. He found a greater gain in height for the boy in the physical education class, which would either imply that the stress of physical education is beneficial to growth or that those excused were essentially a different population with other stresses that might be impairing growth.

Fait,[23] also in a study on junior high school boys, discovered essentially the same factors as Rowe: the height of the boy engaged in the more strenuous type of activity grew less in a period of six months than did that of the boys not participating in such activities. He also recorded the measurements of the chest, hips, and shoulders; here, the results favor the group that had participated in interscholastic athletics. From this study, Fait infers that growth in height was affected by the long bones in the body since the flat, irregular-shaped bones, which are more associated with the girth of the chest, hips, and shoulders, grew more on the participating group. He also indicated that a follow-up should be made to test the theories of Jokl[14] and Courtes,[11] (That retardation of growth resulting from stressful activities will be later erased, if sufficient time for rest were to be allowed).

CHAPTER III

METHODOLOGY

This study has been prepared to determine the effects of stressful activity on the growth of fifteen year old boys; and, to determine the pattern of growth following a period of stressful activity.

Most persons would agree that exercise for growing children is essential. There are, however, many persons who are concerned with the amount of exercise a growing child should have, and also, the type of activity to which these children should be exposed.

Parents, physicians, and educators, have, for many years, been arguing the question as to the value of stressful activity for boys during their growing years. Some of these people argue for--others against--this type of activity. Some criticize strenuous activity as being harmful to the normal growth of the child; others, often with little supporting evidence, criticize such activity because of possible damage to certain organs of the body. But, regardless of the position taken, more evidence than is now available is required before any such claims may be substantiated. Too many assumptions are based on general observations--or personal biases or experiences which have little scientific basis.

This study will approach two parts of this problem. In the first part, we will determine whether a fifteen year old boy's growth will be slowed down as a result of strenuous exercise.

The second section will attempt to discover those changes, if any, which occur in the growth pattern of the boys after the strenuous exercise has been concluded.

SELECTION OF SUBJECTS

The subjects used in the study were all fifteen year old sophomore boys in physical education classes. None were participating in competitive athletics in either junior or senior high school; neither were any planning future athletic participation. All subjects in the study were selected and paired from a group of four hundred (400) boys enrolled in physical education classes. The pairs were carefully matched in height; a further attempt was made to match weight and body type as closely as possible. The pairs were then randomly divided into two groups: experimental and control.

EXPERIMENTAL DESIGN

To determine the effects of stressful activity on the growth of fifteen year old boys; and, to determine the pattern of growth following a period of strenuous activity;

twenty pairs of boys were carefully matched on height, and, as nearly as possible, on weight and body type. The pairs were then randomly divided into two groups: experimental and control. The subjects in the experimental group were placed on a schedule of training for distance running. The control group received no activity other than the usual school chores. The experimental period lasted fourteen (14) weeks; the follow-up period extended another twenty-seven (27) weeks. No rigorous activity, other than than prescribed, was permitted during the entire range of the study.

Fourteen (14) weeks were used in the experimental period because that is the natural break in the school year --as well as being the length of the usual competitive sports season. The experiment was conducted at Eastern High School, Lansing, Michigan.

MEASURES USED

The height measures were taken using a meter scale taped to a pillar without a baseboard. A small steel square was used to get the measure as accurate as possible when measuring from the top of the boy's head to the scale on the pillar. Each boy would stand barefooted with his heels against the pillar, holding himself as erect as possible after taking a deep breath. The height was recorded on the basis of a single measure. All measures were taken by the

same individual.

The weight measures were taken on a scale which had passed the inspection of an official from the Lansing Bureau of Weights and Measures. Again, all of these measures were taken by one person. The mile times were recorded by stopwatch to the nearest second; one individual recording all times.

The training program, which the boys in the experimental group followed, consisted of interval training techniques. The boys ran repeat 220's, 440's, and 880's with occasional overdistance running. Each period consisted of fifty-five (55) minutes. The program of training used was formulated by a former cross-country coach. A typical training period consisted of the following activities:

Jog	1 Mile
Walk	440 Yards
Sprint	220 Yards
Walk	220 Yards
Sprint	220 Yards
Walk	220 Yards
Jog	880 Yards
Run	440 Yards
Rest	Five Minutes
Walk	440 Yards
Sprint	220 Yards
Walk	220 Yards
Sprint	220 Yards
Walk	440 Yards
Jog	880 Yards

In order to prevent monotony and to maintain or promote interest, one day per week was used for competitive

races. Various races, such as the 880, the mile, or a cross-country run of two miles, were used for these purposes. Thursdays or Fridays of the training week were usually set aside for these competitive days.

If weather prevented outdoor activity, the boys were exposed to competitive swimming, basketball, or wrestling. These served the same purposes as the competitive days mentioned above.

TECHNIQUES OF ANALYSIS

The data for the mile times and weight measures were statistically analyzed using the "t" test.[3] Height measures were interpreted by means of the analysis of variance technique.[4]

CHAPTER IV

ANALYSIS OF DATA

The data for the mile times were analyzed using the "t" test. The analysis was done in two parts. First, the experiment's data were analyzed from the initial time through seven (7) weeks of the experimental period--to test the severity of the training program (see Chapter I). The improvement of 1:58 minutes--from 8:48 minutes to 6:50 minutes--was significant at the .001 level ($t = 11.77$). These data are graphically illustrated in Chart I.

The initial mile times were slow. All of the subjects were forced to walk part of the distance; however, at the end of the seven (7) week period, all had improved to such an extent that they had no troubles in running the full distance.

The second analysis of the mile times was made by comparing the initial figures with those obtained nine (9) weeks after the conclusion of the experimental period. Both the experimental and control groups are included in this material; the control group was not measured at the seven-week mark as it was believed that this would disturb their schedule of inactivity. (See Chart II.) The improvement, of 118 seconds in the mile times of the experimental group during the period between the first and twenty-third weeks,

was not significant when comparatively analyzed with the improvement of 63 seconds in the mile times of the control group during the same period ($t = 1.2$).

The charts show an improvement in mile times for both groups. The initial mile time was not a good test of a mile run as not one of the subjects could run a full mile; all stopped at one or more points to walk and catch their breath. In the final mile run, all but three (3) subjects in the control group were able to run the entire mile.

At the completion of the fourteen (14) week experimental period, both groups were returned to normal school activities (including physical education classes; this could be the reason the control group showed a slight improvement). The final mile time was recorded at twenty-three (23) weeks after the initial time because this was the first opportunity the subjects had to run out-of-doors after the winter indoor season. It is possible that the experimental group had a better mile time at the end of the fourteen (14) week experimental period. This does not show on the graph because they were not tested at this time. It does not, however, seem credible that they could have retained the same stamina or endurance to run the mile in as near the same time as was their ability during the midpoint of the experimental period. We could, therefore, assume that their times would have continued to improve through the

fourteenth week, and thereafter declined to the point of the final measure at the twenty-third week. At the same time, we could say that the control group might have been consistent at the time (9:08) through the first fourteen (14) weeks, and then have improved--as a result of the exercise received in physical education classes during the time between the end of the experimental period and the twenty-third week, when measurements were taken.

The height measures were analyzed using the analysis of variance techniques. This analysis was done in two parts. First, the differences found in the fourteen (14) week training period were compared. Second, the post-training data for the control and experimental subjects were compared (The data are presented in Chart III and Table I).

None of the "F" values were significant. Although the graph shows the growth of the experimental group to be less during the training program, it is evident from the "F" values that these differences are attributable to chance factors.

The second analysis, made on the measures taken after the conclusion of the training period, is shown in Table II.

The "F's" for the test period and individuals were both significant at the .001 level. This was expected since the individuals were different and growth did take place during this period of analysis. No significance was found

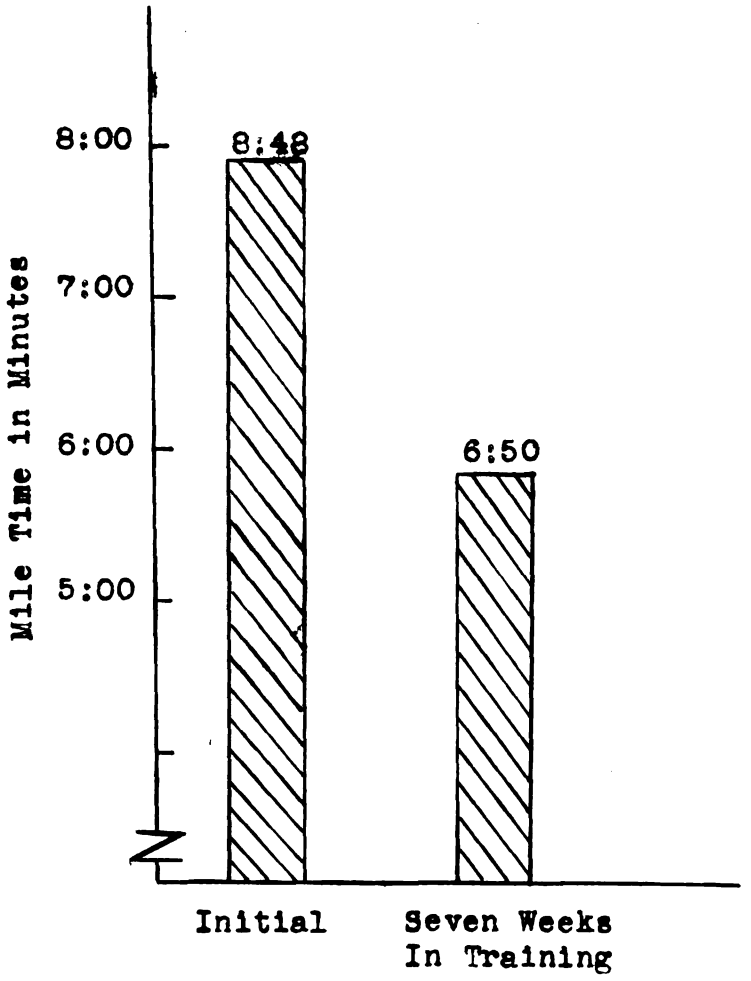

CHART I. ANALYSIS OF EXPERIMENTAL PERIOD.

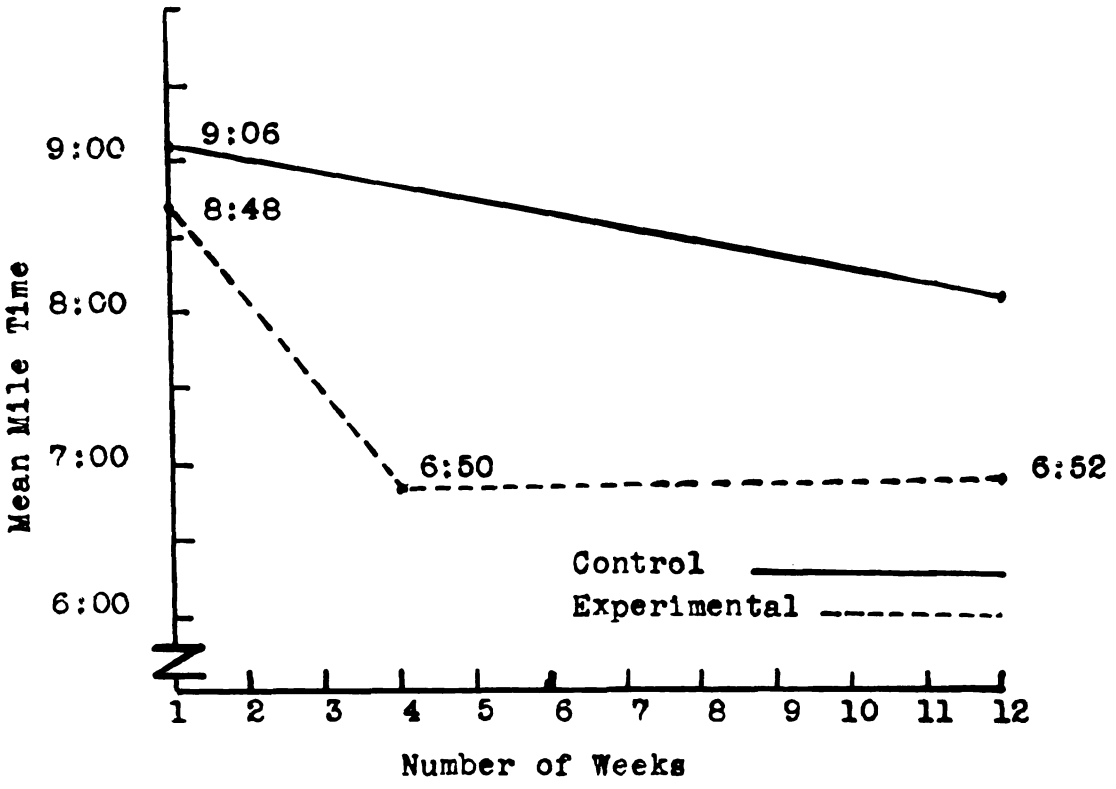

CHART II. ANALYSIS OF POST-EXPERIMENTAL PERIOD.

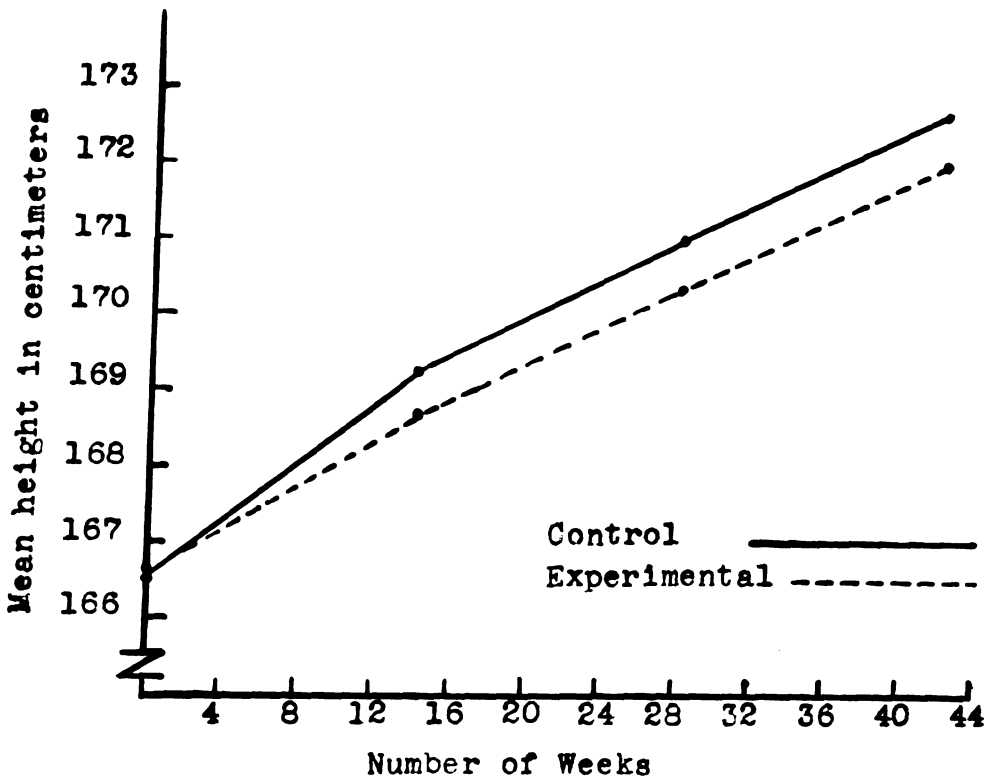

CHART III. ANALYSIS OF HEIGHT MEASURES.

TABLE I

ANALYSIS OF EXPERIMENTAL PERIOD

	Sum of Squares	df	ems	F
Total	1418.51	59		
Group	.87	1	.87	.0696
Test Period	68.27	1	68.27	5.4616
Individuals	998.57	28	25.66	2.0528
Group X Test Period	.91	1	.91	.0728
Error	349.89	28	12.50	

TABLE II

ANALYSIS OF POST-EXPERIMENTAL PERIOD

	Sum of Squares	df	ems	F
Total	2276.25	89		
Group	6.77	1	6.770	3.5820
Test Period	161.37	2	80.685	42.6904
Individuals	2002.05	28	71.500	37.8306
Group X Test Period	.07	2	.035	.0185
Error	106.00	56	1.890	

TABLE III

ANALYSIS OF WEIGHT MEASURES

	Initial	Final	Difference	t
Experimental Group	1810.50	1861.00	50.50	
Control Group	1800.00	1877.25	77.25	
				.69

in the groups or "groups X test period" interaction, indicating that there were no significant differences in the groups following training.

The final analysis was made on the weight of the subjects using the "t" test. The data were collected on the initial measure at the beginning of the experiment and the final measure was taken at the conclusion of the experimental period. Although the control group gained one (1) pound more than the experimental group, the difference was not significant (Table III). This could be explained by the short period of the experiment, or by the possibility that the training program was not of sufficient intensity to produce weight changes. Weight alone does not tell the entire story. It is possible that the experimental group lost in fat, but that this was compensated for by an in-

crease in muscle bulk. Only a careful tissue analysis could provide this answer.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study was designed to determine the effects of stressful activity on the growth of fifteen year old boys; and, to determine the pattern of growth following a period of strenuous activity. For the experiment, twenty pairs of boys were carefully matched on height--and as closely as was possible--weight, and body type. The pairs were then randomly divided into two groups: experimental and control. The subjects in the experimental group were placed on a schedule of training for distance running. The control group received no activity other than the usual school chores. The experimental period lasted fourteen (14) weeks and the follow-up period extended another twenty-seven (27) weeks. During both the experimental and follow-up periods, the subjects were permitted no rigorous activities--other than those prescribed by the study.

The height of the boys in both groups were recorded four (4) times. The initial height was recorded at the beginning of the experimental period; the second measure at the end of the fourteen (14) week experimental period. The third and fourth measures were made at the end of twenty-eight (28) and forty-one (41) weeks respectively.

The mile time for the experimental group was taken

at the beginning of the experimental period and again after seven (7) weeks of the training period had elapsed. Both groups were recorded in their mile times at the beginning of the experiment and, also, nine (9) weeks after the experimental period ended.

The weight was recorded at the beginning and at the conclusion of the experimental period.

CONCLUSIONS

The data comparing the two groups were analyzed using the "t" and analysis of variance techniques. The results indicate no significant differences in the growth in height of the two groups.

RECOMMENDATIONS

If the study were to be conducted again, it is recommended that more subjects should be included in the study; and, a longer experimental period should be used.

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APPENDIX

DATA SHEET

EXPERIMENTAL GROUP

GROUP	HEIGHT MEASURES[x]				WEIGHT MEASURES[xx]		MILE TIMES[xxx]		
Experimental	Sept. 15	Dec. 19	Mar. 27	June 5	Sept. 15	June 5	Sept. 14	Oct. 30	April 15
Subject 1	171.6	173.3	173.4	175.5	117.00	119.75	8:26	6:13	6:09
Subject 2	167.1	168.5	170.5	174.1	133.00	133.50	8:41	6:30	6:48
Subject 3	171.7	172.9	174.6	177.1	110.25	116.25	8:52	6:28	7:20
Subject 4	171.1	174.7	177.9	179.3	160.00	161.00	9:28	7:19	7:11
Subject 5	175.4	177.2	178.7	178.9	137.00	143.00	8:29	6:31	5:34
Subject 6	165.6	166.6	167.8	169.3	122.50	124.00	8:22	6:28	6:03
Subject 7	159.5	162.1	162.3	165.7	104.00	104.50	8:24	6:13	6:03
Subject 8	162.7	163.3	163.4	164.8	118.50	123.00	9:44	8:01	7:36
Subject 9	159.6	162.2	164.3	165.9	95.00	98.00	8:21	6:40	6:35
Subject 10	168.1	170.3	172.6	172.6	121.50	124.00	8:32	6:02	6:34
Subject 11	167.9	169.8	171.0	172.1	109.75	111.00	8:58	6:48	6:12
Subject 12	164.0	167.8	170.5	172.2	132.50	138.00	9:08	7:45	6:46
Subject 13	167.8	169.6	170.8	171.9	109.00	112.00	9:56	8:28	9:30
Subject 14	171.0	171.0	173.3	175.4	127.25	136.00	8:19	6:27	8:03
Subject 15	160.3	162.4	164.4	165.6	113.25	117.00	8:19	6:36	6:40

x In centimeters.

xx In pounds.

xxx In minutes.

DATA SHEET

CONTROL GROUP

GROUP	HEIGHT MEASURES[x]				WEIGHT MEASURES[x]		MILE TIMES[x]		
Control	Sept. 15	Dec. 19	Mar. 27	June 5	Sept. 15	June 5	Sept. 14	Oct. 30	April 15
* Subject 1	171.2	172.2	173.5	174.8	119.00	117.00	9:14	**	8:12
Subject 2	167.2	170.4	170.5	173.4	133.75	140.00	8:26		8:03
Subject 3	171.6	173.5	177.0	178.1	109.75	115.00	9:01		7:58
Subject 4	170.3	171.7	172.4	175.1	160.00	173.00	13:08		11:46
Subject 5	175.4	178.4	179.4	182.1	135.50	136.50	8:14		7:12
Subject 6	164.4	168.5	171.7	172.5	118.00	126.00	10:12		9:07
Subject 7	159.2	161.9	163.7	165.3	104.00	104.50	10:08		7:13
Subject 8	162.8	166.5	168.1	168.4	116.25	125.75	8:27		6:30
Subject 9	159.6	160.3	162.1	164.3	97.00	100.75	8:32		7:14
Subject 10	168.1	171.8	174.4	175.7	119.25	126.25	8:26		7:03
Subject 11	167.9	170.0	170.6	172.2	109.50	117.00	8:10		6:28
Subject 12	164.6	164.6	166.7	168.3	129.00	139.50	8:11		7:12
Subject 13	169.1	171.0	172.8	174.3	106.00	110.00	8:19		6:22
Subject 14	170.7	175.4	176.5	178.0	126.00	130.00	9:15		8:22
Subject 15	160.2	162.8	165.1	166.2	117.00	115.75	8:47		12:04

* Numbers correspond to matched experimental subject.

** Measurements of control group not taken at this time; see page 13.

x Measurements are on the same basis as the experimental group.

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