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The Effect of a Corrective Exercise Program on Ninth Grade Boys with Foot Deviations

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THE EFFECT OF A CORRECTIVE EXERCISE PROGRAM ON NINTH GRADE BOYS WITH FOOT DEVIATIONS

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS

I. THE PROBLEM

Statement of the Problem. The purpose of this study was to determine the effects of a corrective physical education program on ninth grade boys with orthopedic foot deviations and their performance on a motor ability test battery.

A secondary problem was to determine if voluntary participation in a regimen of corrective exercises would minimize existing conditions of foot deviations. To solve the problems it was necessary to consider the following sub-problems:

Sub-problem I. The identification of boys with foot deviations.

Sub-problem II. The development of a corrective program for individual cases of foot deviations.

Sub-problem III. The association of being highly skilled with improvement in the J.C.R. Test.

Importance of the study. Mr. Lowman emphasizes that because of the importance of the foot as the base of support of the body, it should be well understood by the teachers of physical education. It is the foundation and has to stand the stress and strain of weight bearing activity. This together with the abuse from faulty shoes, causes, even in a child, frequent deviations from the normal. At least seventy per cent of all school children have some modification or deviation from the normal lines of foot development (18:69). Another important aspect of foot deviation was explained by Hawley. As an individual approaches middle age, foot abnormalities which may have caused little or no trouble in youth generally become aggravated often resulting in more or less deformity and disability.(11:83).

Some of these problems could be prevented to a great expent if people would only become foot conscious before it is too late. To attain this goal of being foot conscious, this study attempts: (1) To bring to the attention of the school board, teachers, parents, and pupils the need for a special corrective physical education program in the school. (2) To show how to discover the physical disabilities of children which produce crippling conditions in later life. (3) To show corrective exercises, specifically chosen to correct or lessen the effects of foot deviation from the normal.

<u>Limitations of the study</u>. This study is limited to ninth grade boys on Elmendorf Air Force Base, Anchorage, Alaska. It is further limited to those with orthopedic

defects in foot deviation from the normal. The boys used were all military connected in some way. The diagnostic technique for foot deviations was subjective and the data on practice time was not supervised. Also, it is limited by voluntary participation in the exercise program. Because of these limitations, the results of the study may be generalized with caution.

II. DEFINITION OF TERMS

Abduction. A movement in the ankle joint resulting in the part moving away from the mid sagittal plane or median plane of the extremity.

Adduction. A movement in the ankle joint resulting in the part moving toward the median plane of the extremity.

Corrective Exercises. Exercises specifically chosen for strengthening muscles of individuals who have deformities such as pronated or flat feet.

Dorsal Flexion. The upper portion (dorsum) of the foot is drawn toward the front of the leg.

Extension. A joint movement where the angle between the anterior aspects of the parts, except at the knees and toes, becomes larger. Some anatomists refer to an extension movement beyond 180 degrees as hyper-extension

First Degree Pes Planus. Approximately three-fourths of the plantar surface of the foot was seen as a white surface on the 'mirror test'.

Hallux Valgus. A marked deviation of the great toe toward the midline of the foot.

Hammer Toes. In this deviation the toes are sharply hyper-extended at the metatarsophalangeal joints and flexed distally, as though the digits had buckled as a result of pressure against the ends of the toes.

Highly Skilled. A term used in this study to describe a boy making an average sigma scale score of 180 or over in entire J.C.R. Test battery.

J.C.R. Test. The J.C.R. is a three item test using the vertical jump, chinning, and a one hundred yard shuttle run in which the subject runs a ten year course ten times. Bank-boards, approximately forty degrees with the floor, are used to assist the subject in making the one hundred and eighty degree turn. The test is designed to measure total motor ability.

Lateral. A point or area that is more distant from the mid sagittal plane.

Longitudinal Arch. This arch extends from heel to toes and from side to side, across the entire plantar surface of the foot.

Medial. A point or area that is closer to the mid-sagittal plane than another point.

Pes Planus or Flat Feet. The long arch of the foot is flattened out and the medial border of the foot assumes a convex appearance.

Plantar Flexion. A movement in the ankle joint resulting in a decrease in the angle between the sole or plantar surface of the foot and posterior aspect of the leg.

Pronation. The combination of rotation downward of the inner surface of the calcaneus with eversion and abduction in the foot.

Second Degree Pes Planus. Approximately one-half of the plantar surface of the foot was seen as a white surface on the 'mirror test'.

Structure of the Foot. The foot, considered mechanically, is an elastic arched structure, with three points of support: the calcaneus, the astragalus (talus), the scaphoid (navicular), the three cuneiforms, cuboid, five metatarsals and fourteen phalanges. The last nineteen bones are known as the 'dynamic' portion of the foot.

Supination or Inversion of the Feet. A movement where the soles of the feet turn in towards each other at the ankle joint as if trying to clap the soles of the feet together.

Toeing In. Walking in the 'pigeon toe' manner. The inner edges of the feet instead of being parallel to each other run forward and medially.

Toeing Out. Walking in a manner in which the inner edges of the feet instead of being parallel to each other run forward the laterally.

Transverse Arch. Extends from side to side, under the entire foot, from the anterior portion of the calcaneus to the distal heads of the metatarsals andthe phalanges.

CHAPTER II

REVIEW OF LITERATURE

I. CAUSES OF FOOT DEVIATIONS

The review of publications available regarding obesity as a factor in pes planus and pronation indicates that there is a positive relationship between body weight and flat feet. Obesity increases the strain on the arches and the tendency to pronation. The rather overweight infant or youngster will many times develop an attitude of weak feet under the stress of unbalanced movement. A functional condition becomes structural due to overweight (2:524).

The scaphoid bone of the foot has frequently been termed the Keystone of the arch. It, with the other bones that form the arch of the foot, is held in place by strong ligaments as well as by muscles and tendons. Frequently in persons who are overweight and in others who have faulty foot position, there is a breaking down of the longitudinal arch.

The mechanics of the foot are extremely complicated. The peroneus longus, tibialis posterior and anterior, and many other muscles sag, the ligaments are strained. Although the ligaments may assist in prevention, under severe and continuous strain they may give way. When this occurs, more strain is added to the bony framework of the foot, and it then alters its structure (5:102-103, 28:116, 4:134-136).

Strength and foot position are factors in the treatment of weak feet. The bony configuration of the foot makes the inner border particularly susceptible to foot strain. Therefore, slight in-toeing while walkingis a position of strength whereas a position of weakness is out-toeing.

In a normal gait the body weight is transmitted from the heel across the outer side of the foot, over the transverse arch and off the great toe. The movement of all the toes should accompany every step, trying to grasp unevenness in the ground and thereby, with varying positions of the foot, toes, and leg produce constantly changing use of the various short and long muscles of the foot and leg (4:832).

Correct footwear in the prevention of foot defects is very important. Manufacturers of shoes seem to pay little attention to the requirements of the body, trying to place the buyers by style instead of need. A shoe that is too short tends to cause pronation of the foot, for as the weight is placed on the arch it tends to lengthen, and if short, tends to cause pronation of the foot, for as the weight is placed on the arch it tends to lengthen, and if a short shoe prevents this, it pronates instead, tipping inward and start-in the foot on the way to flat feet (4:134 -136).

Shoes were first designed for protection of the feet from stones, thorns, rough surfaces, and the weather. Gradually, adornment and decoration became important. Sometimes shoes not only interfere with walking but cause actual damage to the feet. Most of the foot complaints of the present day are directly attributable to faulty shoes. The foot should not be required to conform to the shape of the shoe, but the shoe should be constructed to the fit the foot (2:524, 17:248).

Kelly in her study relates:

> Considerable conflict is found in the literature on statics and function of the lower extremity. The criteria reported seem to have been established largely on empirical bases. Fifty to sixty per cent of the child population shows pronation to a greater or lesser degree. Toward this end a comparative study of normal, pronated, and painful feet among children was undertaken. This study has presented mean scores and significant differences for groups of normal pronated, and painful feet with regard to thirty-five anthropometric and X-ray variables related to statics, flexibility, strength, morphology, and sensitivity to pain.
>
> Both pronated and painful groups showed greater flexibility variables studied.
>
> Low positive significant correlation was found between flexibility of the arch and degree of out-toeing.
>
> The pronated and painful groups showed as great strength of pronator, supinator, and toe flexor muscles proportional to body weight as the normal group. In this study the pronated and painful feet were not muscularly weak feet.
>
> The condition of short first metatarsal was frequent in the normal, pronated, and painful groups, with the incidence only slightly higher in the two latter groups.
>
> Pain or pressure to the sole of the foot differentiated from the painful feet. It should be studied further as a possible diagnostic criteria or potentially painful feet.
>
> The sex differences shown seem to be related to the greater flexibility among girls.

Multiple factor analysis indicates the presence of three or four common factors in foot structure and function. Three have been tentatively identified as foot disalignment, ankle flexibility, and general flexibility. A possible fourth factor may be related to strength at the feet (14:291-311).

Bressler in his study states:

> The study was an effort to verify the relationship between body weight and flat feet and is restricted to the structure deformity in the longitudinal arch of the foot, commonly called flat foot. The study is not concerned with foot function or weak feet in as much as flat foot is not necessarily accompanied by impairment of function or by weakness of the foot.
>
> The evidence indicates a positive relationship between body weight and flat feet. Among 4,323 college men examined, of whom 2,648 had structurally normal feet and 1,674 had flat feet in some degree as diagnosed by trained physicians, the Flat Footed group was on the average 4.2 pounds heavier. The difference was statistically completely reliable. The two groups were not different on the average with respect to two other values, height and age (5:102-113).

II. THE SYMPTOMS OF WEAK FEET

To understand why the foot, in spite of the great amount of physical activity it has, should so frequently suffer from the lack of muscular strength, we have to keep in mind that no other group of muscles in the body has to bear so often the entire body weight. Weak arches are due primarily to relaxed ligaments, but are often associated with muscles which are relaxed and underdeveloped. The most frequent foot abnormality is pes planus. In the very first stage the subject may notice that the feet and legs are frequently tired especially after standing for long periods. Symptoms of strain appear in the knee and hip-joints as a result of the malalignment of the entire lower extremity produced by fallen arches. The outside of the arch held up by less flexible bony architecture and by plantar ligaments, is apt to stand the strain better and as a result the foot tips inward, making the inner malleolus prominent, bending the tendon Achilles share of the body's weight on the weak inner side of the foot. In all cases we have the beginning of the series of changes that end in flat feet. Unless remedial measures intervene, the condition gradually develops to the stage of a pronated foot, with the navicular bone prominent and the bending of the foot at its middle, convex on the inner side (4:134-136, 3:94, 22:31-34).

III. THE INCIDENCE AND IMPORTANCE OF FOOT PROBLEMS

Mr. Root says that ninety-nine per cent of all feet are perfect at birth. Yet, according to a ten year study by the Podiatry Society of the state of New York, eight per cent have developed troubles at one year, forty-one per cent at age five, and eight per cent at twenty. We limp into adulthood on corns, calluses, bunions, ingrown toenails, hammer toes, plantar warts, and dozens more grown getters (23:69-72).

Thomas explained faulty weight-bearing as a national problem. Flat-footedness was a prevalent cause for unfitness in the Army and it is an important problem in civilian life as well. One factory of ready-made arch supporters claims to sell three thousand pairs each month to shoe stores. This shows a demand by the public. Seventy-seven per cent of the under-graduates at Wellesley College have faulty weight-bearing lines. American public schools show the same large percentage. This is an important question in relation to the efficiency of the race, that should be attacked in public schools. The problem of the physical director is to prevent foot strain, weak feet, and flat feet, rather than seek a cure. The end to work for is the habitually correct mechanical use of the feet (27:61).

Cureton explains various studies have shown that nearly three-fourths of the population of young adults have symptoms of weak feet. The seriousness of the problem is reflected in rejections from the Army, police departments, fire departments, and postal positions (7:368).

Scere states that from 50 to 80 per cent of school children have foot problems. Usually the result of poor foot care, many of these problems become painful deformities by the time the children reach the age of twenty (26:164).

Deaver in attempting to show the importance of correction or orthopedic defects states: "How many parents look at their children's feet, back, spine, etc.? How many physical directors examine the members of their classes for the orthopedic defects? The numbers are few and as a result it seems that every week in my clinic I say, "If I had only seen this case two years ago how easy it would be to correct." (8:1).

IV. CORRECTION AND IDENTIFICATION OF FOOT DEVIATIONS

Dr. Colonar in his text of Regional Orthopedic Surgery, reported that in adults excellent foot balance may be obtained with exercises. The basic principle here is to strengthen the inverters of the feet and constantly to bear the weight slightly on the outer border, walking with the feet parallel. It is most important that the patient becomes 'foot conscious' if he wishes to obtain the greatest benefit from foot exercises (6:842).

Kelly states that when the feet show marked prominence of the inner ankle bones and toeing out of the fore part of the feet, corrective foot exercises are desirable. They are generally of two types: those which teach improved habits of the foot and those of walking properly (15:167).

Root writes in his article that the accumulation of scientific data on the structural causes of foot defects weaken the case for foot exercises. They may refresh and relax, authorities agree, but they cannot affect skeletal structure (23:69-72).

It has been reported by Williams and Worthington that:

> There is a wide difference of opinion with regard to the part the muscles play in arch support in foot balance. While some believe bone and ligamentous structures are the primary factors in maintaining the arch, others contend that, as stated by Keith, '. . . Muscles are all important in the support of the longitudinal arch and ligaments come into play only after the muscles have failed.' While the relative importance of the foot structures may be in dispute, many agree that the muscles do play a significant part in foot posture and it is on this premise that exercises are prescribed (28:127).

Exercises for the corrrection of feet difficulties seem to be accepted among most authorities. Exercises tend to be selected to develop strength as evidenced in recommended series by Stafford, Rathbone, and Kelly (27:190-195, 22: 31-34, 15:167.). Some of the exercises recommended by these authorities are included in the appendix.

General techniques have been developed for identification of foot deviation. Among them are the Iowa Posture Test, Washington State College Test, and a procedure used in the Army. These tests are described in Appendix C. These tests are all subjective types of tests.

Dr. Lovett comments on foot impressions as follows. "In imprint tracings the non-weight-bearing tracing is indelibly recorded before weight bearing position is reached." He gives as his method of determining the weight-bearing position as follows: "The patient stands on a piece of plate glass, under which, and facing the light, is a mirror set at an angle of forty-five degrees to the floor. In this mirror may be seen with great clearness the reflection of the bottom of the feet, bearing surfaces appear as dead white areas, while lines of the contact can be seen easily." (27:183).

CHAPTER III

METHOD AND MATERIALS

I. SELECTION OF THE SUBJECTS AND DESCRIPTION OF THE EXPERIMENT

The subjects of this study were selected from a total enrollment of one-hundred ninth grade boys in physical education classes at Elmendorf Air Force Base, Anchorage, Alaska.

The entire group was given the J.C.R. Test of physical performance, and a screening test for orthopedic foot deviations. In addition, age, height, and weight records were obtained on each boy.

From the results of the orthopedic screening test the boys with foot difficulties of pes planus and pronation were selected as subjects for this study. Out of the total of one hundred, twenty-four boys were found to have conditions of flat and pronated feet ranging from second degree to first degree. These boys comprised the experimental or the orthopedic group. They were orientated to the exercises that were to be used and the importance of participation was stressed. The lunch hour was used for the supervision of the corrective exercises. The boys imprint tracing and prescription of corrective exercises used were placed in a folder along with his medical history.

The time spent in each daily exercise session was recorded. This was strictly a voluntary program. The foot pedestal was left in the room used for corrective exercises so that the student could check his progress from time to time. As much individual help was given the student as possible, but in most cases they worked together in pairs. Games were devised in a non-weight bearing position such as picking up marlbes or tennis balls for relaxation and motivation.

Twenty-four boys were selected from the remaining seventy-six without foot deviations and matched approximately equally on age, height, and weight with the orthopedic group. This constituted the control group. Both the orthopedic and the control group continued their usual physical education program, but in addition, the orthopedic group voluntarily took part in the individual foot correction exercise program.

The experiment was conducted for seven months lasting from October to May. At the conclusion of the time period both groups were tested again using the J.C.R. test and orthopedic screening test. Results were analyzed to determine improvement in foot deviations by the orthopedic group and to determine differences in improvement within each group and between the groups on the J.C.R. test.

To determine if original skill ability of the subjects in both groups was a factor in improvement, the subjects were all rated as to their skill ability and the data on the

J.C.R. test was analyzed accordingly. Analysis was also made of the relationship between hours spent on foot exercise and improvement on the vertical jump.

II. SELECTION AND ADMINISTRATION OF THE TESTS

The J.C.R. was selected after reviews of other similar tests due to the material available and the simplicity. It is essentially a performance test. It purports to measure the ability of an individual to perform fundamental motor skills such as jumping, climbing, running, and dodging which involve the basic elements of power, strength, speed, agility, and endurance.

Reliability coefficients ranging from .91 to .97 are reported for the test. Reliability and validity coefficients have been computed from data collected in mass testing (12:29).

The complete description of the test items is included in Appendix B. When administering the test the introductory remarks included a brief discussion of the test items, a statement as to what the test purports to measure, an explanation of the purposes for administering the test, and the manner in which the test results were to be used. The procedure for conducting the test was outlined briefly and the boys were encouraged to give maximum effort. The performance scores are reported in Chapter IV.

The test was administered without disrupting the regular physical education program simply by moving boys through activities while not actually being tested.

To identify boys with foot deviations, an orthopedic screening examination for foot deviations was given to the group of one hundred boys in physical education.

The 'Mirror Test' was used to discover cases of flat or pronated feet. The following is a description of this screening device:

> Mirror Test: The pupil stands on a plate glass under which is a light and a mirror set at an angle of 45 degrees to the floor. In the normal foot which has the proper distribution of weight the weight-bearing surface is seen as a white area on the heel, along the outer border of the foot, and along the area behind the toes. When the weight-bearing is seen along the inner border of foot, and the outer side pink, it indicates faulty weight bearing and a pronated foot. If the whole plantar surface is white it indicates a flat foot (pes planus). If the middle of the foot does not touch the plate glass it is considered a high arch (pes cavus), or claw foot.(8:3-4).

This instrument was made in the high school shop. The device was built according to plans from the originator.*

The method involves subjective evaluation in the classification of the defects. The students were classified by degree of deviation, first degree deviation as being the flattest to second degree deviation being the least flat. The test was selected due to its ease of administration and

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*The plans for the Mirror Screening Device may be obtained from: Dr. George C. Beaver, Institute for the crippled and Disabled, 400 First Avenue, New York 10, New York.

on the basis of recommendations by medical men presented in the chapter on review of literature.

The transverse arch was inspected by having the pupil sit on a pedestal and remove weight-bearing pressure. The feet were inspected for the following signs of a low transverse arch:

1. Depression behind the toes on the dorsum of the foot and a shortening of the extensor tendon of the toes.

2. The toes flexed with ends flattened, producing what is known as 'hammer toes'.

3. Callouses on the plantar surface of the foot located under the heads of the metatarsal bones.

The toes were examined to determine if the big toe pointed outward indicating a condition of hallux valgus. It was noted if hammer toes, overriding toes, deformities, such as web toes or extra toes, or callouses were present. Only the boys with pronation or flat feet were used as subjects. Data relating to the findings of the orthopedic screening are presented in Chapter IV.

III. THE CORRECTIVE PROGRAM

The corrective program was organized and conducted as a remedial program for all boys showing pronation or flat feet. The exercises used in this program were carefully selected for the specific problem of each subject. The exercises used in this study were selected because of adaptability to the program and they appeared to be valid on the basis of recommendations of at least three authorities in the field of corrective physical education (Appendix A).

EXERCISES FOR FOOT CONDITIONS

I. Pes Planus Exercises

A. Exercises without weight bearing

1. The boy is seated, foot in normal position. The exercise is done in four counts. On the count of one, the feet are forcibly put in the position of plantar flexion. On the count of two the feet are forcibly inverted. On the third count the boy is told to return to the number one position and on the fourth count to return to the starting position. There is a strong muscular effort put forth in the third and fourth positions. The subject is told to keep the knees rather close together throughout the exercise.
2. The same exercise as number 1 but the subject is sitting on a table and the operator sits on a chair so he can grasp the subjects feet and resist the movements performed on the first and second counts. Do not resist on the third and fourth counts.

B. Exercises with weight bearing

1. The subject was instructed to stand with feet parallel and to a slow count of 1-2-3- perform the following:

   a. Rise on tiptoes.
   b. Tilt the weight to the outer borders of the feet so that it is centered just behing the little toe side of the foot.
   c. Return to starting position and relax.

2. The subject was instructed to stand with feet parallel, four inches apart, hands on hips. Rise on tiptoes, do full knee bends and throw weight to the outer border of the feet as you do it. The knee bends cut out the action of the gastrocnemius. ?

3. The subject was instructed to walk on a line with arches raised and feet inverted.

4. The subject was instructed to stand and raise the arches with the toes curled. This exercise works the toe flexors.

   a. This can also be done from a sitting position.

II. Exercises for pronation

A. Exercises without weight bearing

1. The subject is told to make a basket of his feet by turning them onto the outer border, soles of feet together and increase the arch between them.

   a. This exercises both of the tibial muscles.
   b. Also, we exercise the same muscles by having the individual pick up a ball using the soles of both feet.

2. The subject was instructed to assume the sitting position, dorsi flex and invert the feet.

   a. Exercises the anterior tibial mainly.

3. The subject was instructed to sit, knees crossed leg down, in, up, and then relax.

4. The subject was instructed to assume position with knees extended, attempt to touch the soles of the feet together.

5. The subject was told to assume the sitting position, actively invert the feet by contracting the tibials, hold this position momentarily, then relax.

B. Exercises with weight bearing

1. The subject was instructed to stand barefooted, feet parallel, two to four inches apart. On the count of one, the feet are forcibly turned out onto the outer border (inverted), and on two they are rolled slowly in, but not all the way.

2. The subject was instructed to do the same as exercise 1 except that the two big toes maintain contact with the floor.

3. The subject was instructed to walk on the outer borders of feet with toes flexed.

    a. We hoped this would stretch the peroneals.

III. Exercises for Fallen Transverse Arch (metatarsal arch)

A. Exercises without weight bearing

1. The subject was instructed to pick up a pencil with the toes.

2. The subject was instructed with the toes, to crumple a towel under the feet.

    a. Have the long axis of the towel parallel to the long axis of the feet. While flexing the toes, gradually work more and more of the towel in under the feet.

B. Exercises with weight bearing

1. With a piece of 2 x 8 or 3 x 8 two feet long, the subject was instructed to stand on it so the edge of the block strikes the foot right behind the metatarsophalangeol joints of the toes. Curl the toes down and try to touch the vertical side of the block.

    a. We also used a thick book for this exercise.
    b. Stand on a step and curl the toes over the edge of a step.

The progression of the exercises used for each subject over the seven month period was subjective. The increase in the number of repetitions was voluntary.

CHAPTER IV

ANALYSIS OF DATA

Table I shows the age, height, and weight of both groups as well as the means in each of the classifications. The orthopedic group had an average age of fourteen, an average height of sixty-six inches, and an average weight of one hundred and thirty-four pounds.

The control group consisted of twenty-four subjects selected to match the orthopedic group as closely as possible in factors of age, height, and weight. This group had an average age of fourteen, an average height of sixty-five inches, and the average weight was one hundred and thirty-seven.

Both groups were given the J.C.R. pre and post test battery. Tables II and III give the raw scores, means, and standard deviations from these tests.

In observing the means of the pre and post tests it may be noted that both groups showed little change, but the means were slightly higher on most of the post test items. To determine if these observed differences were real or due to chance, the data were analyzed by the Fisher "t" technique. The results of this analysis are shown in Table IV. For the purpose of this study .05 level of confidence was accepted as indicating a real difference. As can be observed from

TABLE I

THE AGE, HEIGHT AND WEIGHT OF THE CONTROL AND ORTHOPEDIC GROUPS

No. in each group	Control age	Group height in inches	Group weight in pounds	Ortho-pedic age	Group height in inches	Group weight in pounds
1	14	65½	161	14	66	178
2	14	65½	109	14	66½	102
3	14	67½	158	14	68	165
4	14	67½	124	14	67¼	120
5	14	65½	158	14	67½	168
6	14	71	155	14	70¼	152
7	14	67	145	14	66½	142
8	14	68	125	14	65	128
9	14	66	143	14	67	141
10	14	72¼	169	14	69½	166
11	14	70½	140	14	71½	146
12	14	67½	124	14	63½	123
13	14	70	183	14	70	186
14	14	69½	181	14	72	192
15	14	65	144	14	63	148
16	14	62	110	15	63½	115
17	14	69½	130	14	65¼	125
18	14	63½	108	13	57½	77
19	14	68½	153	15	68	153
20	14	62	103	14	63½	104
21	14	67½	135	14	67	143
22	14	60½	93	14	58½	99
23	14	63½	147	14	70½	147
24	14	65	128	14	66	128
	Mean age 14 years	Mean height 65 inches	Mean weight 134 pounds	Mean age 14 years	Mean height 66 inches	Mean weight 137 pounds

TABLE II

THE SCORES, MEANS AND STANDARD DEVIATIONS
OF THE ORTHOPEDIC AND CONTROL GROUPS
ON PRE J.C.R. TEST

No. in each Group	Pull Up Control group times	Pull Up Ortho-pedic group times	Vertical Jump Control group inches	Vertical Jump Ortho-pedic group inches	100 Yard Dash Control group seconds	100 Yard Dash Ortho-pedic group seconds
1	2	0	16	15½	17.5	27
2	7	13	21	17	24.5	23
3	3	0	19	14	32	27
4	7	0	16	17	27	24.5
5	0	0	15	14	29	26.5
6	2	3	19	20½	29	23.5
7	5	0	20	14	24.5	28.5
8	0	2	17	16	29	27
9	1	2	16	15½	28.5	25.5
10	0	5	17	21	27	23
11	3	3	19	18	27	27
12	1	1	16	15	28.5	26.5
13	0	0	14	14	27	29
14	9	0	18½	13	24	26
15	1	0	18½	15	25.5	29
16	11	12	18	16½	24.5	23.5
17	4	4	18	17½	26	24.5
18	1	9	16½	19	26	25.5
19	3	3	17	18	27.5	25.5
20	1	5	16½	17	29	22.5
21	6	7	20½	17½	22	28
22	2	1	16½	16	25	29
23	0	1	17	15	27	26.5
24	2	1	16	18	27	26
Means	2.96	2.90	17.3	16.4	26.8	26.0
Standard deviations	3.00	2.98	1.87	2.02	2.2	1.95

TABLE III

THE SCORES, MEANS AND STANDARD DEVIATIONS OF THE ORTHOPDEIC AND CONTROL GROUPS ON POST J.C.R. TEST

No. in each group	Pull Up Control group times	Pull Up Ortho-pedic group times	Vertical Jump Control group inches	Vertical Jump Ortho-pedic group inches	100 Yard Dash Control group seconds	100 Yard Dash Ortho-pedic group seconds
1	2	1	16½	16	27	26
2	8	14	21½	21	23	21
3	3	1	19½	15	30	27
4	8	1	16	21	26.5	23
5	1	0	16	16	28	25
6	2	3	19	21	28.5	22
7	7	0	21	14	24	28
8	0	2	17	18	28	25
9	1	2	16½	18	28	24
10	1	6	17	23	27	21
11	3	4	20	21	26.5	26
12	1	2	16	18	28	26
13	1	0	14	15	26	28
14	9	1	18½	16	24	25
15	2	1	20	17	26	27
16	12	13	19	18½	24	23
17	4	4	18	19	25	24
18	1	9	17½	21	26	24½
19	3	3	17	19	27	25
20	1	6	17	20	28	21
21	7	7	21	18	22	28
22	2	2	16	17	25	29
23	0	1	17	15	27	26
24	2	2	18	18	25	26
Means	3.37	3.5	17.8	18.1	25.3	24.2
Standard Deviations	3.08	3.57	1.86	1.62	1.88	2.24

TABLE IV

FISHER "T" RATIOS ON J.C.R. TEST
GIVEN TO BOTH GROUPS

	Pre JRC test to Post JRC test control group	Pre JRC test to Post JRC test ortho-pedic group	Pre JRC test control to Pre JRC test ortho-pedic	Post JRC test control to Post JRC test ortho-pedic
Pull up	.046	.061	.007	.050
Vertical jump	.002	.074	.026	.039
100 yard dash	.053	.146	.041	.050

Table IV, the J.C.R. test did not show any significant difference between the pre and the post test scores on any of the items of the J.C.R. test. It must by assumed that neither group improved in ability on these test items during the length of the study.

Since neither group made significant gains between the pre and post tests, it could not be expected that there would be significant differences between the two groups in performance on the post tests in the J.C.R battery. However, significant differences were computed, resulting in a confirmation of the assumption that true differences in the mean scores did not exist between the two groups. Neither group made more improvement that the other.

It is noted in Table IV that no significant differences existed between the two groups on any test item at the first test administration. From this and the similarities in age, height, and weight of the subjects, it may be assumed that the two groups were alike at the beginning of the study.

In order to determine the effects of being highly skilled, the raw scores achieved on the three test items on the first testing session on both groups were converted to sigma scale scores ranging from 0 to 100. In order to do this the following formula was used: Mean plus or minus three standard deviations over five (21:41-42). The highly skilled included boys with an average sigma scale score of 180 or above. The sigma scale scores of the groups are shown on Tables V and VI with a star in front of the total sigma scale score of the highly skilled. It can be observed that there were five from the control group and six from the orthopedic group who were considered highly skilled. The sigma scale score table is included in Appendix D.

Table VII shows the comparisons of the improvements of the highly skilled and non-highly skilled in both groups. It may be noted in examining this table that 100 per cent of the highly skilled in the orthopedic group improved on one or more of the test items with an average improvement of 2.2 inches in the vertical jump, .8 times in the pull up, and 1.4 seconds in the 100 yard dash in their raw scores.

TABLE V

CONTROL GROUP RAW SCORES AND SIGMA SCALE SCORES

Number of subjects	PULL UP Raw score times	PULL UP Sigma scale score	VERTICAL JUMP Raw score inches	VERTICAL JUMP Sigma scale score	100 YARD DASH Raw score seconds	100 YARD DASH Sigma scale score	TOTAL Sigma scale score
1	2	45	16	42	27.5	34	121
2	7	73	21	84	24.5	59	216*
3	3	51	19	68	32	0	119
4	7	73	16	42	27	38	153
5	0	0	15	34	29	21	55
6	2	45	19	68	29	21	134
7	5	62	20	76	24.5	59	197*
8	0	0	17	51	29	21	72
9	1	40	16	42	28.5	26	108
10	0	0	17	51	27	38	89
11	3	51	19	68	27	38	157
12	1	40	16	42	28.5	26	108
13	0	0	14	26	27	38	64
14	9	84	18.5	63	24	63	210*
15	1	40	18	59	25.5	51	150
16	11	100	18	59	24.5	59	218*
17	4	56	18	59	26	46	161
18	1	40	16.5	47	26	46	133
19	3	51	17	51	27.5	34	136
20	1	40	16.5	47	29	21	108
21	6	67	20.5	80	22	80	227*
22	2	45	16.5	47	25	55	147
23	0	0	17	51	27	38	89
24	2	45	16	42	27	38	125

TABLE VI

ORTHOPEDIC GROUP RAW SCORES AND SIGMA SCALE SCORES

Numb ber of sub- jects	PULL UP		VERTICAL JUMP		100 YARD DASH		TOTAL
	Raw score times	Sigma scale score	Raw score inches	Sigma scale score	Raw score seconds	Sigma scale score	Sigma scale score
1	0	0	15.5	38	27	38	76
2	13	100	17	51	23	71	222*
3	00	0	14	26	27	38	64
4	0	0	17	51	24.5	59	110
5	0	0	14	26	26.5	42	68
6	3	51	20.5	80	23.5	67	198*
7	0	0	14	26	28.5	26	52
8	2	45	16	42	27	38	125
9	2	45	15.5	38	25.5	51	134
10	5	62	21	84	23	71	217*
11	3	51	18	59	27	38	148
12	1	40	15	34	26.5	42	116
13	0	0	14	26	29	21	47
14	0	0	13	18	26	46	64
15	0	0	15	34	29	21	55
16	12	100	16.5	47	23.5	67	214*
17	4	57	17.5	55	24.5	59	171
18	8	79	19	68	25.5	51	198*
19	3	51	18	59	25.5	51	161
20	4	56	17	51	22.5	76	183*
21	7	73	17.5	55	28	30	158
22	1	40	16	42	29	21	103
23	1	40	15	34	26.5	42	116
24	1	40	18	59	26	46	145

TABLE VII

COMPARISON OF AVERAGE IMPROVEMENTS OF HIGHLY SKILLED AND NON-HIGHLY-SKILLED USING RAW SCORES IN J.C.R. TEST BATTERY

	CONTROL GROUP		ORTHOPEDIC GROUP	
	Highly Skilled	Non-Highly Skilled	Highly Skilled	Non-Highly Skilled
Pull up	1.0 times	.8 times	.8 times	.5 times
Per cent Improving	80	21 1/3	100	50
Vertical Jump	.6 inches	.5 inches	2.2 inches	1.6 inches
Per cent Improving	80	52 1/2	100	83 1/3
100 yard Dash	.5 seconds	.7 seconds	1.4 seconds	.8 seconds
Per cent Improving	80	72	100	77 7/9

In the highly skilled group in the control group, 80 per cent improved on one or more of the test items with an average improvement of .6 in the vertical jump, 1.0 times in the pull up and .5 seconds in the 100 yard dash in their raw scores.

In the non-highly-skilled in the orthopedic group, 100 per cent improved on one or more of the test items with an average improvement of 1.6 inches in the vertical jump, .5 times in the pull up and .8 seconds in the 100 yard dash in their raw scores.

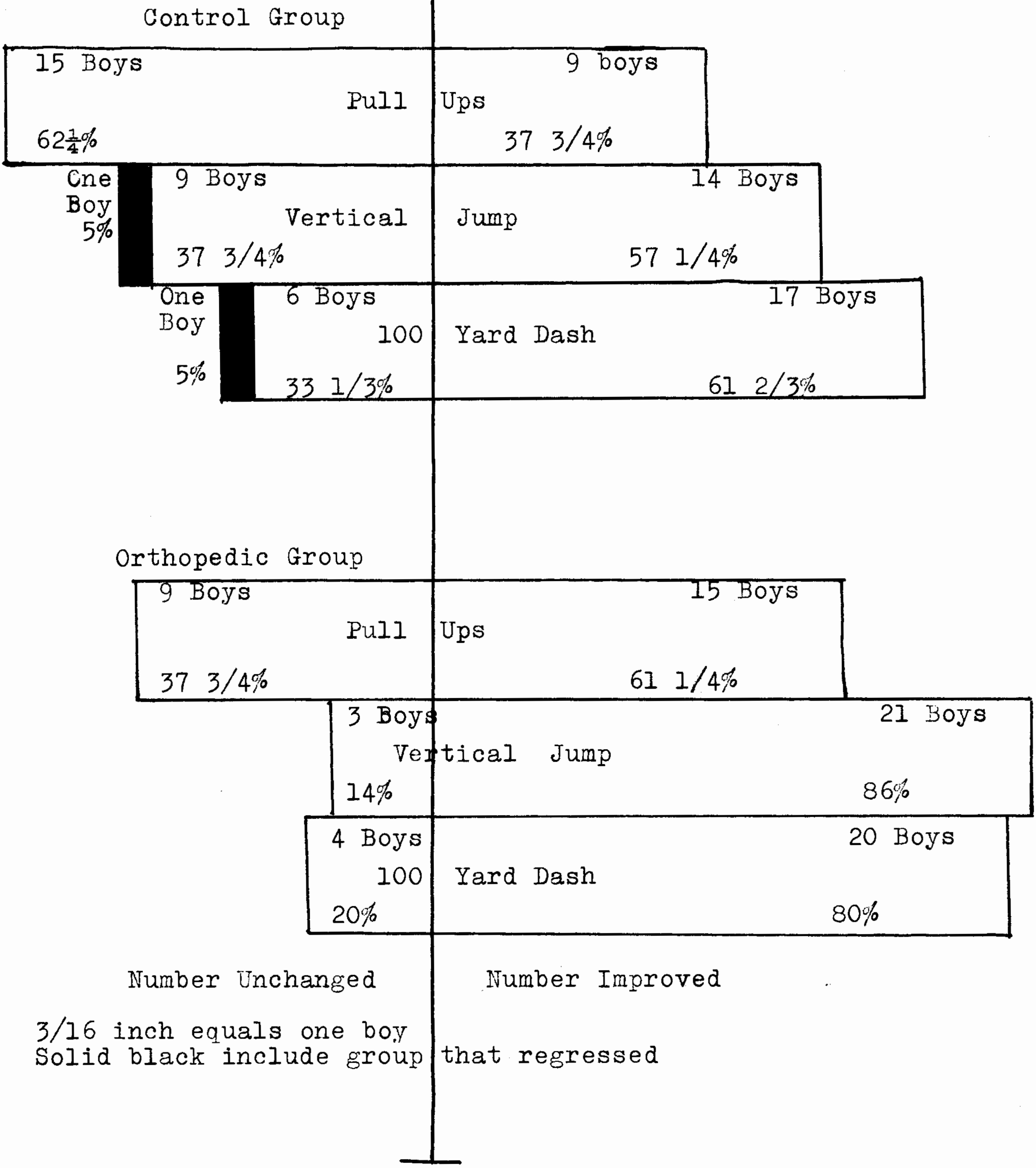
In the non-highly-skilled in the control group 95 per cent improved on one or more of the test items with an average improvement of .5 inches in the vertical jump, 13 times in the pull up and .9 seconds in the 100 yard dash in their raw scores.

It may be concluded that the number of boys improving on each item in the J.C.R. test and on the total test battery was higher among the orthopedic group even though the amount of improvement was not significantly different from the control group. Also, skill level, as determined by the sigma scale scores, did seem to be a factor in the per cent of boys making improvement, in each individual test item.

A graphic comparison of the performance of the two groups is shown in Figure 1. This shows the number of

Figure 1

Improvement of both groups in J.C.R. test



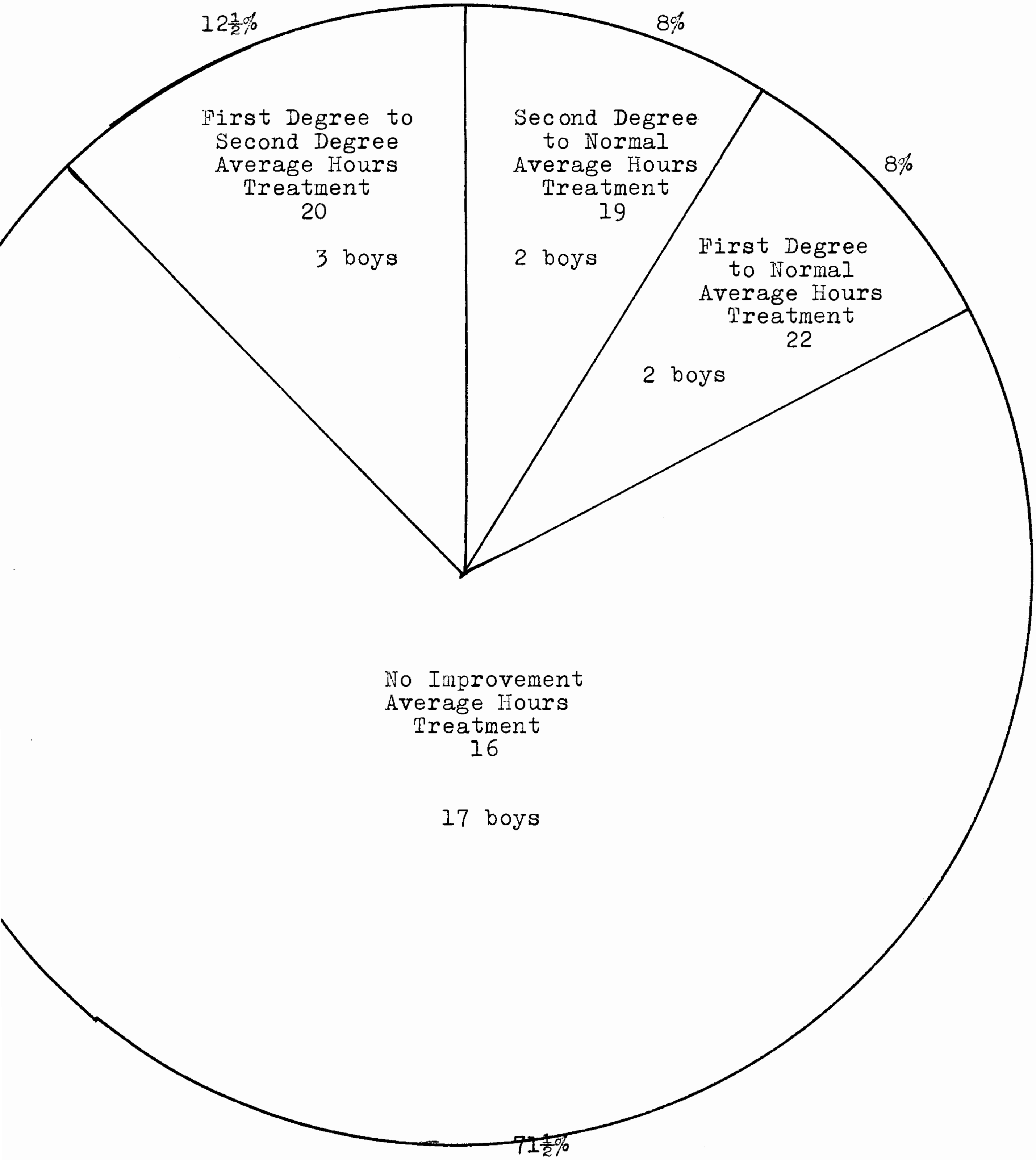
individuals improving or not improving in the J.C.R test battery. The orthopedic group had 80 per cent improvement in the 100 yard dash and 20 per cent of group unchanged, 86 per cent improvement in vertical jump and 14 per cent unchanged, and 62 and one-fourth per cent improvement in pull ups and 37 and three-fourths per cent unchanged.

The control group had 61 and two-thirds per cent improvement in the 100 yard dash, 33 and one-thirdper cent unchanged, with 5 per cent of group regressed; 57 and one-fourth per cent improved in vertical jump, 37 and three-fourths per cent improvement in pull ups with 62 and one-fourth per cent unchanged. Apparently in each test a greater number of boys showed improvement in the orthopedic group in each test than did the control group.

A tabulation was made of the status of foot deviation in the orthopedic group before and after the corrective exercise participation, The improvement was evaluated in terms of first degree to second degree to normal. Figure2 shows that 29 and one-half per cent of the orthopedic group showed some improvement. This graph also shows the average hours of participation in corrective treatment. The number of hours spent in treatment appeared to be related to the degree of improvement in foot deviations. Figure 2 indicates two boys improved from first to normal after spending

Figure 2

This graph indicates the per cent analysis of the orthopedic group with relation to the average number of hours treatment.



an average of twenty-two hours in the program. Two boys improved from second degree to normal after an average of nineteen hours of exercise, and two boys improved from first degree to second degree after twenty hours of exercise. The remainder of seventeen did not show improvement after spending an average of sixteen hours in the corrective program.

The number of hours spent in taking corrective exercises was correlated with improvement in the vertical jump in the J.C.R test in the orthopedic group. This correlation was plus .316. The method used is shown in Table VIII. Although low, the findings do represent a positive relationship between the number of hours spent in treatment and improvement in jumping.

TABLE VIII

RELATIONSHIP BETWEEN IMPROVEMENT IN VERTICAL JUMP AND HOURS SPENT IN TREATMENT OF PES PLANUS AND PRONATION

No. of sub-jects	Vertical jump improvement in orthopedic group multiplied by 6	Hours of treat-ment	No. of sub-jects	Verticall jump improvement in orthopedic group multiplied by 6	Hours of treat-ment
1	3	23	13	6	18
2	24	22	14	18	18
3	6	22	15	12	18
4	24	21	16	12	17
5	12	20	17	12	17
6	3	20	18	12	17
7	0	19	19	6	16
8	12	19	20	18	15
9	15	19	21	15	14
10	12	19	22	6	12
11	18	18	23	0	12
12	18	18	24	0	10

Mean of Vertical jump improvement x 6 = 10.9

Mean of Hours of correction = 18.3

* This relationship was found to have a correlation coefficient of + .316. This correlation was found through the Pearson "r" on ungrouped data.

CHAPTER V

SUMMARY AND CONCLUSIONS

This study was designed to determine the effects of a corrective exercise program on ninth grade boys with foot deviations and their performance on a motor ability test battery. To carry out the purpose of this study it was necessary to select an appropriate screening method to determine foot deviations and select the type of corrective treatment to be used. Also, it was necessary to select an appropriate motor ability test.

Concern over the increase in the growth of foot problems has increased among medical men over the past few years. The literature reviewed was limited to reports of opinions and recommendations regarding foot problems written by prominent physical educators and medical men.

The F.C.R. test was used in this study to measure motor ability. The scores on the J.C.R. test in motor ability of the control and the orthopedic groups were analyzed before and after corrective exercises were given to determine differences between the groups. The mirror test was used for determining the degree of foot deviation. A seven month period elapsed between the first (pre) and the last (post) tests during which the orthopedic group participated valuntarily in a corrective exercise program. Both groups participated in a regular physical education program throughout the seven month period.

Conclusions based upon the analysis of data are as follows:

(1) There was no significant change within the control group between the pre and the post tests, indicating that the physical education program did not seem to develop this group enough to show improvement in the areas included in the J.C.R. test battery. Lack of improvement may be accounted for by limitation in the physical education program. The physical education program for the ninth grade was limited to three sessions a week. The size of the classes ranged from thirty-five to forty students. Due to the climate of Elmendorf, Alaska, the activities were held inside except for three weeks during the year. The multi-purpose room used for the physical education program was much smaller than normal size gyms. In some activities many students would be forced to watch from the side lines. The calisthenics which are usually given a short time in the beginning of each period were omitted due to the lack of time for participation in the seasonal sports.

(2) There was no significant difference between the pre and post J.C.R. test results of the orthopedic group.

Perhaps the lack of improvement may be explained by the failure of the corrective exercise program to progress in difficulty or in number of repetitions. Apparently such a regimen does not produce any measurable strength changes if the vertical jump is a measure.

(3) There was a positive, though low, relationship between the hours of corrective exercise and improvement in the vertical jump. This relationship does not show up as a significant difference between pre and post J.C.R. tests, probably due to the small number who participated diligently enough to make improvement. It is possible that if all subjects in the orthopedic group spent the maximum twenty-two hours in the exercise program, then the mean score in the vertical jump may have shown a significant improvement for the orthopedic group on this last item.

(4) There was no significant difference in motor ability between the two groups on their post test scores. Since neither group made significant gains between the pre and post tests, it could not be expected that there would be significant differences between the two groups in performance on post tests in the J.C.R battery.

(5) The number of boys improving in each item in the J.C.R. test and on the total test battery was higher among the orthopedic group, even though the amount of improvement was not significantly different from the control group.

(6) The skill level, as determined by the sigma scale score, did seem to be a factor in the per cent of boys making improvement in each individual test item.

The study might have had more significant changes had more time been spent in corrective exercise treatment. A special class in school time would create a better situation for improvement.

This study was very beneficial to the students, ma king them more conscious of their foot defects. In some cases it was the first time the parents had been aware of the defect in their child.

It was found in research in this field that many studies are done in the field of postural defects in general, but not foot defects specifically.

Although it is believed that this research is reliable, valid, and free from bias, the results are possibly misleading due to the lack of adequate control of the variables involved. It is, therefore, recommended that the results of this study be verified by further study of the effects of a corrective exercise program on foot deviations and relationships between foot deviation and performance in which the corrective exercise program is controlled in elements of time, difficulty, and progression.

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APPENDIX

APPENDIX A

CORRECTIVE EXERCISES

Technique of exercising may be either active or passive, weight bearing or non-weight bearing. Exercises recommended in common by Stafford, Rathbone, and Kelly are as follows: (27:190-195, 22:31-34, 15:167)

A. Fundamental Non-weight bearing Passive Exercises.

1. Position: Student sits on a chair. Instructor grasps the ankle of the student with the left hand, the foot with the right.

   Action: Instructor slowly moves the foot in
   a) Plantar Flexion
   b) Inversion
   c) Dorsal Flexion

   Remarks: The movement is carried as far as possible without causing pain.

B. Fundamental Non-weight-bearing Resistive Exercises.

2. Position: Same as in Number 1.

   Action: Same as in Number 1 except that the student resists the movement.

3. Position: Student sits on chair. The outer side of his right ankle is resting on his left knee.

   Action: Right foot is adducted against the resistance of his own or the instructor's hand.

C. Fundamental Non-weight-bearing Active Exercises.

4. Position: Student sits on chair or stool. Both legs are straight, and the heels rest lightly on the floor. The feet are slightly adducted.

Action: (1) With the knees straight, the feet are plantar flexed and the soles inverted until they almost face each other. (2) The feet are now dorsi-flexed and an attempt is made to keep the soles inverted.

Remarks: The knees must be straight throughout the exercise.

5. Position: Same as Number 1 except that the student performs by hisoown power and volition the three movements of plantar flexions, inversion, and dorsal flexion.

6. Position: Student sits on chair or stool. The feet are flat on the floor and parallel. The knees are bent at a right angle.

   Action: 'Ground Gripping' movement as follows: The student plantar flexes the toes of both feet, keeping the heels in the original position and attempting to raise as high as possible the arches of the feet.

   Remarks: The Tibiallis anticus (outer side of the front of shin bone) will respond strongly in this movement. The student should be told of the advisability of his performing this valuable exercise whenever possible.

7. Position: Same as Number 6.

   Action: (1) The student places a marble six inches to the outside of the toes of the left foot. (2) He reaches over with the right foot and picks up the marble with the toes of the right foot. (3) Keeping the right foot to the left of the body, he slowly raises the right foot to the outside of the left knee where the marble is placed in the waiting left hand. (4) He repeats, using left foot to pick up the marble from the outside of the right foot.

   Remarks: The foot which remains on the ground must be kept in the correct foot position. This exercise is especially good for metatersalgia.

8. Position: Student lies on back on floor. The legs are flexed at right angles to the floor.

<u>Action</u>: The instructor tosses a tennis ball which the student catches with the soles of his feet. The catch is made by a slight bending of the knees and inversion of the feet.

9. <u>Position</u>: Student lies on back on floor, hands under head.

   <u>Action</u>: (1) He raises the right leg, with knee straight and foot inverted and dorsi-flexed, to a position at right angles with the body. He exhales. (2) He lowers leg to floor, pauses, and inhales. He repeats with the other leg.

   <u>Remarks</u>: Progression can be given by keeping both heels about a foot off the floor and alternately raising and lowering legs.

10. <u>Position</u>: Student sits on floor, arms folded on chest.

    <u>Action</u>: He alternately flexes and extends knees, keeping both feet in a position of adduction, inversion, and dorsal flexion.

11. <u>Position</u>: Student lies on back.

    <u>Action</u>: (1) He alternately dorsi and plantar flexes the feet as the heels are slowly drawn toward the buttocks. (The toes a re held in plantar flexion throughout this part of the movement.) (2) Using toes as fulcrum (feet slightly toes in) he pushes the heels toward the toes. (3) He keeps heels in position and extends toes forward. (4) He repeats action Number 2 and Number 3 alternately pushing heels toward toes. He continues. At this point the student urges to 'grip with the toes and push the heels toward the toes'.

D. Fundamental Weight-bearing Exercises.

12. <u>Position</u>: Correct standing position, except with feet four inches apart.

    Action: Roll the weight of the body to outer borders of the feet, plantar flex the toes, and hold for thirty seconds. Relax to a normal weight bearing position, and repeat.

13. <u>Position</u>: Same as Number 12.

<u>Action</u>: Keeping the knees straight throughout the movement, rotate the thighs and the lower legs outward, and plantar flex the great toes.

<u>Remarks</u>: Emphasize to the student the necessity of feeling the tibial muscles: "Lift you by your boot straps."

14. <u>Position</u>: Correct standing position.

<u>Action</u>: Walk with the body in good position and feet inverted and adducted.

<u>Remarks</u>: The walk will be stilted at first. Emphasize the necessity of getting 'spring' into the walk. Progression is then made by giving the correct 'heel and toe' walk.

15. <u>Position</u>: Same as Number 14.

<u>Action</u>: Grip step. Grip with the toes as the forefoot meets the floor.

<u>Remarks</u>: This is called 'Ground gripping walk'. A toe and heel exercise or goose step can be used as a preliminary to this exercise.

16. <u>Position</u>: Same as Number 15 except that the feet are ten inches apart. The forepart of the right foot adducted and resting on the nearest end of a towel.

<u>Action</u>: With vigorous plantar flexions and adductions of the right foot, the towel is drawn toward the left foot. Repeat with the left foot (drawing towel toward right foot).

<u>Remarks</u>: The heel is the pivot for the active foot. The knee is held straight, and the knee-cap must not turn inward. All the movement is done at and below the ankle. Progression can be made by placing a weight on the further edge of the towel.

17. <u>Position</u>: Standing on the right foot, which is in the correct weight bearing position. The left foot rests, at the base of the metatarsal bones, on the rung of a chair.

18. Position: Standing on the right foot, which is in the correct weight-bearing position. The left foot rests, at the base of the metatarsal bones, on the rung of a chair.

    Action: Plantar flex the left foot, curling the toes downward and around the rung of the chair.

    Remarks: Progression can be given by (1) having the student move the chair forward and backward while the toes grasp the rung, (2) by bending the knee (one-half squat) of the supporting leg while the other foot is grasping the chair rung.

19. Position: Correct standing position, except with slight exaggeration on adducted position of the feet.

    Action: Execute a full squat (very slowly), and keep heels on floor.

    Remarks: The knees are spread, and the adducted position of the forepart of the feet is maintained as the squat is executed.

20. Position: In front of ladder.

    Action: Climb ladder. Weight of body is borne on the balls of the feet. The feet are turned slightly inward (adduction) (25:191-194).

The muscles to be strengthened in these exercises are: (1) Posterior Tibial, (2) Long and short Toe Flexors, and (3) Lumbricales and interossi.

The muscles to be stretched in these exercises are: (1) Gastrocnemius, (2) Soleus, and (3) Peroneal group.

APPENDIX B

J.C.R. TEST BETTERY

Item One: Vertical Jump

Procedure. The subject stands with one side to a vertical wall and, with both feet flat on the floor, he reaches as high as he can with the hand nearer the wall. This height is marked. The subject then moves comfortably away from the wall and jumps, again reaching up the wall as high as he can. This second height is marked. This second height is marked and the difference between the maximum standing reach and the maximum jumping reach is recorded to the nearest one-half inch. Jumping is done from a hard and level surface which assures good footing.

Scoring. The difference to the one-half inch between the standing reach and jumping reach is the performance record. The Best jump of three trials is recorded.

Points to observe. (1) That the subjects standing reach is his maximum; (2) that no extra hop, step, or jump is taken before the jump.

Item Two: Chinning

Procedure. The subject hangs from a horizontal bar and pulls himself up until the arms are straight. He is not permitted to kick, swing, or to rest. He continues at a moderate rate of speed to do the movements as long as possible. The forward grip (back of hands toward face, palms forward) is used.

Apparatus. Chinning spaces was constructed by running one or one-and-a-quarter-inch pipe through four-inch by four-inch posts arranged in a straight line. The spaces were from three to four feet wide and the bar eight feet above the ground. Steps were provided at each bar for those unable to jump and reach the bar easily.

Scoring. One for each chin. Partial or fault chins did not count but the subject may continue, and proper chins counted. Any swinging or movement of the legs was stopped by the examiner in such a way, however, that the subject is able to continue. The count was given audibly.

Points to observe. (1) That the subject starts from a full-hand and not from a jump; (2) that the subject comes to a full-hand but does not rest between chins; and (3) that the subject does not kick, swing, or rock up.

Item Three: Shuttle Run

Procedure. The subject runs 100 yards over a ten-yard course; that is, he runs ten yards, makes a 180 degree turn, and returns to the starting line. He makes another 180 degree turn and continues for five complete round trips. Runners may turn in either direction but must touch the bankboard in making the turns.

Scoring. To facilitate timing, several runners in each heat, the subject's time was recorded in half-seconds; 21 seconds represents performance from 21.00 through 21.49 seconds, 21.50 from 21.50 through 21.99, etc. Subjects not touching the bankboards at either end are required to stop, rest a short time, and re-run the event.

Points to observe. (1) That runners stay in their own lanes and are encouraged to go 'all out' for the complete distance; (2) that bankboards are used from which to 'spring' and not to 'bounce'; and (3) that runners are given a few lengths in practice before running for time (21:12-29).

APPENDIX C

METHODS OF SCREENING FOR FOOT DEFECTS

For the most part, test of foot measurement represent attempts to measure functional foot efficiency. The multitude of foot complaints by adults has provided impetus to the search for measures of foot function. The following are a few of the tests used.

Iowa Posture Test. The Iowa Posture Test represents an attempt to measure dynamic as well as static posture and is comprised of subjective rating of six functional conditions; foot mechanics, standing, walking, sitting, stooping, and stair ascending and descending. The various factors comprising each condition are rated either 3, 2, or 1 as being a good, fair, or poor manifestation respectively, of the item in question. The test procedure follows:

1. Foot mechanics test. Each subject walks first forward ten steps and back while the tester stands at the side and then toward the tester and back. The teacher or tester makes three separate ratings under foot mechanics; (a) heel-toe walking (first walk), (b) absence of pronation (second walk), a nd (c) feet parallel (second walk).

2. Standing-position test. Viewing from the right side of the subject, the tester makes a rating of correct alignment of body segments and notes on the chart any deviations from the normal.

3. Walking Test. As the subject walks around a set course, the tester rates two factors from the side view, namely, correct alignment of body segments and weight distribution. The manner of weight carriage is noted on the chart as forward or backward.

4. Sitting Test. The tester rates two factors in this test: sitting position and rising from sittling position. In checking the former, and as the subject leans forward about 30 degrees. The second rating is given upon observing the carriage in rising from the chair and walking a few steps.

5. Stooping to pick up light objects. Each subject is rated on the way in which a small object is picked up and returned to the floor.

6. Ascending and descending stairs test. The carriage of the testee is rated during ascent and descent of eight to ten stairs.

Washington State College Test. Washington State College employs a screening test and a functional posture appraisal resembling the Iowa Test somewhat. The screening test purports to discover students needing a more detailed examination. By means of a check list, the examiner subjectively rates antero-posterior and lateral balance; alignment of the feet and legs in the standing position; as well as efficiency of the gait as observed from the side, back, and front. In addition to observation of standing and walking postures, this appraisal includes being seated, sitting, and rising from a chair; ascending and descending stairs; lowering and skipping rope. Ratings on a four-point scale are recorded on the score card. The functional appraisal is intended for use in conjunction with special body mechanics classes or medical referral of students, or both (19:272-275).

An army procedure of examination which ca n be used to handle a large number in a short space of time is as follows:

An incline twenty feet long leads to a platform four feet square and about three feet six inches from the ground. Seated facing the platform and the incline are two doctors. The men to be examined walk up the incline and come to a halt on the platform. The doctors note, during the men's ascent of the incline, the use of the feet. As the man reaches the platform, further examination is made as to the musculature, pain range of motion, etc. A quick classification based on foot function is possible by this means (27:184).

APPENDIX D

SIGMA SCALE SCORES ON TOTAL ORTHOPEDIC AND CONTROL GROUPS

Scale Score	Pull Ups Times	Vertical Jump Inches	100 Yd. Dash Seconds
100	11.90	22.90	19.60
90	10.10	21.70	20.80
80	8.30	20.50	22.00
70	6.50	19.30	23.20
60	4.70	18.10	24.00
50	2.90	16.90	25.60
40	1.10	15.70	26.80
30	____	14.50	28.00
20	____	13.30	29.20
10	____	12.10	30.40
0	____	10.90	31.60

(19:41-42)