THE EFFECTS OF CERTAIN FITNESS PROGRAMMES
UPON THE CARDIO-VASCULAR AND MUSCULAR
STATUS OF BUSINESS MEN

by

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF PHYSICAL EDUCATION
in the School of
PHYSICAL EDUCATION
AND
RECREATION

We accept this thesis as conforming to the required standard:

THE UNIVERSITY OF BRITISH COLUMBIA
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Date March 29, 1962
ABSTRACT

The purpose of this study was to determine the effects of a circuit training and a calisthenics programme on the cardio-vascular and muscular strength of business men.

Sixty-three business men from the Vancouver Central YMCA and the British Columbia Electric Company were used as subjects. Forty-two subjects from the YMCA were equated into two experimental groups, while twenty-one British Columbia Electric employees acted as a control group. Following the initial tests, Experimental Group I underwent a programme of calisthenics while Experimental Group II took part in a programme of circuit training and the Control Group was restricted from physical activity. At the end of the eight week period, the three groups were retested in the same manner.

Both Experimental Group I and Experimental Group II averaged gains in performance that were statistically significant for the cardio-vascular and muscular strength tests. No statistically significant gains were obtained for the Control Group. The improvement of Experimental Group I significantly exceeded the improvement of the Control Group, but did not significantly exceed the improvement of Experimental Group II in the muscular strength test. The improvement of Experimental Group II significantly exceeded the improvement of the Control Group but did not significantly exceed the improvement of Experimental Group I in the muscular strength test.
There was no statistically significant improvement between the experimental groups in the cardio-vascular test.

It was concluded that both the calisthenics and the circuit training programme, as used in this study, are effective methods of improving the cardio-vascular and muscular status of business men.
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CHAPTER I

STATEMENT OF THE PROBLEM

One of the major objectives of YMCA physical education has been defined by Hamlin (1), in a recent YMCA survey, as being to promote physical fitness through programmes which develop bodily strength, motor co-ordination, endurance, organic power and vitality.

At the Central YMCA in Vancouver, British Columbia, the fitness activities that a member may select include swimming, handball, squash racquets, track, volleyball, basketball, weight training, sport judo and calisthenics.

One of the most popular classes for businessmen is the calisthenics programme conducted by the various staff members. Brewer (2), in a national survey, found that the most frequently mentioned activity for men was a calisthenics programme. This type of approach to the fitness of businessmen has been traditional in the YMCA. Although the presentation of the exercises may differ, the basic idea of group calisthenics remains the same.

Through the above type of programme, the YMCA attempts to improve and maintain the physical fitness of its members.

Another programme which could be utilized by the YMCA for its businessmen is that of "Circuit Training". Circuit
training aims to improve the following components of physical fitness (3):

a. Muscular strength.
b. Muscular endurance.
c. Circulo-respiratory endurance.
d. Muscular power.

This study will investigate whether the physical fitness of businessmen at the Central YMCA in Vancouver, British Columbia, will be increased more by a forty-five minute period of circuit training or by a forty-five minute calisthenics programme conducted twice weekly over an eight week period.

Delimitations:

1. This study will deal with two businessmen's classes at the Vancouver Central YMCA.

2. The experiment will be conducted over an eight week period.

3. The subjects will have completed three months of their regular programme of calisthenics before the experimental period begins.

4. The elements of physical fitness to be studied will be those measured by the Larson Muscular Strength Test and the Harvard Step Test.
REFERENCES


CHAPTER II

JUSTIFICATION OF THE PROBLEM

The typical middle-aged man in business is often subject to rapid physical deterioration because of sedentary living habits, which may lead to poor circulation, nervous tension and an overweight condition. The indoor office worker is especially subject to a loss of physical fitness mainly due to lack of exercise (1).

Steinhaus (2) states that the weakness of modern man in society has been caused by today's labor-saving devices, which utilize muscles as little as possible. He says that the resulting muscle weakness shows in three places (2).

First, hands, arms, shoulders and upper trunk muscles. Consequently, their chins protrude and shoulders sag. Second, weak abdominal muscles accented by a layer of fat allow the pelvis to sag. This tips the spine forward in the lower back, and the resulting sway-back invites low back pain. Third, many people have weak, aching and deformed feet so they cannot enjoy movement of any kind.

The R.C.A.F. (3) in its "5BX Plan" states that:

Mechanization, automation and work saving devices to make life easier are depriving us of desirable physical activity. Canadians, as a result, are in danger of deteriorating physically despite the high standard of living.

With numerous authors deploring the physical fitness of modern man, many leaders in the field of physical education have expressed the need for research in this area. McCloy (4)
stated that there is, in spite of large amounts of health knowledge at the time, much to be studied as to the best methods of achieving and maintaining physical fitness.

In a statement on physical fitness prepared by Broer for a meeting of the American Association for Health, Physical Education and Recreation in 1956, she stated that among the research studies needed are those, "...to determine the changes in levels of fitness accompanying various types of activity programs" (5).

With the concern of the fitness of businessmen in mind, Jokl (6) has assembled evidence which indicates that people who are continuously active will maintain exceptional athletic performance well into their sixties, and will exhibit exceptional performance in lesser activities even beyond that age.

According to Norris and Shock (7) this leads us to consider the possibility that older people who have become inactive, and by that token incapable of even the normal every­day activities, might, with proper motivation, be retrained to conduct their everyday routine.

With this type of information being distributed to the general public, an increased awareness of the improvement of body health has influenced numerous businessmen to join organizations conducting keep fit programmes.

These programmes usually take the form of calisthenics or weight training exercises. Various types of fitness tests
are sometimes given at the beginning and the end of the individual's activities.

Calisthenics are exercises in which no barbells, dumb-bells, accessory equipment or any other devices are used. They are used for stretching, limbering, warming up and improving muscle tone.

The great disadvantage of calisthenics or free standing exercises is that progression in strength, stamina and actual bodily development is limited. There are, of course, countless exercises, but the range of progress is limited. The only way to progress is by increasing the number of times the same exercise is done, and this often leads to fatigue and monotony. Calisthenics are of little value in body building because in order to build muscles it is necessary to exercise these muscles against continually greater resistance (8).

Weight training is a programme of progressive resistance used to develop strength, power and endurance. Some of the disadvantages of this type of programme are the length of time needed and the amount and cost of equipment required.

According to Capen (9) in a study on the effect of systematic weight training on power, strength, and endurance, there were no significant differences between a weight training and a conditioning class in the improvement in muscular endurance or in circulo-respiratory endurance.

In recent years, a new form of fitness training, circuit training, has developed in the British Isles. Circuit training
may eliminate many of the disadvantages of calisthenics and weight training. Circuit training aims to increase cardio-respiratory endurance, muscular strength, muscular endurance and muscular power; to provide a daily self-evaluation chart for individuals to follow; and to allow each individual to develop towards his maximum capacities at his own rate (10). However, as yet there is no scientific evidence concerning the effect of a circuit training programme on older people.

One of the values of circuit training is its adaptability to different gymnasiums or club facilities, as it may be designed with or without equipment, and can be modified to operate in almost any reasonable area.

If a programme of circuit training improves the physical fitness of businessmen, and provides an adequate measure of self-evaluation by measuring daily improvements, then the results could have a significant influence on present methods of conducting businessmen's "keep fit" classes.
REFERENCES


2. Steinhaus, A. H., How to Keep Fit and Like It, Dartnell Corporation, Chicago, 1957, p. 6.


CHAPTER III

REVIEW OF THE LITERATURE

Physical fitness has been a consistently accepted objective of physical education throughout the history of the profession. Not a little of the difficulty in measurement in this area had been due to the lack of a concise and generally accepted definition of the term physical fitness (1). Sheele suggested a cause for the difficulty of finding a perfect definition of fitness by saying (2):

Health and fitness are invisible characteristics of the individual being; but they are also rather abstract concepts which even experts find difficult to express in concrete terms...one reason for this difficulty may be that we do not always keep in mind the important factor of change. The ever changing life processes create within the individual an ever changing ideal of fitness.

The report of the Baruch Committee on Physical Medicine (3) serves to clarify, though by no means solve, problems of measurement of physical fitness.

This committee recognized (4) that: "Physical fitness is a complex concept difficult to define and more difficult to measure, but one which in its most useful form must evaluate the total individual". It is the committee's concept that (5) "...the only final test of fitness seems to be the ability to perform the task desired without undue fatigue or exhaustion, and the qualities making this possible are those of the total personality". In other words, (6) "Physical fitness describes
the functional capacity of the individual for a task. It has no real meaning unless the task or job for which fitness is to be judged is specified.

Others agree in whole or part with the committee's findings. Karpovich (7), for example, defines physical fitness as, "A fitness to perform some specified task requiring muscular effort".

Steinhaus (8) defines fitness in four parts:

a. A body free from disease.

b. Muscles, heart, and lungs developed to give strength, speed, agility and endurance, to do easily the tasks of each day.

c. An alert mind - free from undue worry, fear or tension - that can relax completely with the moment of opportunity and as quickly be engrossed in the next challenging task.

d. A spirit that feels itself unselfishly part of an important venture and important to that venture.

Morgan and Adamson state (9) that it is commonplace nowadays to observe that fitness can have no meaning except in relation to a specific task. The fitness required by the foundry worker differs from that of the ballet dancer or the long-distance runner. Yet, the idea of a general condition of fitness which will be reflected in performance at any task involving strenuous physical work has always been accepted by active people. It may be of secondary importance to the highly specialized performer whose existence is organised for maximum efficiency for one type of activity, but it is essential to the
man who wishes to give a good account of himself in varied and unforeseen circumstances and to enjoy a wide variety of active pursuits.

Gallagher, et al, stated (10) that there are three kinds of physical fitness: static or medical fitness, which is "soundness" of the organs of the body; functional or dynamic fitness, which is the efficiency of the body during strenuous work, and motor skills' fitness which is related to muscle co-ordination and strength in performing specific activities. These three aspects of physical fitness are inter-related and are all the concern of the physical educator.

The American Association for Health, Physical Education and Recreation concluded (11) that:

Fitness is that state which characterizes the degree to which the person is able to function...It implies the ability of each person to live most effectively within his potentialities. Ability to function depends upon the physical, mental, emotional, social and spiritual components of fitness, all of which are related to each other and are mutually interdependent.

McCloy (12) listed the components of physical fitness as the hereditary quality of the vital organs, good health, good hygienic habits, physical conditioning, endurance and flexibility.

Clarke (13) refers to physical fitness as:

The development and maintenance of a sound physique and of soundly functioning organs, to the end that the individual realizes his capacity for physical activity, unhampered by physical drains or by a body lacking in physical strength and vitality.
La Salle states (14) that the trained individual results from vigorous physical activity. The heart of a trained individual nourishes the cells, carries away waste products more effectively and serves the individual better in his day-to-day living, than does the heart of an untrained person.

Although many physical educators deplore the use of the term "physical" fitness on the basis that fitness cannot be achieved by the development of any one of its components but rather can be achieved only by a simultaneous development of all its components, physical fitness is used to imply the following two items (15):

a. Alleviation of hereditary or of acquired physical ailments. There is little that can be done to remedy many hereditary shortcomings. Persons who acquire disabilities can, however, frequently be helped by medical science.

b. Development of physical efficiency. Persons who function physically at a high level of efficiency are said to be in "good condition", "in excellent training", or "physically fit".

Morehouse (16) stated that the word fitness has been used to describe "...the adequacy of interactions of organisms with environments".

It can be seen that definitions may vary, but the term physical fitness implies a degree of muscular strength, endurance, and power (17) as well as cardio-vascular endurance (18).

Muscular strength has been defined (19) as:

...the ability to sustain a muscle force, although the absolute strength of body musculature cannot be measured.
Strength of the muscles can be developed only by exercising them against gradually increasing resistance such as pulling or pushing springs, lifting weights and by moving the body at increasing speed. The gain in strength is more striking than the hypertrophy of the muscle: it is possible to increase the strength of muscles three times or more without a proportional increase in volume (20).

Endurance may be considered as the ability of the body to withstand the stresses set up by prolonged activity (21). Factorial techniques of analysis have resulted in the isolation of four factors in endurance: circulo-respiratory, velocity, muscular structure and body build (22).

Dawson (23), serving as his own subject, conducted experiments from age 41-71 using a bicycle ergometer to perform the heaviest work load that could be accomplished in thirty minutes. The conclusions obtained were that endurance drops precipitously with age. Dawson's findings have been corroborated by Simonson (24,25) who found that the running endurance of eleven men of average age fifty-three was about half that of twenty-five men of average age thirty-three.

Muscular power has been defined (26) as:

The ability to release maximum force in the shortest period of time. Power = Force x Velocity. Speed and force must in this instance be combined for effective performance. Thus a powerful person is an individual who has:

a. A high degree of muscular strength.
b. A high degree of speed.
c. A high degree of skill in integrating speed and muscular strength.
For many years, physiologists have attempted to analyze cardio-vascular responses in order to determine (27):

1. Present status of health.
2. Condition of the heart.
3. General physical condition.
4. Basal metabolic rate by indirect measurement.

The concept that physical exercise may be a "protective" factor safe-guarding the middle aged from the ravages of cardio-vascular disease is not new (28); however, most investigations of this problem were initiated only recently.

Programme. Many studies have been undertaken in an effort to evaluate the ideas expressed by leaders in the field of physical education with regard to the kind of programmes that might best contribute to the development of physical fitness.

A statement by the American Association for Health, Physical Education and Recreation calls for a varied programme by stating (29):

Throughout man's history he has been an active organism. Organically he was, and still is, designed for vigorous activity. Man's biological design has not changed, he is still meant to be an active, not a sedentary creature. Modern man is, therefore, confronted with a critical choice. Either he includes valid health information and vigorous physical activity in his life or he suffers inevitable losses. If he chooses to remain fit, he must elect those practices and activities that will lead to this end.

In an article by Kidder (30) the author warned physical educators not to think of fitness in terms of physical fitness
alone. In itself, the physical is just a means to an end, and that end is total fitness "...we need to promote the efficiency of existing programs and launch additional ones" (30).

Two thoughts in regard to programme content were offered by Kendall in 1943. He stated that (31):

The needs of the body in regard to strength and flexibility, as well as the accomplishment of well balanced muscular strength are best accomplished by a carefully planned exercise program as differentiated from an activity program.

In 1957 it was suggested that (32): "a program to increase physical fitness should include activities that will develop strength, endurance, organic efficiency, flexibility, and neuromuscular efficiency."

In discussing the values of a conditioning exercise programme on the elements of physical fitness, Broer stated (33) that:

...this type of program alone does not lead to the development of specific skills necessary to a high level of fitness in this civilization; its chief contribution is to the organic objective of physical fitness. It seems obvious that a varied program will be necessary if all-round fitness is the goal.

Review of Various Studies. In a study by Brouha, et al (34), the Harvard Step Test was used to measure the physical efficiency of college men. The preliminary test results showed:

10% - poor condition
55% - average condition
24% - good condition
11% - excellent
All students participated in a conditioning exercise programme. As a result of this programme the lowest students improved their physical fitness, but the tendency was for the students whose scores classified them as good or excellent, to show a poorer score on their second test two or three months later. This indicated that, although the programme was adequate for the unfit, the already fit needed harder or more strenuous activity to maintain or improve their previously attained level.

Wilbur (35) studied the gains in physical fitness made by college men in two physical education programmes, the apparatus and the sports programme. From the results, it was concluded that the sports method was superior to the apparatus method for improving physical fitness.

Nunney (36) instituted a six week programme of circuit training to study the relationship between circuit training and the improvement of endurance, speed, weight, and strength of swimmers, using an exercise circuit of:

1. Two-arm curl - 45 lbs.
2. Bounce jumps with knee lift at stall bars.
4. Leg Press - 180 lbs.
5. Two-arm Press - 150 lbs.

Nunney concluded that the experimental group made significant gains in swimming endurance and speed, weights, chins, and push-ups, but did not improve significantly in dips
or vertical jump. The evidence appeared to justify the generalization that it is possible to combine a circuit training programme with a swimming programme without detrimental effect on swimming improvement. Furthermore, the gains in swimming endurance and speed made by the experimental group suggested that this combination was beneficial.

The findings of this study supported the evidence of previous studies reported in the Research Quarterly (37,38,39, 40,41,42,43) concerning progressive resistance exercises. There was no significant evidence to show that weight training was in any way detrimental to athletic performance.

Exercise For the Middle-Aged Man. Popular periodicals abound with articles in which opinion varies to the extent that the aging process can be decelerated by a rigorous programme of exercise to one which advises that even moderate exercise can be detrimental to good health (44). It has been implied that many people feel a compulsion which might be brought on by fear of the detrimental effects of exercise (45); Steincrohn (46) "believes that the force of self-destruction is the motivator which makes the middle-aged person exercise."

There are contrary opinions as to whether people should exercise in middle age. Stiegletz (47) has summarized these opposing views:

One concept postulates that involutional degeneration results from exhaustion and depletion of reserves by
living and the wear and tear of existence. In opposition is the theory that the atrophies of senescence are due largely to disuse, that structural involution follows diminution or cessation of functional work. In the simplest terms in which these two opposing concepts can be stated, we either wear out or rust out. The known facts support both ideas.

The question as to what kind and amount of exercise is best suited to the "average" middle-aged person is not easily answered. It would seem that most middle-aged persons may profitably engage in activities provided that the intensity and duration of the activity are realistically adjusted to their physical condition at the time (48). With this in mind, the programme should be developed as a result of systematized knowledge based on verifiable general laws (49).

If the physical education programme is to contribute significantly to the improvement of physical fitness, emphasis should be placed especially on those individuals who are deficient in basic fitness elements. We cannot assume that participation in the "regular" physical education programme, no matter how well organized, will automatically increase the level of fitness for those who are below average. The most satisfactory programme would be one that is progressive and takes into account individual differences (50).

Clarke (51) suggested the following principles as a guide in developing an exercise programme for the low fitness individual:

a. Physical activities should be adapted to the individual's exercise tolerance. Such indicators as pronounced discomfort during
exercise, slow recuperation after exercise, especially sore muscles and the like help in determining this level.

b. "Overloading" a muscle induces a higher level of performance. In overloading, the muscle works with greater intensity, or for a longer time than normally; dosage should be increased within the individual's exercise tolerance.

c. The activity programme should provide for gradual progression in order systematically and consistently to improve the individual's fitness.

d. A steady effort should be made to advance the individual's psychological limits of effort, as psychological tolerance for strenuous exertion is usually reached long before physiological limits are approached.

e. The type of body exercised should be taken into account; as, generally speaking, the endomorph is phlegmatic, the mesomorph likes exercise and the ectomorph fatigues easily.

Circuit Training. For several years after the second world war, two English university physical education teachers tried, without success, to discover a form of general fitness training which would attract and hold the interest of students attending Leeds University. Although the students were interested in games and skilled athletic activities, no physical training programme seemed to hold them.

The lack of interest in physical education, on the part of the students, posed a challenge to Morgan and Adamson. From this challenge they developed circuit training, a programme that would attempt to encourage all-round fitness rather than fitness required for any particular activity or game. Although
circuit training was designed to meet the needs of university undergraduates, there is no doubt that with modifications it can be made to serve other purposes (52).

Circuit training has the following features that make it adaptable to a developmental programme (53):

a. The participant starts off easily and is able to experience some degree of success early in the programme.

b. The participant is one of a class, but is not asked to do anything beyond his own capabilities each day.

c. The participant, when ready, progresses to an individual circuit, based on his maximum performance.

d. The participant works inconspicuously among the other class members and is free from continuous direction from the instructor.

e. Large numbers can work at the same time.

f. The circuit selected should have a positive effect on muscular power, muscular endurance, strength and circulo-respiratory endurance.

g. The exercises are easily standardized, so that the participant is able to perform the same way each day (54).

h. The participant knows exactly how he progresses each day. He can set a daily goal and objectively
see how he is progressing toward the target time.

i. Circuit training is based on the work rate of the individual and employs the principle of "progressive loading", which is the same as the overload principle. However, in circuit training, one does not increase the resistance, but decreases the time it takes to perform the circuit, plus increasing the number of repetitions per exercise at specific times.

This same principle is stressed by Steinhaus (55) in his summary of research on strength:

Second, no matter how much a muscle is used, it will not grow larger or stronger until it is overloaded. This means that the intensity of the work required of it must be increased above that to which it is currently accustomed, i.e., it must be required to exert more power (foot pounds per minute) or work against greater resistance than before.

To outline the circuit procedure in more detail, the essential features (56) are as follows:

1. A number of exercise stations are set up in a consecutive pattern around the gymnasium. The length of time required to perform the exercise at each station should be approximately the same, so as to avoid crowding up or "bottle-necks".

2. The specific exercises to be performed at each station will depend on the conditioning effects sought.

3. While the exercises remain essentially the same for all performers (although some individual modifications are
possible, if desired), the dosage and progression in the circuit are arranged in accordance with the exercise tolerance of each participant.

The literature pertaining to circuit training and its effects, it may be seen, is rather meagre (9,36,50,57). However, with the increased number of schools and universities adopting such programmes, more comprehensive findings should soon be available.
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4. Ibid., p. 765.

5. Ibid., p. 764.

6. Ibid., p. 767.


27. McCloy, loc. cit.


44. Elsworth, Counsilman, op.cit., p. 504.


51. Clarke, *loc. cit.*


CHAPTER IV

METHODS AND PROCEDURE

Two Business Men's Keep Fit Classes at the Vancouver Central YMCA and one control group of non-participating businessmen were used in this experiment.

Each businessman was given a standardized physical fitness test before the experimental programme was started. All three groups were equated on the basis of the initial test scores and age.

Experimental Group I participated in a Keep Fit Programme consisting of forty-five minutes of a calisthenics routine for an eight week period. Experimental Group II performed a forty-five minute Circuit Training Programme for a similar period of time. The Control Group took no physical activity during this time.

The two Experimental Groups participating in the programme met twice weekly over the eight week period.

At the end of eight weeks, the two groups were again given the same physical fitness test.

Tests Selected. The physical fitness tests selected were the Larson Muscular Strength Test and the Harvard Step Test.

A. Larson Muscular Strength Test

Classification: Muscular Strength Test

Purpose: a. To measure dynamic strength.

b. To diagnose individual strengths and weaknesses of dynamic strength.
Validity: The three items, chinning, dipping and vertical jump correlate 0.82 with the fifteen item composite motor ability criterion. This relationship was obtained with a sampling of college men (1).

Reliability: The reliability of the test items has been ascertained to be:

a. Vertical jump (McCloy) \( r = 0.83 \),
b. Chinning (Cureton) \( r = 0.89 \),
c. Dips (Cureton) \( r = 0.90 \)  (2)

B. Harvard Step Test

Classification: Cardio-vascular Test

Purpose: The pulse count in the Harvard Step Test was developed as a simplification of the original method of counting pulse beats continuously for ten minutes after exercise.

Validity (3): Original evidence of validity for the Harvard Step Test was based upon endurance in treadmill running, maximum heart rate per minute and blood lactate level. These studies on Harvard undergraduates showed that athletes scored higher with less variable scores than did non-athletes, and the athletes increased their scores with more training, while termination of training resulted in lower scores.

Reliability: This was verified by Rankin (4) who found, on 132 subjects, that the coefficient of correlation between the ten-minute pulse count and
the one pulse count was +0.92. Under laboratory conditions (test-retest), the reliability for the one pulse count was +0.89. Under tests outside the laboratory, Karpovich (1) found that the test-retest of the "rapid" form score was +0.73 on 187 men.

Description of the Larson Muscular Strength Test. Test Item I - Chins (5): A horizontal bar was used for this test. The subject was instructed to hang by the hands from the bar using the reverse grasp, to pull the body upward until the chin was over the bar and then to lower the body until the arms were straight. The subject was not permitted to kick, jerk, or use a "kip" motion. Any such manoeuvre, or the failure to go down until the arms were straight or up to the prescribed position counted half a movement. After four consecutive half movements the exercise was stopped.

Test Item II - Dips (5): The subject stood at one end of the parallel bars, grasped the bars, one in each hand and jumped to the cross-rest position. At the end of this movement, which counts one dip, the forearms were completely extended. The subject then lowered the body until the angle in front of each of the elbows was less than ninety degrees and then pushed the body up until the forearms were again completely extended. These movements were repeated as many times as possible. The trunk was in approximately a straight line with the legs and under no circumstances was a jerk or kick permitted. The
subject was allowed to do the exercise as rapidly as he wished. If he did not go down to the prescribed position, or all the way up to a straight-arm position, only half a credit was given. After four consecutive half movements, the exercise was stopped.

Test Item III - Vertical Jumps (7): In the jump and reach test, a blackened one quarter inch plywood board, five feet long and one foot wide was used. The board was marked off in half inches.

The jumper toed a line, one foot in front of the board. The index fingers of both hands were chalked with magnesium. The subject reached as far as possible with heels kept on the floor and made a mark on the board with a chalked finger. He next executed three jumps from a crouched position, making a mark each time on the board. The distance from the top of the reach mark to the top of the highest jump mark was recorded as his score. The measurement was taken to the nearest half inch.

**Description of the Harvard Step Test** (8): The subject stood at attention in front of a bench twenty inches high. An observer stood behind the subject. The subject placed one foot on the bench, stepped up until both feet were fully on the bench, with the legs straightened and the body erect, and immediately stepped down again one foot at a time. The cadence was thirty steps per minute.
The pace was counted by one of the observers: "Up-2-3-4", "Up-2-3-4", as in military marching. The command "up" came every two seconds. Usually the performer led off with the same foot each time, but some subjects changed the procedure two or three times during the test. The exercise was kept up for five minutes continuously or until the subject stopped from exhaustion before the end of that time. In that case, the duration of the exercise in seconds was recorded. The subject was required to step fully up on the platform without assuming any crouch position and had to keep pace with the counting. If the subject was unable to keep pace for ten or fifteen seconds, the observer stopped him.

As soon as the subject stopped of his own accord, or was stopped by the examiner at the end of five minutes, he sat down. The observer noted the duration of the exercise, and recorded the pulse from 1 to 1½ minutes following the cessation of exercise. The actual number of heart beats during the thirty-second period was recorded.

Testing Team: All testers were physical education instructors from the University or the YMCA.

All testers took part in a training session before the first test was administered and again before the retest was administered. At this time, specific instructions were given to all testers, procedures were demonstrated and a practice session was conducted. The same testers were used for both test periods and tested the same item each time.
Procedure: Each testing station was clearly marked. All equipment was in place and all testers were at their stations before the start of the test period.

Each subject was given a recording card on which the testers recorded test scores. The subjects completed the tests in the following order: 1. Vertical Jumps, 2. Dips, 3. Chins, 4. Harvard Step Test.

Description of the Circuit Training Items:

Exercise No. 1 - Squat Thrusts (Burpee): From a standing position the body was lowered to a squat-rest position, leaning forward, the subject placed his hands on the floor in front of the feet. The legs were thrust backward to the front leaning-rest position, they were returned almost to the squat-rest position, and then returned to a standing position.

Exercise No. 2 - Regular Barbell Curl (20 lbs.) (9): Standing with the feet a comfortable distance apart, the subject grasped the bar with the undergrip about shoulder width apart. Starting with the arms straight, bar resting against the thighs, the weight was curled to the upper chest, then lowered to the starting position and repeated the desired number of times.

Exercise No. 3 - Back Extensions (Medicine Ball): The subject started in a prone position, a medicine ball squeezed between the knees and hands clasped behind the head. He raised his head and trunk upward until only the lowest portion of the
rib cage was touching the floor. The subject then returned to the prone position.

   Exercise No. 4 - Stair Running: The subject ran up three flights of stairs stepping on each stair.

   Exercise No. 5 - Straight Arm Pull Over (10 lbs.) While lying in a supine position on the back, the subject grasped and moved a weight, in an arc, from the thighs to the back of the head.

   Exercise No. 6 - Bench Jumps: The subject straddled a bench twelve inches in height. From this position, he jumped to the top of the bench placing both feet on top at the same time. From here, the subject returned to the floor and repeated the exercise the desired number of times.

   Exercise No. 7 - Sit Ups: The subject sat on the floor, with the hands behind the head and fingers interlaced. The subject sat up, touching the right elbow to the left knee, and then returned to the starting position. He sat up touching the left elbow to the right knee, and then returned to the starting position.

   Exercise No. 8 - Push Ups: The subject was in a front lying position, the palms of the hands flat on the floor approximately one foot from the ears, directly to side of head. the subject straightened the arms to lift the body from the floor, supported the weight on hands and toes, and kept the body straight from the shoulders to the toes, lowering the body until the chest touched the floor. Each time the subject
returned to the floor was counted as one push-up.

Exercise No. 9 - Running: The subjects ran around outside of the gymnasium floor, which was approximately 200 feet for each lap. A complete circuit of the floor was counted as one lap.

Exercise No. 10 - Lateral Trunk Bobbing: Standing at attention, the subject held the twenty pounds in each hand and bobbed laterally to the right and left.

Exercise No. 11 - Jump Chin: The subject jumped and reached as high as possible, using arms only, and then chinned himself using a regulation climbing rope.

Exercise No. 12 - Spread Eagle Jumps (10): With feet together, knees bent, the subject sat on his heels with finger tips touching the floor. Next the subject jumped in the air with feet astride, arms swung overhead, returning directly to the starting position on landing. The feet were at least shoulder width apart in the astride position before landing.

Outline of Circuit Training Program: Day 1. The subjects were given the Harvard Step Test and Larson Muscular Strength Test. They then went through the circuit training programme to be used. Each exercise was explained, demonstrated and practiced by the subjects so that all exercises were correctly executed.

Day 2. (1) Each subject was provided with a score card. (2) The subjects were paired off (one's and two's). (3) Each pair was assigned to a specific circuit station. (4) On the
whistle the number "one's" performed while the "two's" counted the repetitions until the whistle sounded at the end of one minute. (5) The subjects changed places and number 4 was repeated. (6) The groups then progressed one exercise at a time around the circuit, recording their scores as they proceeded.

In some exercises the subjects were fatigued in a few seconds and at this point the maximum number of repetitions was recorded.

After the testing period was over each subject calculated his training assignments from his maximum repetitions of the exercise correct to the next highest whole number. The training dose was then determined by taking one third of the maximum. A forty-five minute circuit with four laps was used.

Day 3. The subject began the circuit training, striving to complete four laps in the "target" time of forty-five minutes. If at some later date, he was able to do so, he was retested and given a new and higher training assignment based on this new maximum repetitions of the exercise.

Each subject wrote in the number of circuits completed at each station so that any daily improvement could be noted. (see Appendix B for example).

Day 4 to 15. Each subject completed the circuit each day.

Day 16. The Harvard Step Test and the Larson Munscular Strength Test were readministered.
Description of the Calisthenics Programme: The calisthenics programme consisted of the following exercises which were completed over a forty-five minute period. The time and sequence of the exercises varied from day to day.

Exercise No. 1 - Running: The calisthenics class period began with intervals of running, jogging, and fast walking. The distance covered was approximately one mile.

Exercise No. 2 - Stride Jumping: Using alternate forward and sideward movements with the legs, the subjects performed for approximately three minutes. Variation was added to the exercise by swinging the arms in the same alternate patterns.

Exercise No. 3 - Neck Rotation: Subjects spent from three to four minutes rotating the head clockwise and counterclockwise, as well as forward and backward.

Exercise No. 4 - Push-Ups: Were performed as described in the circuit training programme. (Page 34, exercise no. 8).

Exercise No. 5 - Arm Swinging: Standing at attention the subjects performed rhythmic arm swinging movements, forward and to the side.

Exercise No. 6 - Sit Ups: Were performed as described in the circuit training programme. (Page 34, exercise no. 7).

Exercise No. 7 - Shadow Boxing: Subjects moved about the floor in a boxers stance, emulating punching movements with right and left hand.

Exercise No. 8 - Bending and Stretching: Subjects used various trunk bending forward and laterally plus rotational movements from the waist.
Exercise No. 9 - Squat Jumps: Were performed as described in the circuit training programme. (Page 35, exercise no. 12).

Exercise No. 10 - Leg Raising: The subject assumed a supine position on the back, and raised the legs approximately twelve inches from the floor. From this position legs were alternately bent and stretched.

Exercise No. 11 - Bicycle Riding: From a supine position on the back the subjects raised hips and legs overhead, from this position the feet and legs were moved in a forward circular motion, similar to pedalling a bicycle.
REFERENCES


6. Ibid., p. 152.


CHAPTER V

RESULTS

The data obtained from the two experimental groups and one control group are summarized in the accompanying tables. Experimental Group I underwent an eight week calisthenics programme. Experimental Group II underwent an eight week circuit training programme. The Control Group refrained from physical activity for an eight week period.

The statistical treatment of the results deals with the improvement scores of inter-group comparison, and the difference scores in comparing groups.

The Harvard Step Test, Inter-Group Comparison: In Experimental Group I all subjects but one showed an improvement score in the post-test. In Experimental Group II all but one subject displayed improvement. This was not the case in the Control Group, in which only four of the eleven subjects showed an increase in performance.

The changes in the performance level of the three groups over the eight week period are summarized in Table I.
TABLE I

Comparison of Results Between Pre-test and Post-test Means of the Harvard Step Test

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
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<tbody>
<tr>
<td>( \Delta )</td>
<td>-2.63</td>
<td>14.45</td>
<td>10.18</td>
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<td>( \Delta )</td>
<td>17.40</td>
<td>11.10</td>
<td>13.72</td>
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<td>( \Delta )</td>
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<td>3.38</td>
<td>4.41</td>
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<tr>
<td>( t )</td>
<td>0.50</td>
<td>4.24*</td>
<td>2.45**</td>
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</table>

* Statistically significant at the .01 level of confidence
** Statistically significant at the .05 level of confidence

When analyzing the changes within each group over the eight week period, the investigator found that Experimental Group I and II showed mean differences of improvement between the initial and the final tests that were statistically significant. The mean improvement score of Experimental Group I was 14.45 with a \( t \) score of 4.24 which was statistically significant at the .01 level of confidence. The mean improvement score of Experimental Group II was 10.18 with a \( t \) score of 2.45 which was statistically significant at the .05 level of confidence. The Control Group, on the other hand, showed a mean decrease in performance of -2.63 and a \( t \) score of 0.50 which was not statistically significant.
Larson Muscular Strength Test, Inter-Group Comparison: In Experimental Groups I and II all subjects showed improvement in the post-test over the pre-test scores. In the Control Group, only four out of the ten subjects showed an improvement in performance.

The changes in the performance level of the three groups over the eight week period are summarized in Table II.

TABLE II

Comparison of Results Between Pre-test and Post-test Means of the Larson Muscular Strength Test

<table>
<thead>
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<td>( t )</td>
<td>3.60</td>
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<td>( t )</td>
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<td>( t )</td>
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<tr>
<td>( t )</td>
<td>0.86</td>
<td>4.17*</td>
<td>3.80*</td>
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</table>

* Statistically significant at the .01 level of confidence

Of the three groups, the mean improvements between the pre-test and post-test in Experimental Groups I and II were statistically significant. The mean improvement score of Experimental Group I was 27.00 with a \( t \) score of 4.17 which was statistically significant at the .01 level of confidence. The mean improvement score of Experimental Group II was 26.90 with a \( t \) score of 3.80 which was also statistically significant at the .01 level of confidence. The Control Group showed a mean improvement of 3.60 and a \( t \) score of 0.86 which was not statistically significant.
Harvard Step Test, Differences Between Groups: Table III summarizes the difference in performance levels of each group over the eight week period.

TABLE III

Differences Between Groups:
Harvard Step Test

<table>
<thead>
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<th>Experimental II</th>
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</thead>
<tbody>
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<td>Experimental II</td>
<td>Experimental I</td>
<td>Experimental II</td>
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<td>14.90</td>
<td>12.00</td>
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<td></td>
<td>6.87</td>
<td>6.66</td>
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<td></td>
<td>2.16</td>
<td>1.80</td>
<td>1.90</td>
<td></td>
</tr>
</tbody>
</table>

There were no statistically significant differences of the means of improvement between the Control Group compared to the Experimental Group I and II or between the two Experimental Groups.

Experimental Group I improved over the Control Group with a mean improvement of 14.90 \( (t = 2.16) \) which was not statistically significant. The mean improvement of 12.00 \( (t = 1.80) \) of the Experimental Group II over the Control Group was also not statistically significant. The mean improvement of 7.70 \( (t = 1.90) \) for Experimental Group I over Experimental Group II was likewise not statistically significant.
The Larson Muscular Strength Test, Difference Between Groups: Table IV summarizes the differences in performance levels of each group over the eight week period.

**TABLE IV**

Differences Between Groups:

**Larson Muscular Strength Test**

<table>
<thead>
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</tr>
<tr>
<td>(\hat{D})</td>
<td>21.29</td>
<td>30.81</td>
<td>31.85</td>
<td></td>
</tr>
<tr>
<td>(\hat{D})</td>
<td>6.73</td>
<td>9.73</td>
<td>10.07</td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>3.46*</td>
<td>2.38**</td>
<td></td>
<td>0.001</td>
</tr>
</tbody>
</table>

* Statistically significant at the .01 level of confidence
** Statistically significant at the .05 level of confidence

Experimental Group I improved over the Control Group with a mean improvement of 23.40 which was statistically significant at the .01 level of confidence \((t = 3.46)\). The mean improvement 23.30 of the Experimental Group II over the Control Group was statistically significant at the .05 level of confidence \((t = 2.38)\). The mean improvement of 0.01 which resulted in a \(t\) of 0.001 for the Experimental Group I over the Experimental Group II was not statistically significant.
CHAPTER VI

DISCUSSION

The inter-group results with respect to the Harvard Step Test showed statistically significant improvements within both the experimental groups following eight weeks of activity, with the control group showing a non-significant difference between the pre- and post-test scores. When comparing the differences between groups, however, although the mean improvement of the experimental groups over the control group was noted, such differences were not enough to be statistically significant. Herkimer (1) found marked cardio-vascular gains in adult men who participated in a calisthenics programme over a seven month period. Nakamura (2) found that a ten week programme of swimming for adult males increased the step test score by 57.2%. The results of this study are in agreement with these findings, although inter-group comparisons did not prove to be statistically significant in the present study.

Data on age differences in cardiac output during exercise are scarce. Mori (3) has reported cardiac output measurements before and after exercise in eleven subjects from seventeen through fifty-seven years of age. His data indicates that after exercise there is a lesser increase in cardiac output in subjects of greater age. In the present study the mean age of
the subjects was 35.63 for the Control Group, 35.09 for Experimental Group I and 34.54 for Experimental Group II. The thirty-three subjects ranged from twenty through forty-seven years of age. With the exception of eight subjects it was found that test scores decreased with age. These findings agree with Mori (3).

It has been stated by Norris and Shock (4) that strenuous tests are considered inappropriate for people above forty-five years of age who have not maintained physical conditioning. It is generally believed (5) that:

One should be extremely skeptical of using performance tests for middle aged men which are dependent on subjective end points (step tests, etc.) because of the distinct possibility that motivation is indeed rather poor.

This is in agreement with a study by Eichna, Bean and Ashe (6), who found when evaluating the fitness of a group of one hundred and twenty-five enlisted volunteers, that a highly motivated man would tend to continue the Harvard Step Test even though he was greatly fatigued. However, the less motivated individual tended to stop the test at the onset of fatigue thus producing a lower test score.

Kristufek (7), in a study of endurance training, found that running three miles per day, one hundred and forty-one miles in forty-nine days, increased the Larson Muscular Strength Test of chinning, vertical jump and dipping by 6.8%. However this study was limited to one subject twenty-two years of age.
Wolbers (8) conducted an experiment with an adult male volleyball class, and found, over a twenty-six week period, that test scores from the Larson Muscular Strength Test improved by 9%.

These results compare favorably to the present study. In looking at the individual test items it was noted that for all the subjects only ten increased their vertical jump scores while thirteen remained the same and five decreased their score. This compares with an unpublished study by Morford (9) in which very little increase was noted in vertical jump scores of subjects taking part in a circuit training programme. This is in direct contrast to a study by Nakamura (2) in which he found no increase in chinning or dipping but the vertical jump improved six inches in adult subjects taking part in a swimming programme. Brodt (10) found that weight lifting over an eighteen week period increased the Larson Muscular Strength Test by 21.6%, which was statistically significant at the .01 level of confidence.

Wolbers (8) who conducted a study using adult men as subjects, found that a prescribed calisthenics programme improved the vertical jump scores by 11%.

Although there was little change in vertical jump scores, this was not true of the chinning and dipping scores, for the subjects in both experimental groups showed an increase in performance after eight weeks of exercise. Out of the twenty subjects in the two experimental groups, three scores remained the same, in chinning, while seventeen subjects improved their test score. Eighteen subjects increased their dipping total,
while two subjects remained the same.

Both a circuit training and calisthenics programme for middle aged businessmen seem to improve fitness as measured by this study. It would be deemed advisable to use both programmes interchangeably so that interest and enthusiasm could be maintained throughout a year long keep fit programme.

Although the circuit training provided a daily evaluation that each man could use, it was observed that it lacked the fellowship of the calisthenics programme. The calisthenics programme, on the other hand, did not provide a criteria for a daily evaluation for the men and individuals tended to slow down or go through the "motions" of exercising when they felt fatigued.

From the data in this study and observations made during the eight week period it can be fairly stated that both programmes have merit in being implemented to improve the cardio-vascular and muscular status of middle aged businessmen.
REFERENCES


6. Eichna, F. W., Bean, W. B., Ashe, W. F., "Comparison of Tests of Physical Fitness", Fort Knox Army Ground Forces Medical Research Laboratory, March 10, 1944, Project No. 5, Sub-project No. 5-29.


CHAPTER VII

SUMMARY AND CONCLUSIONS

Forty-two business men, taking part in keep fit classes at the Vancouver Central YMCA, and a control group of twenty-one non-participating business men, were used in this experiment.

Each group was submitted to two tests, the Harvard Step Test and the Larson Muscular Strength Test at the beginning of the experiment. Experimental Group I then participated in an eight week calisthenics programme, while Experimental Group II participated in a circuit training programme of similar duration. The Control Group did not take part in physical activity for the eight week period. At the end of the eight weeks the three groups were re-tested in the same manner. The mean improvement was analyzed statistically within each group and a comparison was made of the mean improvement between groups.

On the basis of statistical treatment the following results were evident:

1. Experimental Group I, which participated in a calisthenics programme, showed a mean gain in the Harvard Step Test \( t = 4.24 \) and in the Larson Muscular Strength Test \( t = 4.17 \), both improvements statistically significant at the .01 level of confidence.
2. Experimental Group II, which participated in a circuit training programme, showed a mean gain in the Harvard Step Test \( (t = 2.45) \) which was statistically significant at the .05 level of confidence and in the Larson Muscular Strength Test \( (t = 3.80) \) that was statistically significant at the .01 level of confidence.

3. The Control Group, which took no part in physical activity for the course of the study, showed no statistically significant improvement in performance in the Harvard Step Test or in the Larson Muscular Strength Test.

4. The means of improvement of Experimental Group I did not significantly exceed the means of improvement of Experimental Group II or the Control Group in the Harvard Step Test.

5. The means of improvement of Experimental Group I did not significantly exceed the means of improvement of Experimental Group II, but Experimental Group I did significantly exceed the means of improvement of the Control Group in the Larson Muscular Strength Test \( (t = 3.46) \); statistically significant at the .01 level of confidence.

6. The means of improvement of Experimental Group II did not significantly exceed the means of improvement of Experimental Group I or the Control Group in the Harvard Step Test. However the means of improvement of the Experimental Group II exceeded the means of improvement of the Control Group
in the Larson Muscular Strength Test \((t = 2.38)\), which was statistically significant at the .05 level of confidence.

From the results of this study evidence is provided indicating that two physical education programmes, calisthenics and circuit training, conducted over an eight week period, significantly improve the muscular status of business men as measured by the Larson Muscular Strength Test. The results also indicate, to a lesser degree, that these two programmes will increase the cardio-vascular status of business men over an eight week period as measured by the Harvard Step Test.
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Steinhous, A. H., How to Keep Fit and Like It, Dartnell Corporation, Chicago, 1957.


PERIODICALS


Eichna, F. W., Bean, W. B., Ashe, W. F., "Comparison of Tests of Physical Fitness", Fort Knox Army Ground Forces Medical Research Laboratory, March 10, 1944, Project No. 5, Sub-project No. 5-29.


APPENDIX A

STATISTICAL TREATMENT

The raw scores obtained from the initial and final test results of the two tests from each of the three groups were analyzed statistically in the following manner:

Study Design

A. Control . . . . . . No activity
B. Experimental I . . . Calisthenics
C. Experimental II . . . Circuit Training

Tests: Harvard Step Test
Larson Muscular Strength Test

Procedure and Formulae

1. Determination of the significance between correlated means of the initial and final results of each test in each group. The level of confidence to reach 0.05 to be acceptable. The table of t at both the 0.05 and 0.01 level of confidence for eleven degrees of freedom (n - 1) is shown as 2.20 and 3.11 respectively. The table of t at both the 0.05 and 0.01 level of confidence for ten degrees of freedom (n - 1) is shown as 2.23 and 3.17 respectively (1).

To obtain significance the following formulae were used in inter-group comparison:

1. Number of Subjects (N)
2. Mean Score $\frac{\sum N}{N}$
3. Standard Deviation $\sqrt{\frac{\sum i^2 - \frac{N\sum i^2}{N-1}}{N-1}}$
4. Standard Error of Mean 
\[
\sigma_I = \frac{\sigma_I}{\sqrt{N}}
\]

5. Calculation of the "t" Ratio 
\[
t = \frac{I}{\sigma_I}
\]

2. Determination of the significance of difference in the means of the improvement in each test between groups. The level of confidence was required to reach 0.05 to be acceptable. The table of t at both the 0.05 and 0.01 level of confidence for eleven degrees of freedom (n - 1) is shown as 2.20 and 3.11 respectively. The table of t at both the 0.05 and 0.01 level of confidence for ten degrees of freedom (n - 1) is shown as 2.23 and 3.17 respectively (2).

To obtain significance the following procedure was used:

1. Number of Subjects (N)

2. Mean Score of the Differences 
\[
\frac{\sum D}{N}
\]

3. Standard Deviation of the Differences 
\[
\sigma_D = \sqrt{\frac{\sum D^2 - N \overline{D}^2}{N-1}}
\]

4. Standard Error of the Differences 
\[
\sigma_D = \frac{\sigma_D}{\sqrt{N}}
\]

5. Calculation of the "t" Ratio 
\[
t = \frac{\overline{D}}{\sigma_D}
\]
REFERENCES


APPENDIX B

INDIVIDUAL SCORE SHEET

TEST RESULTS

NAME ___________________________ AGE ______
ADDRESS ___________________________ WEIGHT ______
PHONE ___________________________ HEIGHT ______

HARVARD STEP TEST

TEST I
Test Time ______
Pulse Rate ______

TEST II
Test Time ______
Pulse Rate ______

LARSON MUSCULAR

TEST I
Chins ______
Vert. Jump ______
Dips ______

TEST II
Chins ______
Vert. Jump ______
Dips ______
APPENDIX C

CIRCUIT LAYOUT

Stairs (4)

Pull Over (5)  Extension (3)

Bench Jumps (6)  Burpee (2)

Sit Ups (7)  Curls (1)

Push Ups (8)

Rope Climb (11)  Spread

Running (9)  Eagle

Lateral Trunk  Jumps (12)

Bending - Weight

in One Hand (10)
APPENDIX D

RAW SCORES OF THE HARVARD STEP TEST

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<th>Post-test</th>
<th>Subject</th>
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APPENDIX E

RAW SCORES OF THE LARSON MUSCULAR STRENGTH TEST

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<tr>
<th>Subject</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Subject</th>
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