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Title: The Effects of Flexibility on the Development of Cardiovascular Endurance in Mildly and Moderately Mentally Retarded Adults.

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This study was completed to determine if a significant difference existed between a program of continuous motion (run/walk) preceded by a flexibility warm-up period and a continuous motion program in the development of cardiovascular endurance in mildly and moderately mentally retarded adults. Thirty-nine subjects were randomly divided into three groups. All groups were tested for cardiovascular endurance using the six-minute run/walk. Flexibility measures for the ankle, knee, hip, and shoulder were also taken. Group I ran and walked for fifteen minutes following ten minutes of static flexibility exercises. Group II ran and walked only. Group III was designated as the control group. Training continued for eight weeks, twice a week. Results showed a significant increase in cardiovascular endurance for Group I and increases for Group II, although not significant. No increase was seen for Group III. Five of the seven flexibility measures showed a significant increase for Group I, one for Group II, and none for the control group, Group III.

THE EFFECTS OF FLEXIBILITY ON THE DEVELOPMENT OF CARDIOVASCULAR ENDURANCE IN MILDLY AND MODERATELY MENTALLY RETARDED ADULTS

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Chapter 1

INTRODUCTION

The material in this chapter has presented information concerning physical fitness and its relationship to man in today's society. Implications for the study of flexibility in relation to cardiovascular endurance in the mentally retarded through the use of a continuous motion (run/walk) program were discussed. The significance of the study, the statement of the problem, the purpose, and the null hypothesis were also presented. The limitations and delimitations of the study as imposed by uncontrolled variables, and the definition of terms which required further clarification were included.

THEORETICAL FORMULATION

For centuries man used his body in its physical capacity as his means of locomotion and to meet the work requirements of society. Fitness and health were considered very important and necessary, with emphasis placed on development of the body. Physical activity has been for many centuries an integral part of the life style of man.

In more recent times, sophistication of life styles, reliance upon man-made tools and equipment, development of attitudes conducive to greater relaxation, and sedentary

modes of behavior have resulted in increasingly poorer fitness levels. Emphasis has been placed on decreasing the work efforts necessary for living. Having experienced this type of life and observing the results for many years, researchers have concluded that the sedentary life style of today has been physiologically harmful. Fitness through some type of physical work, has again been recognized as necessary for preservation of the physical body as noted by Shepard (45).

With the resurgence of interest in the body's physical state have come several new and different meanings for physical fitness. Morehouse (35) identified three levels of fitness: 1) the irreducible minimum below which degradation of the body occured; 2) the general level, where a safe margin of adaptation for change was possessed; and 3) preparation for strenuous recreational or occupational activity such as athletic competition. For the vast majority of individuals, the general level, as described by Morehouse, has been a satisfactory and necessary state of fitness. It must be noted further that fitness varied from one person to another, based on what their life style required and how they functioned physiologically. As Peebler stated (38:3), total fitness is possessed by an individual when " . . . he can successfully cope with all demands of living and stresses of all kinds, mental, emotional, and physical."

To some experts, total fitness has incorporated the following items; strength, flexibility, cardio-respiratory endurance, weight control, and other specific factors (51). Recent research in physical fitness has dealt primarily with cardiovascular efficiency, as a general indicator of and a means with which to develop physical fitness, more specifically, cardiovascular fitness. The surge of research directed toward cardiovascular efficiency or fitness has in part been due to the high incidence of related heart and blood vessel diseases. Cardiovascular fitness has been recognized as significantly related to the occurance or absence of heart disease and the human being's ability to withstand stress.

Cardiovascular fitness has not been important for the general public alone, but more recently has been seen as valuable also for special populations such as the mentally handicapped. The mentally handicapped, long pushed out of the mainstream of society, have now been given the opportunity to be involved with society. Research concerning their abilities has increased tremendously and the interest in this area has continued to grow. It has been recognized that the mentally retarded have the same basic emotional and physical needs as the "normal" population and that many can and have functioned successfully outside of an institution. If the mentally handicapped were to function at their full potential, they needed a good state of physical

fitness just as did the "normal" population.

Numerous studies have been completed dealing with the motor functioning and physical fitness of the mentally retarded as well as studies concerning their mental functioning. Research has indicated that several factors are common to the majority of the mentally retarded which interfere with normal motor functioning or physical ability. One of the common problems in the physical development of the mentally retarded individual has been a lower than average degree of flexibility (20), which may be due in part to rigidity of the muscles. Rigidity has been defined as the resistance of movement by the muscles of a body part (18). This characteristic has caused diminished motility and inefficient locomotor patterns.

THE PROBLEM

The mentally retarded have been characterized as having low motor abilities and fitness levels, as well as low mental abilities. Although many mentally retarded individuals have demonstrated good motor functioning, with skills equal to or higher than the non-retarded, the majority of the mentally retarded individuals have fallen two to four years behind their chronological age group in motor development. Studies have also shown significantly lower fitness levels in mentally retarded children as compared to the non-retarded (10, 43). Other studies have

shown that the fitness levels of mentally retarded individuals can be significantly improved (1, 31).

It appeared important to develop cardiovascular endurance in the mentally retarded in order for them to obtain the highest possible level of functioning, which would prepare them in part for participation in society. In order to obtain cardiovascular endurance, individuals must move continuously for an extended period of time, which further requires an adequate locomotor pattern. It seemed possible that a more efficient locomotion would enable an individual to move further for a longer period of time, by expending less energy than would be required by a less efficient movement pattern. If limited flexibility of the ankle, knee, hip, and shoulder hindered development of efficient locomotor patterns as previously discussed, it seemed possible that development of cardiovascular endurance would also be hindered.

Statement of the Problem

Is there a significant difference between a program of continuous motion (run/walk) preceded by a flexibility warm-up period and a continuous motion program in the development of cardiovascular endurance in mildly and moderately mentally retarded adults?

Statement of the Hypothesis (Null Form)

There is no significant difference between a program of continuous motion (run/walk) preceded by a flexibility warm-up period and a continuous motion program in the development of cardiovascular endurance in mildly and moderately mentally retarded adults.

Purpose of the Study

The purpose of this study was to investigate the effects of a warm-up period consisting of stretching and flexibility exercises prior to running/walking for fifteen minutes, on the development of cardiovascular endurance in the mentally retarded. Was it possible that increased range of motion would improve the efficiency of locomotion patterns, thereby enabling individuals to increase endurance activity times and distance?

Significance of the Study

Few studies in physical fitness of mentally retarded adults have been attempted concerning cardiovascular endurance. Whereas most research has dealt with children, generally of elementary school age levels, recognizing the fact that motor dysfunctions were common in the mentally retarded, little has been done to relate these dysfunctions with development of cardiovascular endurance in adults. Therefore, it was considered beneficial to determine if stretching of the antagonistic muscles would enhance the

cardiovascular effects of a continuous motion program (run/walk), by creating a more efficient and relaxed locomotor pattern.

DEFINITION OF TERMS

The following terms were considered to need further clarification. They were defined according to their use in this paper.

Cardiovascular Endurance

Cardiovascular endurance is the ability of the heart, lungs, and circulatory system to adapt to the demands of prolonged, total body exertion (33:28).

Flexibility

Flexibility is the ability of body segments to move through normal ranges of motion (33:26).

Mildly Mentally Retarded

Individuals considered to be mildly retarded have a measured intelligence quotient of 52-67 on the Stanford-Binet test of intelligence (33:7).

Moderately Mentally Retarded

Individuals considered to be moderately retarded have a measured intelligence quotient of 36-51 on the Stanford-Binet test of intelligence (33:7).

Continuous Motion Exercise Program

This program consisted of running and/or walking for fifteen minutes without stopping the movement.

Flexibility Warm-up Period

This ten minute period consisted of flexibility exercises, as illustrated in appendix B, page 73, utilized to loosen and relax the individuals involved, and to increase the range of motion in shoulders, hips, knees, and ankles.

LIMITATIONS OF THE STUDY

The population for this study was limited by the fact that all individuals available could not be required to participate. Subjects were obtained on a volunteer basis. Furthermore, the population was small in number (sixty) and therefore the sample participating was small.

It was noted that the individuals of this population demonstrated extreme fluctuations in emotions between exercise sessions. This made it difficult to keep the individuals working (running/walking) at their ability level. Diet, sleep patterns, and recreation could not be strictly controled, however, due to the living arrangements of the subjects, these factors were similar for all subjects.

DELIMITATIONS OF THE STUDY

The subjects for this study were volunteer mildly and moderately retarded clients of the Franklin County Rehabilitation Facility, Ottawa, Kansas. Subjects ranged in age from twenty-one to thirty-nine. The subjects were asked to refrain from any outside vigorous exercise which might have had a bearing on their cardiovascular fitness level, and which was not part of their normal routine.

Static flexibility exercises were used to eliminate any direct effect on cardiovascular endurance which may have been obtained through dynamic flexibility exercises. All post-tests were administered in an identical manner to pre-tests, for all groups.

Chapter 2

REVIEW OF RELATED LITERATURE

As late as 1963, Stein reported complete absence of research in organic fitness of the mentally retarded (48). However, since that time many studies have been completed in relation to physical fitness levels and development of physical fitness in mentally retarded children, with research directly or indirectly pertaining to development of cardiovascular fitness. Physical characteristics and motor performance have also been investigated. Presented in this chapter was related literature, categorized into three areas, Mental Retardation and Motor Function, Flexibility, and Development of Cardiovascular Fitness. A summary and interpretation of the literature was also included.

MENTAL RETARDATION AND MOTOR FUNCTION

Mental retardation has had many causes, not all of which have been identified. Some cases of mental retardation have not been classified as to type or cause. However, according to Fait (20), a substantial number of moderately and profoundly retarded cases were the result of brain damage, although no percentage could be determined exactly.

Brain damage has also been shown as a factor in mild retardation. The extent of its contribution was not known and expert opinion has been divided (20).

Poor physical fitness and motor ability of the mentally retarded has been accepted as unavoidable, but more recently has been recognized as the result, in part, of slower maturation processes (51:217). Voss (50) suggested that it may also be due to intellectual problems and the complexity of games that fitness and motor ability appear to be low. The mentally retarded have been generally two to four years behind the normal child of the same chronological age in physical development, eighty percent falling below the median of national scales (39:21). Wortis stated:

> If, in addition, they have a greater prevalence of physical handicaps, are more prone to injury, and have possible brain damage, we would certainly expect them to be slower, weaker, more easily fatigued, and more poorly coordinated (52:217).

Wortis (52) further questioned the amount of motor retardation caused by a sedentary life, starting early in childhood.

Intelligence in relation to motor ability has been the object of many studies. Campbell (10) commented that intelligence, social maturity, and academic achievement are only correlated with fitness, not a cause and effect relationship. Liese and Lerch reported that a significant relationship did exist between fitness and intelligence, although the cause was not determined (31:51). Asmussen

and Heeboll-Nielson (1) showed that below an intelligence quotient of ninety-five, motor performance can be distinguished as lower than normal in boys. Boys with a higher intelligence quotient could not be readily distinguished in motor performance.

Peries (39), however, completed a study showing no relationship between IQ and fitness. Peries study was designed to determine the sub-maximal cardiovascular endurance level of selected trainable mentally retarded children, using the Ohio State University Step Test. He further compared the data to that of normal children performing similar tests, and the relation of IQ to performance level. The subjects were one hundred twenty-nine boys, ages seven to nineteen with an IQ below fifty. Eighty-five boys were found capable of completing the step procedure. He designated those boys able to complete the step procedure as Group I and those not able to complete the step procedure as Group II. No relationship between IQ and fitness for this group could be found.

Four thousand two hundred thirty-five children were evaluated by Rarick, Widdop, and Broadhead (41). Groups consisted of two hundred boys and two hundred girls from each chronological age level. The children were tested on the AAHPER modified fitness test. The results showed that the subjects exhibited the same age trends as the normal in muscular strength and in sit-ups, but were well below

normal in the shuttle run and other fitness areas.

Nordgren investigated physical capacity of young adult mentally retarded individuals (36). IQ levels ranged from thirty to seventy in the sixty-three men and thirty-nine women. Subjects were divided into educable and non-educable groups and compared to normal populations. The results showed: 1) no significant differences existed in body build between the mentally retarded and the normal population; 2) lower muscular strength of subjects than in normal, being more pronounced in the non-educable subjects; and 3) considerable variation in subjects circulatory functional capacities, although the mean physical work capacity did not deviate essentially from those of the normal population.

Drowatzky (18) noted studies that illustrated several tendencies of the mentally retarded. One tendency was that of overweight, partially as a result of lack of physical exercise. Other tendencies were those of low muscle strength and poor coordination. In agreement with the study by Nordgren (36), Sengstock (51) and Auxter (47) reported lower achievement in educable mentally retarded than in normal, but higher than in trainable mentally retarded. Even with the lower levels of the mentally retarded, significant gains have been seen in six weeks in physical fitness.

Fait (20) pointed out that the mentally retarded are characterized further by a shuffling, inefficient walking gait, which is illustrative of poorly coordinated body movements. Poor posture was common as was low physical vitality. Some children tended to have excessive movements, while others were subject to diminished motility or muscular asthenia (20:153). Voss (50) outlined some common running deviations of the mentally retarded. They included landing on the heel of the foot, running in a stiff upright position, failure to lift knees high, no arm swing, and failure to watch forward.

Testing the Mentally Retarded

One problem in working with the mentally retarded, as Wortis pointed out, was establishing satisfactory performance tests. The results may have been complicated by cognitive elements. Attention and effort were not easily achieved in the mentally retarded, making accurate testing difficult (52:216).

FLEXIBILITY

Flexibility refered " . . . to the ability of a subject to move the body and parts through as wide a range of motion as possible without undue strain to articulations and muscle attachments (27:70)." The need for flexibility and to what degree has been controversial. It has been

generally accepted however, that flexibility is specific to the joint involved and the need for flexibility depends on the endeavor (17:432). Johnson and Nelson (27:70) have added to that statement by saying that the degree needed was determined by the ease of performance and safety involved. They further stated that the correlation of flexibility to motor abilities is low with some, but necessary to others. DeVries (17) pointed out that graceful movement in running and walking was impossible without flexibility.

There were two identified types of flexibility exercises, static and dynamic, or ballistic. Dynamic or ballistic stretching involved rapid movement or bouncing. Static stretching involved slow continuous stretching motion. The range of motion was primarily involved in static stretching, while speed was involved in dynamic flexibility. According to deVries (17:433), range of motion is the only factor which has been widely investigated. When comparing static with dynamic flexibility exercises, deVries noted no significant difference in gains between the two methods. However, static stretching was found to have three major benefits: 1) there was less danger of exceeding the extensibility limits of the tissue, 2) energy requirements were lower, and 3) static stretching did not cause muscle soreness. It was added that flexibility levels were retained up to eight weeks.

DeVries continued (17:434) that limitations in flexibility, as often seen in the mentally retarded, may be caused by muscle and its facial sheaths, skin, or the connective tissue with tendons, ligaments, joint capsules. He further noted the two major factors in joint movement as plasticity and elasticity. Voss (50:8) stated that in many cases of the mentally retarded, low motor coordination may be the result of strength and flexibility deficiencies, coupled with a poor self-image.

Sherrill (46) refered to rigidity as associated with mental retardation and cerebral palsy. Rigidity, or lack of range of motion, was generally caused by damage to the basal ganglia and/or the cerebellum, resulting in resistance of movement of a body part by a set of muscles.

Retarded subjects, as reported by Heeboll-Nielson (25), appeared to progress differently in learning motor skills, particulary at the beginning of a session, indicating that they may have needed a warm-up to lose rigidity. Flexibility, according to Jokl (29:70), was one constituent of the physical complex involved in a given motor task and was considered to reflect the quality of performance as a whole.

Poor performance on flexibility tests was noted by Rarick, Dobbins, and Broadhead (40), for the mentally retarded. Specifically, the range of motion in the spine

and hip joint needed improvement. It was stated " . . . the reason for the great difference in flexibility between the normal and the retarded children can be only conjecture at this point (40:113)." One reason may have been the lack of use of the full range of motion in the individuals, causing the decreased flexibility.

Auxter (4) investigated flexibility and strength among normal, non-brain-damaged, brain-damaged, and undifferentiated educable mentally retarded boys, along with other kinesthetic factors. The flexibility measures included were the trunk flexion and ankle flexibility. On the selected measures, the typical boys were more proficient than any of the other groups, and the non-brain-damaged boys were more proficient than the brain-damaged.

Some studies have reported improvement in flexibility by warming of the muscles and joints. Grobaker and Stull (23) completed a study on fourteen male college students. The students underwent treatments of cold and hot water for eight weeks. The results indicated no affect by cold water on range of motion (wrist and ankle), but range of motion at the wrist was enhanced by immersion in hot water for ten minutes. DeVries (17) noted that dynamic flexibility was improved twenty percent by local warming to 113 degrees Fahrenheit. Dynamic flexibility was further decreased by ten to twenty percent by cooling to 65 degrees Fahrenheit. It was further suggested that the effects on

static flexibility were probably similar.

Testing of Flexibility

The testing of flexibility has been under some criticism because the range of motion desirable has not been determined and because it has been felt that anthropometric measures interfer with accurate and comparative measurement. However, deVries noted that the Leighton flexometer overcomes subjectivity to a large extent. He stated: "It appears that static flexibility can be measured indirectly, with no undue interference by varying anthropometric measurements (17:436)." Johnson and Nelson (27) regarded the Leighton flexometer and electrogoniometer as accepted as the most accurate instruments for flexibility measurement. The reliability of the Leighton flexometer was reported by deVries at r = .90 or above.

Johnson and Nelson (27) listed several practical measures for the measurement of flexibility. Although not considered to be as accurate, they were used in many cases. The Modified Sit and Reach test was used to measure flexion of the hip and back as well as elasticity of the ham string muscles. A reported reliability of r = .92 was possessed by this test with an objective reliability comparing an experienced/inexperienced tester, of r = .98. Face validity was accepted for this measure.

The shoulder elevation was used to measure the ability to elevate the shoulders. Reliability had been reported as high as .85 and objectivity as high as r = .91, by Johnson and Nelson (27:74).

Trunk extension was used to measure the ability to hyperextend the trunk. The reliability between three scores on separate days was determined to be r = .89. Objectivity of r = .96 with two testers of a group of twenty-five subjects was found also (27:81).

DEVELOPMENT OF CARDIOVASCULAR ENDURANCE

Cardiovascular fitness parameters have been the subject of extensive studies with normal and abnormal populations. Continual rhythmical movement has been considered necessary to increase cardiovascular function (3). Distance running, therefore, has long been prescribed for cardiovascular efficiency (32). The mentally retarded have been shown capable of improving their fitness level as can the normal population, through a planned physical experience (47). Solomon noted that the improved condition of individuals after a fitness program continued for six weeks after the end of the program. His study further recognized that the mentally retarded were capable of performing equally or better than the normal group of the same chronological age (47).

Buccola and Stone (9) investigated the effects of jogging and cycling programs on physical characteristics and personality variables of aged men. This study included thirty-six males between the ages of sixty and seventy-nine. The fourteen week program of walking and jogging or biking not only increased endurance, but also increased flexibility in joggers.

A study by Milton (32) compared the effectiveness of an isometric exercise program with three running programs. The subjects were pre-tested to determine their initial level of fitness and divided into two groups representing low and high fitness levels. The subjects were then randomly assigned to four exercise programs, with both fitness levels being represented in each program. Groups 1, 2, and 3 ran four days a week for ten, twenty, and thirty minutes respectively. The fourth group did isometric exercises for ten minutes, four days a week. The results at the end of seven weeks showed that in low fitness levels the isometric group improved as much in cardiovascular efficiency as did the thirty-minute running group. There was no apparent difference in the cardiovascular fitness achieved among the ten, twenty, and thirty-minute running programs. No relationship between the amount of running and amount of cardiovascular fitness improvement for high fitness levels was discovered.

Jackson, Sharkey, and Johnston (26) studied cardio-respiratory adaptations to training at specified frequencies. The study consisted of twenty men divided into four training groups which exercised at the treadmill rate of seven miles per hour for ten minutes. The grade was increased one degree for each following session. Groups 1, 2, 3, and 4 exercised for one, two, three, and five days per week respectively. A control group participated in volleyball three times per week. Two to three days per week of exercise was concluded to be more beneficial than one day, and just as beneficial as five days per week, considering the initial fitness levels of the subjects (poor and very poor and the Balke scale). It was stated that although five days of training were not excessive for typical track training, it was too much for good adaptive responses by subjects of low fitness levels.

In a paper presented at the Milwaukee Convention of the American Alliance of Health, Physical Education, and Recreation, Gettman, Milesis, and Pollock (22) reported on the physiological responses to different training frequencies and durations. The results of their study showed that cardio-respiratory fitness, as measured by maximal oxygen uptake, treadmill performance, and resting heart rate, improved in direct proportion to duration and frequency of training. Body weight and fat reductions were found only in

groups training three days per week at thirty minute durations.

Another study, by Zeigler (53), determined that two days per week of planned exercise was as beneficial or better than one or three days per week for college males. In this study, subjects exercised "all-out" on the bicycle ergometer for one, two, or three days per week for eighteen weeks.

In relation to improving the fitness of the mentally retarded, Sengstock (43) compared scores on the AAHPER Physical Fitness Test of educable mentally retarded children with normal children of the same mental and the same chronological age. The results showed that educable mentally retarded children score lower than normal children of the same chronological age and higher than in children of the same mental age in some cases.

Shannon (44) completed a study to compare resting, anticipatory, and recovery heart rates, and exercise times of boys with normal intelligence and trainable mentally retarded boys. His study showed that performance of boys who were retarded was significantly less than normal subjects. As age increased, the retarded boys fell further behind in their capacity for exercise and recovery ability.

The heart rates of two groups of mentally retarded males were compared to heart responses of normal males by Baylor (5). A transistorized cardio-tachometer was used to

monitor the heart during resting and working phases. The results showed no difference in the nature of cardiovascular responses of mentally retarded males to normal males.

Testing of Cardiovascular Endurance

Several tests for cardiovascular fitness or endurance have been devised. However, no suitable test for mentally retarded adults was found. The basic principle for testing aerobic capacity or endurance involved the uptake of and utilization of oxygen.

Astrand and Rodahl (3:348) defined a test of maximal oxygen uptake as meeting the following minimal requirements:

1. the work in question must involve large muscle groups;
2. the work load must be measurable and reproducible;
3. the test conditions must be such that the results are comparable and repeatable;
4. the test must be tolerated by all healthy individuals; and
5. the mechanical efficiency (skill) required to perform the task should be as uniform as possible in the population to be tested.

It would seem logical that these general requirements would hold true for any test of aerobic capacity or cardiovascular endurance. It was further noted that the pace must be one in which the individual could continue for at least three minutes.

Cooper (11) stated that a run of one mile or less was too short to accurately test for endurance or aerobic

capacity. It was felt that such relatively short spurts were anaerobic in nature. Cooper believed that a run of one and a half miles or twelve minutes was necessary to estimate accurately maximum oxygen consumption by field-testing measures. However, based on Astrand and Rodahl's suggested rules, if an individual was incapable of running the one and a half miles or for twelve minutes, then a test of shorter duration would be required and would be satisfactory.

SUMMARY AND INTERPRETATION

There was evidence as to lower flexibility and a high incidence of rigidity in mentally retarded individuals. Motor abilities appeared to be generally lower in the mentally retarded. These characteristics resulted in inefficient movement patterns.

Children with low measured intelligence tended to have lower motor and fitness levels than the normal. Studies did not agree on this factor. Wortis noted (23:218) that this could be due to environment in many cases, or to other factors, rather than innate causes or brain damage.

Cardiovascular endurance or fitness could be developed in normal and mentally retarded individuals with a program of continuous movement. Two to three days was sufficient for individuals with a low initial fitness level, if vigorous exercise was carried out for at least ten

minutes without ceasing.

Flexibility has not generally been considered to relate to development of cardiovascular endurance. However, if muscular movement was sufficiently restricted, locomotor efficiency would be decreased, possibly hindering the ability to develop cardiovascular endurance. Fait (20) reported that some authorities believed that a person with greater flexibility expended less energy in performing skills than someone who was less flexible, because energy need not be expended to overcome the limited range of motion. Astrand (3) pointed out that more movement proximally was the more coordinated and efficient pattern of movement. Greater flexibility in the hip and shoulder should increase the proximal segment movement. Jokl (29:70) indicated, however, that a movement may be less efficient, but will not interfer greatly with quality of performance.

The mentally retarded tended to have a lower flexibility level which did hinder movement, more than in normal individuals. If efficiency of locomotor patterns did affect the development of cardiovascular endurance, then flexibility would play a part, particularly in the mentally retarded.

Chapter 3

METHODS AND PROCEDURES

This study was completed to determine if a significant difference existed between a program of continuous motion (run/walk) preceded by a flexibility warm-up period and a continuous motion program in the development of cardiovascular endurance in mildly and moderately mentally retarded adults. Thirty-nine volunteers from the Franklin County Rehabilitation Facility for the mentally retarded were used for the study. They were assigned to one of three groups by use of the table of random numbers.

Before training began, all subjects were given flexibility tests using the Leighton flexometer for the ankle, knee, hip, and shoulder. Additional measures for flexibility included the Sit and Reach, Trunk Extension, and Shoulder Elevation. Cardiovascular endurance was tested by a six-minute run/walk.

One third of the subjects, designated as Group I, participated in an exercise program consisting of a ten-minute flexibility exercise period followed by fifteen minutes of continuous motion or running/walking. Group II participated in the continuous motion exercise (fifteen minutes running/walking) only. Both groups I and II

attended the exercise sessions twice weekly for eight weeks. Group III was designated as the control group, participating in no programmed exercise.

At the completion of the eight weeks, all subjects were retested for cardiovascular endurance with the six-minute run/walk test and the flexibility measures were again utilized, in an identical manner to the pre-test. Comparisons of all test scores were made and analyzed statistically, using the t-test for two related samples, the analysis of variance, and the Scheffe test.

POPULATION AND SAMPLING

The subjects for this study were thirty-nine volunteers from the Franklin County Rehabilitation Facility at Ottawa, Kansas. The clients, ranging in age from twenty-one to thirty-nine, were permanent residents of the facility housing program. The clients were classified as mildly and moderately retarded by various institutional psychologists in Kansas and by the facility's guidance counselor.

The thirty-nine volunteers were obtained from the sixty facility residents. The residents resided in five homes maintained by the rehabilitation facility. Each home sheltered twelve individuals plus one or two house parents. The house parents were responsible for supervising the daily living patterns of the residents, including food, clothing,

and recreation. All residents worked in the Ottawa facility workshop with the exception of five who did similar work in local businesses.

The sixty residents were informed as to the purpose of this study and encouraged to particpate by the investigator. No individual could be required to participate, thereby necessitating the voluntary participation. Individuals demonstrating severe physical disabilities which prevented them from running and walking for fifteen minutes were not included in the investigation. Of the sixty residents, thirty-nine volunteered, twenty males and nineteen females.

The clients volunteering for the study were assigned to one of three groups before the initial testing, using the table of random numbers. Of the thirty-nine subjects, ten were excused from consideration and participation after the study began, due to failure to attend exercise and/or testing sessions. Of the ten excused, six were males and four were females. The remaining volunteers made up Group I (n = 10), Group II (n = 10), and Group III (n = 9). All groups were retested in an identical manner to the pre-test situation following the eight week exercise program.

PROGRAM ASSISTANTS

It was deemed necessary to utilize aids throughout the testing and exercise program in order to facilitate the testing and administration of the exercise program. Two aids were informed as to the purpose and circumstances of the study. They received instructions on the administration of the flexometer tests and the other flexibility tests and equipment used. They were given practice trials on use of all equipment and testing procedures and were required to take the tests, recording the results in the same manner as when given to the subjects. The aids also were instructed on the administration and evaluation of distance covered in the six-minute run/walk endurance test. The aids assisted in administration of all testing, and were present during the exercise periods to give advise and aid to the subjects when necessary.

TESTING PROCEDURES

Two areas of physical ability were tested, flexibility and cardiovascular endurance. The subjects were informed of the study and the exercises and test to be performed eight, two, and one week in advance of the beginning of testing. These contacts were made in order for the subjects, aids, and the investigator to become better acquainted and thereby reduce unnecessary tension or

distrust. The volunteers were accepted during these visits and they were informed as to proper attire to be worn during testing and exercise, which consisted of shorts or loose pants, tennis shoes and socks, and comfortable shirts.

Equipment and Facilities

The equipment utilized in the testing of flexibility included a Leighton flexometer, yard stick, tape measure, bench, and a slide measure yardstick, as described in Johnson and Nelson (27). Individual data cards were used to record test scores as illustrated in Appendix B, page 72.

The cardiovascular test of six minutes running/walking was completed on a dirt, quarter mile track, marked off in ten yard intervals with stakes and flags. A stop watch was used to time the six minute interval of the test. Results in yards traveled were recorded on the individual's data card.

The flexibility testing was completed in the subject's homes in a large room. This was done in order to reduce tension or anxiety in the subjects from involvement in a new situation. By using the homes for flexibility testing, time was saved and the subjects did not have to wait at the testing site for their turn, eliminating an otherwise long waiting period. The cardiovascular endurance test was completed at the quarter mile track on a

Sunday afternooon. The subjects walked to the track which was four blocks from three houses and five blocks from the other two houses.

Flexibility Testing

The first testing completed involved the flexibility or range of motion of the subjects and was determined by the use of the Leighton flexometer on the ankle, hip, knee, and shoulder. Other measures utilized were the Sit and Reach, Shoulder Elevation, and Trunk Extension. Procedure for administering the tests were explained in Johnson and Nelson (27). Precautions were taken to insure uniformity of measures between subjects. All measures were taken on the right side of the subjects. The floor, boards, and benches or chairs, were used to stabilize joints not being tested.

DeVries (17) reported a reliability coefficient of $r = .90$ and above for the Leighton flexometer. Johnson and Nelson (27) reported reliabilities for the Sit and Reach ($r = .92$), the Shoulder Elevation ($r = .85$), and the Trunk Extension ($r = .89$).

No external comparisons were made for flexibility scores. The two major areas of concern in regard to reliability and validity of flexibility tests were what degree of flexibility an individual should possess and the lack of allowance for variations in anthropometric measures of

individuals (10). A concern in this study was the change or lack of change in flexibility of each individual rather than comparisons with other individuals.

Testing of Cardiovascular Endurance

The second physical condition test used involved cardiovascular endurance. A special endurance test was devised for this type of population because of the very low initial fitness levels and because no tests previously devised for the mentally retarded adult were found. Further, no norms were available for use concerning cardiovascular abilities of this special population. The test devised for this study was a six-minute walk/run with the score being the distance covered in yards during the time period. Serious effort to run/walk for a longer period of time by the subjects was not achieved because of their low fitness and because of their reluctance to push themselves beyond discomfort levels. The subjects were continuously encouraged to cover as much distance as possible during the six minute time period, running as far and as often as possible. Distances of the subjects at the end of the six minutes and at three minutes, were marked on the data cards in yards.

Subjects walked to the track for testing at a specified time on the test day so that they would not have to wait at the track for over fifteen minutes before

completing the test. The subjects completed the running test in groups of five at ten minute intervals. All subjects were able to complete the six-minute run/walk.

Post-testing

At the end of eight weeks of training, all tests were re-administered in the same fashion as originally given and at the same facility. Assistants were again present to collect and record the data. The eight week training period did not include the pre- or post-testing days.

TRAINING PROCEDURES

All subjects of each group completed the pre-tests. Each group consisted of thirteen subjects at the beginning of the training period. Groups I and II participated in the exercise program twice a week for eight weeks. Group I ran/walked for fifteen minutes each session following ten minutes of static flexibility exercises. The exercises for flexibility did not contain any vigorous movements which would have affected the cardiovascular development. Group II participated in the continuous movement portion of the exercise program, again walking/running for fifteen minutes. Group III was designated as the control group and participated in no programmed exercise.

Roll was taken at each session and absences from sessions were recorded. During the eight weeks of

training, seven of the thirty-nine volunteers were excused because of more than two misses. The other three subjects were not used because of failure to appear for the post-testing session.

Rate of movement for each individual depended upon the individual's fitness level and ability. The subjects were routinely encouraged to increase their distance covered each session and to run as much as possible. Pacing was explained to all groups and demonstrated to them in an attempt to avoid individuals who would run very hard and then walk.

Encouragement to improve the distance covered each session by the subjects was given verbally as well as by the charting of progress. Music was used to reduce the monotony of running in circles. Special quiet games and activities following the exercise session were also used as incentives. Refreshments were served following the exercise periods consisting of non-carbonated soft drinks and cookies in limited quantities.

For the first four weeks of training, beginning March 29 and ending April 21, running/walking and the flexibility exercises were completed in a school gymnasium because of the cold and rainy weather. The second four weeks, beginning April 26 and ending May 19, were warm enough with enough light after seven o'clock in the evening, to run on the track outside of the school. Flexibility

exercises were continued outside on a level grassy surface close to the track to eliminate the need for an additional exercise facility. Groups I and II participated separately in the exercise programs, Group I attending at 6:00 p.m. and Group II at 7:00 p.m. on Tuesday and Thursday evenings.

DATA COLLECTION

A card for test results, as illustrated in Appendix B, page 72, was made for each subject, containing their name, random number, and group number. The front side of the card was arranged to record pre- and post-test results of all flexibility and endurance tests given. The back side was used to mark the position of a subject on the track at the completion of the six-minute run/walk.

DATA ANALYSIS

The mean scores for all groups on pre- and post-tests were figured and recorded. The pre- and post-test scores of each test for each group were compared to determine if a significant difference existed at the .05 level of significance, by use of the *t*-test for two related samples. All test measurements were analyzed in this manner for each group.

An analysis of variance for each test was used to determine if a significant difference at the .05 level of significance existed between groups I, II, and III for all

pre- and post-tests. For those tests which did show a significant difference existing between groups, Scheffe's test for analysis of variance was used to determine between which groups specifically the difference occured.

Chapter 4

ANALYSIS OF DATA

This chapter contains the analysis of data for the six-minute run/walk and the flexibility pre- and post-tests for all groups. The statistical procedures used for analysis included the t-test for two related samples and the analysis of variance.

SIX-MINUTE RUN/WALK

The six-minute run/walk was administered prior to and following an eight week exercise program to all groups. The mean scores of the pre- and post-tests for each group were subjected to the t-test for two related samples to determine if a significant difference existed at the .05 level. Further statistical procedures included the analysis of variance and the Scheffe test.

t-test Analysis of Data

As shown in Table 1, Group I (continuous motion with flexibility exercises) had a mean score of 641.7 yards for the pre-test with a standard deviation of 72.70. The mean post-test score of Group I was 726.70 and a standard

deviation of 122.07 was found. The mean difference of the pre- and post-tests was 85.0 yards.

Table 1

t-table for Pre and Post Six-Minute Run/Walk Scores for Group I

Source	Mean	Standard Deviation	t*
Pre-test	641.70	72.70	4.25*
Post-test	726.70	122.07	

*significant at the .05 level, with df = 9

From the statistical data, a t-test value of 4.25 was calculated. A value for $t \geq 1.833$ was necessary at the .05 level to be significant, using nine degrees of freedom.

The results of the data analysis showed that there was a significant increase in cardiovascular endurance scores as measured by the six-minute run/walk, for Group I. The run/walk program in combination with flexibility exercises could be considered successful in developing cardiovascular endurance in the mentally retarded subjects.

Analysis of the pre- and post-test mean scores by use of the t-test for Groups II and III showed no significant difference at the .05 level. The mean difference for Group II was 47.2 with a t-score of 1.01. The Group III

mean score difference was 6.67 with a t-score of 0.245 as illustrated in Table 13, page 66.

Analysis of Variance

The results of the analysis of variance for the pre-test scores of all groups were illustrated in Table 2. The between groups variance, with two degrees of freedom, showed a mean square of 68250.49, while the sum of squares was 136500.99. The mean square for the within group variance was 19461.53 with twenty-six degrees of freedom. The sum of squares for within groups variance was 505999.7. The sum of squares for total variance was 642500.69 with twenty-eight degrees of freedom.

Table 2

Analysis of Variance for the Six-Minute Run/Walk Pre-Test for All Groups

Source	Sum of Squares	df	Mean Squares	F*
Between	136500.99	2	68250.49	3.51*
Within	505999.70	26	19461.53	
Total	642500.69	28		

*significant at the .05 level

An F-value of 3.51 resulted, indicating that a significant difference was present in cardiovascular

endurance between groups before the experimental procedure was initiated. An $F \geq 3.34$ was necessary at the .05 level to be significant.

The Scheffe test for analysis of variance was used to determine where the difference in pre-test endurance means existed. The highest value was found between Groups I and III, with a value of 3.13. To be significant at the .05 level, an $F \geq 3.37$ must occur. Groups I and II showed a very slight difference of $F = 0.25$ and Groups II and III showed a difference of $F = 1.78$. A significant difference existed between groups before the administration of the exercise programs, with the major difference being between Groups I and III.

The analysis of variance between groups for the post-test mean scores showed no significant difference at the .05 level. The F-ratio, as shown in Table 14, page 66, was 1.0750. An F-ratio of 3.34 was necessary to be significant at the .05 level.

FLEXIBILITY MEASURES

Seven flexibility measures were taken for each subject including the ankle, knee, hip, and shoulder with the Leighton flexometer, and three practical measures, the Sit and Reach, Shoulder Elevation, and Trunk Extension.

All measures were analyzed using the t-test for two related samples and analysis of variance.

t-test Analysis of Data

Mean pre- and post-test scores for each group and each flexibility measure were analyzed by the t-test procedure. Significant differences at the .05 level were found in five of the seven measures for Group I, one measure for Group II, and no significant difference for any measure for Group III.

Flexometer measure-ankle. The mean pre-test score for Group I was 20.5 and the standard deviation was 23.11. The post-test mean score was determined to be 37.6 with a standard deviation of 19.59, as shown in Table 3. The mean difference was 17.1 between the pre- and post-test scores of the ankle measure.

Table 3

t-table for Pre and Post Ankle Measure for Group I

Source	Mean	Standard Deviation	t*
Pre-test	20.50	23.11	4.423*
Post-test	37.6	19.59	

*significant at the .05 level, with df = 9

A t-test value of 4.423 was found for Group I on the ankle measure. To be significant at the .05 level, with nine degrees of freedom, a $t \geq 1.833$ was necessary. Group I increased significantly in the ankle flexibility during the exercise program, as shown by the data analysis.

Analysis of the ankle measure for Group II showed a mean score of 16.4 and a standard deviation of 14.19, for the pre-test scores. The post-test mean was 44.8 with a standard deviation of 14.93, as illustrated in Table 4. The mean score difference for Group II was 26.4.

Table 4

t-table for Pre and Post Ankle Measure for Group II

Source	Mean	Standard Deviation	t*
Pre-test	16.4	14.19	4.368*
Post-test	44.8	14.93	

*significant at the .05 level, with df = 9

For Group II a t-value of 4.368 was derived, large enough to be significant at the .05 level, at nine degrees of freedom. The data analysis demonstrated that the ankle flexibility increased significantly for Group II during the exercise program.

The mean scores for the pre- and post-test of ankle flexibility for Group III were 42.67 and 46.22 respectively. A mean difference of 3.555 was found and a t-score of 0.897 was determined. This value was not significant at the .05 level with eight degrees of freedom, as shown in Table 15, page 67.

Flexometer measure-hip. Group I had a mean score of 73.5 and a standard deviation of 17.65 for the pre-test scores, illustrated in Table 5. The post-test mean score was 85.2 with a standard deviation of 12.06. The mean difference found between pre- and post-test scores was 11.7.

Table 5

t-table for Pre and Post Hip Measure for Group I

Source	Mean	Standard Deviation	t*
Pre-test	73.5	17.65	2.80*
Post-test	85.2	12.06	

*significant at the .05 level, with df = 9

A t-score of 1.833 was necessary to be significant at the .05 level with nine degrees of freedom. The hip measure of Group I was determined to have a t-score of 2.80.

This score showed a significant increase in hip flexibility for Group I.

Groups II and III did not show a significant increase in hip flexibility. The mean pre- and post-test scores for both groups can be found in Table 16, page 67. A t-score of 0.743 was found for Group II and a t-score of 1.324 was found for Group III, also illustrated in Table 16.

Flexometer measure-shoulder. The t-test analysis of data showed no significant difference for any of the groups on this flexibility measure. The mean scores, the standard deviation, and the t-scores for this measure can be found in Table 17, page 68 , for all groups.

Flexometer measure-knee. No significant difference was found for this measure between the pre-test and post-test scores for any of the groups. Group I had the highest value for t of 1.458, of all the groups. Groups II and III showed t-values of 1.082 and 0.299 respectively. These scores were not significant at the .05 level. The mean scores and standard deviations can be found in Table 18, page 68 .

Sit and Reach. Group I obtained a mean score of 13.2 for the pre-test with a standard deviation of 3.28. The post-test mean score was 13.8 with a standard deviation of 3.31. The mean difference was 0.60.

Table 6

t-table for Pre and Post Sit and Reach for Group I

Source	Mean	Standard Deviation	t*
Pre-test	13.2	3.28	1.907*
Post-test	13.8	3.31	

*significant at the .05 level, with df = 9

The t-score of 1.907 was significant at the .05 level with nine degrees of freedom for Group I. A $t \geq 1.833$ was necessary at the .05 level to be significant. The data analysis showed a significant increase in flexibility for the Sit and Reach for Group I.

Groups II and III did not show a significant difference between pre- and post-test scores for the Sit and Reach flexibility measure. The mean scores actually showed a decrease for both groups. Group II had a pre-test mean of 18.15 and a post-test mean of 17.9. Group III exhibited a pre-test mean of 18.28 and a post-test mean of 17.33. The t-test results are illustrated in Table 19, page 69.

Trunk Extension. The pre-test mean score for Group I was 31.58 with a standard deviation of 11.42. The mean of

the post-test was 38.97 with a standard deviation of 13.20. The mean difference was determined to be 7.39.

Table 7

t-table for Pre and Post Trunk Extension for Group I

Source	Mean	Standard Deviation	*t**
Pre-test	31.58	11.42	2.0076*
Post-test	38.97	13.20	

*significant at the .05 level, with df = 9

Group I was determined to have a *t*-score of 2.0076, significant at the .05 level with nine degrees of freedom. The flexibility of Group I as evaluated by the Trunk Extension, was shown to have increased significantly.

The pre- and post-test scores of Groups II and III, when anaylzed by the *t*-test did not show a significant difference. The mean scores and *t*-values for Groups II and III are illustrated in Table 20, page 69. Groups II and III did not increase in flexibility as evaluated by the Trunk Extension.

Shoulder Elevation. The mean score for Shoulder Elevation of Group I was 25.55. The standard deviation was 21.59. The post-test mean score was 45.54 with a standard deviation of 26.16. The mean difference between the pre- and post-test scores was 19.99.

Table 8

t-table for Pre and Post Shoulder Elevation for Group I

Source	Mean	Standard Deviation	t*
Pre-test	25.55	21.59	3.8532*
Post-test	45.54	26.16	

*significant at the .05 level, with df = 9

A t-score of 3.8532 was found for Group I on the shoulder extension measure. With nine degrees of freedom at the .05 level of significance, a $t \geq 1.833$ was necessary. The flexibility of Group I for this measure increased significantly.

Group II had a t-score of o.1648 and Group III had a t-score of 1.7562, as shown in Table 21, page 70. The mean scores are also shown in Table 21. The t-values for Groups II and III were not significant at the .05 level. Flexibility for these groups did not increase significantly as shown by the shoulder elevation.

Analysis of Variance

Data of all flexibility measures was statistically treated with the analysis of variance to determine if a significant difference existed between groups on either the pre-test or the post-test. If a significant difference was found, further analysis, using the Scheffe test, was completed to determine between which two groups the difference existed.

Flexometer measure-ankle. The sum of squares of between groups variance was 3367.65 with two degrees of freedom. The mean square was 1683.83. Within groups variance showed a sum of squares equal to 9232.90, with twenty-six degrees of freedom, and a mean square of 355.11. With twenty-eight degrees of freedom, the total variance sum of squares was 12600.55. These values are shown in Table 9 for the pre-test evaluation.

Table 9

Analysis of Variance for the Ankle Pre-Test for All Groups

Source	Sum of Squares	df	Mean Squares	F*
Between	3367.65	2	1683.83	4.7416*
Within	9232.90	26	355.11	
Total	12600.55			

*significant at the .05 level

The resulting F-value of 4.7416 was significant at the .05 level, where an $F \geq 3.34$ was necessary. A significant difference in ankle flexibility existed between groups on the pre-test.

Using the Scheffe test, an F-value of 1.8935 was found between Groups I and II, and a value of 3.2798 was found between Groups I and III. The significant difference between groups on the pre-test was shown to exist between Groups II and III, where an F-value of 4.605 was determined. An $F \geq 3.37$ was necessary at the .05 level of significance.

The post-test analysis of variance for the ankle measure showed no significant difference between groups. An F-ratio of 1.0750, as illustrated in Table 23, page 71, was determined for the post-test.

Flexometer measure-hip. For the pre-test analysis, the between groups sum of squares was 1978.87, with two degrees of freedom and the mean square was 989.43. The sum of squares for within groups variance was 7073.89 with twenty-six degrees of freedom, and a mean square of 272.07. The total variance had a sum of squares equal to 9052.76, with twenty-eight degrees of freedom.

Table 10

Analysis of Variance for the Hip Pre-Test for All Groups

Source	Sum of Squares	df	Mean Squares	F*
Between	1978.87	2	989.43	3.6366*
Within	7073.89	26	272.07	
Total	9052.76			

*significant at the .05 level

An F-value of 3.6366 was found for the pre-test analysis of variance for all groups. This value was significant at the .05 level. Hip flexibility differed significantly between groups on the pre-test.

The Scheffe test showed no significant difference between any two groups when comparing pre-test scores. The largest difference (F = 3.0972) existed between Groups II

and III. An F-value of 2.3523 was shown between Groups I and II and a value of 0.0609 existed for Groups I and III.

As shown in Table 23, page 71, an F-value of 1.2555 was determined in analysis of variance for the post-test. This was not significant at the .05 level, where an $F \geq 3.34$ was necessary to be significant. There was no significant difference at the end of the exercise program in hip flexibility between any groups.

Flexometer measure-shoulder. The sum of squares for between groups variance for the pre-test was 2277.79. The mean square was 1138.89. For within groups variance, the sum of squares was 7802.90 and the mean square was 300.11. With twenty-eight degrees of freedom, the total variance sum of squares was 10080.69.

Table 11

Analysis of Variance for the Shoulder Pre-Test for All Groups

Source	Sum of Squares	df	Mean Squares	F*
Between	2277.79	2	1138.89	3.7949*
Within	7802.90	26	300.11	
Total	10080.69			

*significant at the .05 level

For the pre-test, a significant F-value of 3.7949 was found in analysis of variance. An $F \geq 3.34$ was necessary at the .05 level, to be significant.

Analysis of variance using the Scheffe test did not show any significant difference between any two groups. An F-ratio of 2.59 was the highest value, existing between Groups II and III. An F-ratio of 0.0607 was computed for Groups I and II, and an F-ratio of 1.87 was computed for Groups I and III. To be significant at the .05 level, an $F \geq 3.37$ was necessary.

Post-test analysis of variance showed no significant difference between groups. The F-value for the post-test was 0.4431, not significant at the .05 level. Shoulder flexibility was not significantly different between groups on the post-test, as illustrated in Table 23, page 71.

Flexometer measure-knee. Analysis of variance for the pre- and post-tests showed no significant difference between groups. As illustrated in Table 22, page 70, the F-value for the pre-test was 1.5874. Table 23 further illustrated that the F-value for the post-test was 2.4235. An $F \geq 3.34$ was necessary at the .05 level to be significant with two degrees freedom. Knee flexibility was not significantly different between groups on the pre-test or post-test.

Sit and Reach. Analysis of variance of the pre-test showed a between groups variance sum of squares equal to 164.56, with two degrees of freedom, and a mean square of 82.28. The within groups variance had a sum of squares equal to 362.81, with twenty-six degrees of freedom and a mean square of 13.95. The sum of squares for total variance was 527.31.

Table 12

Analysis of Variance for the Sit and Reach Pre-Test for All Groups

Source	Sum of Squares	df	Mean Squares	F*
Between	164.56	2	82.28	5.8965*
Within	362.81	26	13.95	
Total	527.31			

*significant at the .05 level

The F-ratio for the Sit and Reach was 5.8965 for the pre-test scores. An $F \geq 3.34$ was necessary at the .05 level to be significant. The Sit and Reach was significantly different between groups on the pre-test.

A significant difference existed between Groups I and II and Groups I and III. The F-values, as determined by the Scheffe test, were 4.3899 for the Groups I and II

comparison, and 4.3845 for the Groups I and III comparison. The necessary value for significance at the .05 level, was 3.37. Group I was significantly lower on the pre-test Sit and Reach than either Group II or Group III.

Analysis of variance for the post-test showed no significant difference at the .05 level. The F-value, as shown in Table 23, page 71, was 3.1794.

Trunk Extension. An F-value of 0.5315 was calculated for the pre-test on Trunk Extension. This value was not significant at the .05 level. No further analysis was made for this test. The post-test for Trunk Extension did not show a significant difference between groups. The F-value was 1.9493, not significant at the .05 level.

Shoulder Elevation. Analysis of variance for the pre-test and post-test on the Shoulder Elevation did not show any significant difference between groups, as shown in Table 22, page 70, and Table 23, page 71, respectively. The pre-test F-ratio was 1.5876 and the post-test F-ratio was 0.0625. A greater difference existed between groups on the pre-test than on the post-test, although it was not significant.

SUMMARY

The t-test for two related samples was used to determine if a significant difference existed between pre- and post-tests for all evaluations and all groups. The t-test showed a significant difference between the pre- and post-tests of Group I for the six-minute run/walk, ankle flexibility, and hip flexibility as measured by the Leighton flexometer, the Sit and Reach, Shoulder Elevation, and the Trunk Extension. Group II was found to be significantly higher in ankle flexibility only, at the end of the program. However, increases were made in other measures, although not significantly. Analysis of data for Group III, using the t-test showed no significant difference between pre- and post-tests for any evaluation.

The analysis of variance showed significant differences existed between groups on the pre-test six-minute run/walk, ankle, hip, and shoulder flexibility as measured by the flexometer, and the Sit and Reach. No significant differences existed between groups on the post-tests at the .05 level of significance.

Based on the analysis of data, the null hypothesis was rejected. A significant increase was obtained in the group participating in continuous motion plus flexibility as compared to the group participating in continuous motion and to the control group, participating in no exercise.

Chapter 5

INTERPRETATION AND CONCLUSIONS

This study was completed to determine if a significant difference existed between a program of continuous motion (run/walk) preceded by a flexibility warm-up period and a continuous motion program in the development of cardiovascular endurance in mildly and moderately mentally retarded adults. Data was collected and analyzed as previously described in Chapters 3 and 4.

FINDINGS

The analysis of data established the following:

1. A significant difference existed between the pre-test and post-test six-minute run/walk for Group I (continuous motion plus flexibility exercises) at the .05 level.

2. Group II (continuous motion only) increased, although not significantly on the post-test six-minute run/walk.

3. Group III (control) did not increase significantly on the post-test six-minute run/walk.

4. A significant difference existed between the groups on the pre-test six-minute run/walk, but did not

exist on the post-test. The major difference occured between Groups I and III.

5. Group I increased significantly on the post-test flexibility measures of the ankle, hip, Sit and Reach, Trunk Extension, and Shoulder Elevation.

6. Group II increased significantly on the ankle measure of flexibility. Group III did not increase significantly on any of the flexibility measures.

7. Analysis of variance showed a significant difference between groups on pre-test flexibility measures, including the ankle, hip, shoulder, and Sit and Reach.

8. No significant difference existed on post-test flexibility measures between groups.

CONCLUSIONS

From the results of the statistical analysis and within the limitations of this study, the following conclusions were made:

1. Fifteen minutes of continuous motion (run/walk) in combination with static flexibility exercises twice a week does increase the cardiovascular endurance level of mildly and moderately retarded adults.

2. Fifteen minutes of continuous motion (run/walk) twice a week increased cardiovascular endurance in the retarded subjects.

3. Flexibility can be increased through a program of static flexibility exercises and continuous motion, but is not significantly increased by a continuous motion program alone.

4. The continuous motion in combination with flexibility exercises results in greater increases in cardiovascular endurance than does the continuous motion alone.

COMMENTS

Attitude appeared to play an important part in the efforts of the mentally retarded in physical activity. The attitudes and great fluctuations of emotions noticed in the subjects from session to session may have influenced their work efforts. Attitudes were generally favorable, but on certain days one or more subjects would not willingly put out their best effort. There was no objective way of determining maximum effort.

The group participating in the flexibility exercises received more attention as a result of the extra exercise time. This could be considered an important factor in the development of good attitudes in the mentally retarded, as this special population generally needs more attention than the normal population. This could have been an influencing factor on Group I's incentive to run and walk at their best ability.

The significant difference occurring between groups on the pre-test six-minute run/walk showed a higher initial cardiovascular endurance level in Group III than in Group I or Group II and a higher level in Group II than Group I. The effect of lower initial cardiovascular endurance on the further development of endurance is in question here. Some research has indicated that cardiovascular endurance increases may be more easily obtained in individuals with a lower initial fitness level than in those individuals with a higher initial fitness level. Groups I and II did not differ significantly on the initial testing, but Group I did acheive higher increases in endurance. It was further noted that the higher initial cardiovascular endurance mean could have been unfairly influenced by two scores of individuals portraying much higher fitness levels in Group III. The raw scores of Group III showed very minor fluctuations in the six-minute run/walk test for all individuals.

Because of the inherent properties of flexibility testing, some fluctuations possibly occured in measurement that a more exacting measure would not allow. However, inaccuracies would be expected to average the same for all groups. The significant improvement in Group I and lack of significant improvement in Groups II and III implied that an increase did occur, and was not the result of variation in measurement.

RECOMMENDATIONS FOR FURTHER STUDY

On the basis of the results of this study, the following questions were posed for further investigation:

1. What are the effects of running and walking on flexibility of individuals with a limited range of motion?

2. What are the effects of emotionality on the work efforts of the mentally retarded?

3. Would more or less flexibility training each week affect the development of cardiovascular fitness in a different manner?

4. What are the effects of flexibility training in combination with continuous motion on a more highly defined group of low flexibility level individuals?

5. What are the effects of increased attention on the work efforts of the mentally retarded?

BIBLIOGRAPHY

1. Asmussen, Erling, and K. Heeboll-Nielson. "Physical Performance and Growth in Children, Influence of Sex, Age, and Intelligence," Journal of Applied Physiology, XIII (January, 1956), 371-380.

2. Astrand, P.-O. Experimental Studies of Physical Working Capacity in Relation to Sex and Age. Copenhagen: Munksgaard, 1952.

3. Astrand, P.-O., and Kaare Rodahl. Textbook of Work Physiology. New York: McGraw-Hill, 1970.

4. Auxter, David M. "Differences in Performance on Selected Tasks of Kinesthesis, Flexibility, and Strength Among Intellectually Typical Boys and Non-Brain-Damaged, Brain-Damaged, and Undifferentiated Educable Mentally Retarded Boys." PhD Dissertation (microcard), Boston: Boston University, 1964.

5. Baylor, Terry Leland. "Comparison of Heart Rates of Two Groups of Mentally Retarded Males." Unpublished Master's Thesis, University of Texas, 1971.

6. Brace, David K. "Physical Education and Recreation for Mentally Retarded Pupils in Public Schools." The Research Quarterly, XXXIX (October, 1968), 779-782.

7. Brace, David K. "Motor Learning of Feeble Minded Girls." The Research Quarterly, XIX (December, 1948), 269-275.

8. Brown, Joe. "Comparative Performance of Trainable Mentally Retarded on the Kraus-Weber Test." The Research Quarterly, XXXVIII (May, 1967), 348-354.

9. Buccola, Victor A., and William Stone. "Effects of Jogging and Cycling Programs on Physical and Personality Variables in Aged Men." The Research Quarterly, XLVI (May, 1975), 134-139.

10. Campbell, Jack. "Improving the Physical Fitness of Retarded Boys." Mental Retardation, XII (June, 1974), 31-35.

11. Cooper, Kenneth H. The New Aerobics. New York: M. Evans, 1970.

12. Corbin, Charles B. A Textbook of Motor Development. Dubuque: Wm. C. Brown, 1973.

13. Cureton, Thomas K. "Flexibility as an Aspect of Physical Fitness." The Research Quarterly, XII (October, 1941), 381-390.

14. Cureton, Thomas K. The Physiological Effects of Exercise Programs on Adults. Springfield: Charles C. Thomas, 1969.

15. DeMoor, Janice C. "Individual Difference in Oxygen Debt Curve Related to Mechanical Efficiency and Sex." Journal of Applied Physiology, VI (February, 1954), 460-466.

16. DeVries, Herbert A. "Evaluation of Static Stretching Procedures for Improvement of Flexibility." The Research Quarterly, XXXIII (March, 1962), 222-229.

17. DeVries, Herbert A. Physiology of Exercise. Dubuque: Wm. C. Brown, 1974.

18. Drowatzky, John N. Physical Education for the Mentally Retarded. Philadelphia: Lea and Febiger, 1971.

19. Evan, Jane R. "A Comparison of the Synchronous Rhythmic Motor and Spontaneous Rhythmic Movement of EMR and Normal Children." PhD Dissertation (microfiche), Ohio State University, 1972.

20. Fait, Hollis F. Special Physical Education: Adapted, Corrective, Developmental. Philadelphia: W.B. Saunders, 1966.

21. Francis, R. S., and G. L. Rarick. "Motor Characteristics of the Mentally Retarded." American Journal of Mental Deficiency, LXIII (1959), 792-811.

22. Gettman, Larry R., Christopher Milesis, and Michael L. Pollock. "Physiological Responses of Adult Men to Different Durations and Frequencies of Training." Paper presented at the Convention of the American Alliance of Health, Physical Education, and Recreation, Milwaukee, April, 1976.

23. Grobaker, Mark R. and G. Alan Stull. "Thermal Applications as a Determiner of Joint Flexibility." U.S., Educational Resources Information Center, ERIC Document ED 098 151, 1974.

24. Hayden, Frank J. Physical Fitness for the Mentally Retarded. Ontario: Metropolitan Toronto Association for Retarded Children, 1964.

25. Heeboll-Nielson, K. "The Physical Performance of Mentally Retarded Patients and Their Possibilities for Being Trained-Investigated with Psycho-Technical Tests." Communications for the Danish National Association for Infantile Paralysis, March, 1967.

26. Jackson, J. H., B. J. Sharkey, and L. P. Johnston. "Cardiorespiratory Adaptation to Training at Specified Frequencies." The Research Quarterly, XXXIX (May, 1968), 295-300.

27. Johnson, Barry L., and Jack K. Nelson. Practical Measurements for Evaluation in Physical Education. Minneapolis: Burgess, 1974.

28. Johnson, Ronald. "Recreational Activities for the Mentally Retarded." Seminar Presentation, University of Southwestern Louisiana, AAHPER Project on Recreation and Fitness for the Mentally Retarded, April, 1967.

29. Jokl, Ernst. The Clinical Physiology of Physical Fitness and Rehabilitation. Springfield: Charles C. Thomas, 1958.

30. Lanphear, Margaret L. "Fractionated Reaction and Reflex Times on Nine to Twelve Year Old Mentally Retarded Boys." Master's Thesis (microfiche), University of Massachusetts, March, 1972.

31. Liese, James E. and Harold A. Lerch. "Physical Fitness and Intelligence in Trainable Mentally Retarded." Mental Retardation, XII (October, 1974), 50-51.

32. Milton, George C. "The Effects of Three Programs of Long Distance Running and an Isometric Exercise Program on the Development of Cardiovascular Efficiency." PhD Dissertation (microcard), Louisiana State University, 1966.

33. Moran, Joan May, and Leonard H. Kalakian. Movement Experiences for the Mentally Retarded or Emotionally Disturbed Child. Minneapolis: Burgess, 1974.

34. Morehouse, Laurence E. Lab Manual for Physiology of Exercise. St. Louis: C.V. Mosby, 1972.

35. Morehouse, Laurence E., and Leonard Gross. Total Fitness in Thirty Minutes a Week. New York: Simon and Schuster, 1975.

36. Nordgren, Bengt. "Physical Capabilities in a Group of Mentally Retarded Adults." Scandinavian Journal of Rehabilitation Medicine, II (1970), 125-132.

37. Operation Sports, Health, and Recreation Program. Texas State Department of Mental Health and Mental Retardation, U.S., Educational Resources Information Center, ERIC Document ED 079 269, 1971.

38. Peebler, Jack R. Controlled Exercise for Physical Fitness. Springfield: Charles C. Thomas, 1962.

39. Peries, Vincent P. "Sub-maximal Cardiovascular Endurance of Trainable Mentally Retarded Boys." PhD Dissertation (microfiche), Ohio State University, 1973.

40. Rarick, G. Lawrence, D. Alan Dobbins, and Geoffrey D. Broadhead. The Motor Domain and Its Correlates in Educationally Handicapped Children. Englewood Cliffs: Prentice Hall, 1976.

41. Rarick, G. Lawrence, H.J. Widdop, and G. D. Broadhead. "The Physical Fitness and Motor Performance of Educable Mentally Retarded Children." Exceptional Children, XXXVI (March, 1970), 509-519.

42. Roscoe, John T. Fundamental Research Statistics for the Behavioral Sciences. New York: Holt, Rinehart, and Winston, 1975.

43. Sengstock, Wayne L. "Physical Fitness of Mentally Retarded Boys." The Research Quarterly, XXXVII (March 1966), 113-120.

44. Shannon, Charley H. "Heart Rates of Three Age Groups of Normal and Mentally Retarded Boys." PhD Dissertation (microfiche), University of Texas, 1970.

45. Shepard, Roy J. Endurance Fitness. Toronto: University of Toronto Press, 1969.

46. Sherrill, Claudine. Adapted Physical Education and Recreation. Dubuque: Wm. C. Brown, 1976.

47. Solomon, Amiel, and Roy Pangle. "Demonstrating Physical Fitness Improvement in the Educable Mentally Retarded." Exceptional Children, XXXIV (November, 1967), 177-181.

48. Stein, Julian U. "Motor Function and Physical Fitness of Mentally Retarded." Rehabilitation Literature, XXIV (August, 1963) 230-240.

49. Talag, Trinidad S. "Residual Muscular Soreness as Influenced by Concentric, Eccentric, and Static Contractions." The Research Quarterly, XLIV (December, 1973), 458-469.

50. Voss, Donald G. Physical Education Curriculum for the Mentally Handicapped. Madison: Wisconsin State Department of Public Instruction, 1971.

51. Wilson, Philip K. Adult Fitness and Cardiac Rehabilitation. Baltimore: University Park, 1975.

52. Wortis, Joseph, Ed. Mental Retardation and Developmental Disabilities. New York: Brunner/Mazel, 1974.

53. Zeigler, Robert G. "The Frequency of Maximum Effort Most Favorable for the Development of Endurance in College Students." Unpublished Master's Thesis, Pennsylvania State University, 1960.

APPENDIX A

Table 13

t-table for Pre and Post Six-Minute Run/Walk for Groups II and III

Group	Source	Mean	Standard Deviation	df	t*
II	Pre-test	685.8	174.51	9	1.01
	Post-test	733.0	140.79	9	
III	Pre-test	806.66	270.97	8	
	Post-test	813.33	278.14	8	

* at .05 level of significance, 9 df, $t \geq 1.83$
8 df, $t \geq 1.86$

Table 14

Analysis of Variance for Six-Minute Run/Walk Post-test for All Groups

Source	Sum of Squares	df	Mean Squares	F*
Between	43457.21	2	21728.61	1.075
Within	525486.10	26	20211.00	
Total	568943.31	28		

* at .05 level of significance, $F \geq 3.34$

Table 15

t-table for Pre and Post Ankle Measure for Group III

Source	Mean	df	Standard Deviation	t*
Pre-test	42.67	8	14.45	0.897
Post-test	46.22	8	13.76	

*at .05 level of significance, df = 8, $t \geq 1.86$

Table 16

t-table for Pre and Post Hip Measure for Groups II and III

Group	Source	Mean	Standard Deviation	df	t*
II	Pre-test	89.5	14.09	9	0.74
	Post-test	85.7	12.55	9	
III	Pre-test	70.89	26.09	8	1.32
	Post-test	75.78	18.25	8	

* at .05 level of significance, 9 df, $t \geq 1.83$
8 df, $t \geq 1.86$

Table 17

t-table for Pre and Post Shoulder Measure for Groups I, II, and III

Group	Source	Mean	Standard Deviation	df	t*
I	Pre-test	138.6	20.02	9	1.47
	Post-test	147.1	17.27	9	
II	Pre-test	135.9	16.36	9	0.57
	Post-test	151.5	12.31	9	
III	Pre-test	154.0	11.15	8	0.20
	Post-test	153.11	11.32	8	

*at .05 level of significance, 9 df, $t \geq 1.83$
8 df, $t \geq 1.86$

Table 18

t-table for Pre and Post Knee Measure for Groups I, II, and III

Group	Source	Mean	Standard Deviation	df	t*
I	Pre-test	91.7	18.35	9	1.46
	Post-test	101.2	13.34	9	
II	Pre-test	103.9	11.18	9	1.08
	Post-test	108.7	8.19	9	
III	Pre-test	94.78	14.69	8	0.30
	Post-test	95.33	15.41	8	

*at .05 level of significance, 9 df, $t \geq 1.83$
8 df, $t \geq 1.86$

Table 19

t-table for Pre and Post Sit and Reach for Groups II and III

Group	Source	Mean	Standard Deviation	df	t*
II	Pre-test	18.15	2.23	9	0.58
	Post-test	17.90	3.14	9	
III	Pre-test	18.28	4.79	8	1.26
	Post-test	17.33	4.61	8	

*at .05 level of significance, 9 df, $t \geq 1.83$
8 df, $t \geq 1.86$

Table 20

t-table for Pre and Post Trunk Extension for Groups II and III

Group	Source	Mean	Standard Deviation	df	t*
II	Pre-test	27.85	4.86	9	0.21
	Post-test	28.51	8.95	9	
III	Pre-test	31.32	7.85	8	0.08
	Post-test	31.53	12.05	8	

*at .05 level of significance, 9 df, $t \geq 1.83$
8 df, $t \geq 1.86$

Table 21

t-table for Pre and Post Shoulder Elevation for Groups II and III

Group	Source	Mean	Standard Deviation	df	t*
II	Pre-test	41.81	18.78	9	0.16
	Post-test	40.63	24.92	9	
III	Pre-test	30.40	18.83	8	1.76
	Post-test	42.93	36.49	8	

*at .05 level of significance, 9 df, $t \geq 1.83$
8 df, $t \geq 1.86$

Table 22

Analysis of Variance for Knee, Shoulder Elevation, and Trunk Extension Pre-test for All Groups

Test	Source	df	Sum of Squares	Mean Squares	F*
Knee	Between	2	800.89	400.45	1.59
	Within	26	6558.56	252.25	
	Total	28	7359.45		
Trunk Extension	Between	2	85.67	42.84	0.53
	Within	26	2095.16	80.58	
	Total	28	2180.83		
Shoulder Elevation	Between	2	1389.04	694.52	1.59
	Within	26	11373.75	437.45	
	Total	28	12762.79		

*at .05 level of significance, 28 df, $F \geq 3.34$

Table 23

Analysis of Variance for Post-test Flexibility Measures for All Groups

Test	Source	df	Sum of Squares	Mean Squares	F*
Ankle	Between	2	415.75	207.88	0.70
	Within	26	7771.56	298.91	
	Total	28	8187.31		
Knee	Between	2	855.27	427.63	2.42
	Within	26	4587.70	176.45	
	Total	28	5442.97		
Hip	Between	2	581.92	290.96	1.26
	Within	26	6025.26	231.93	
	Total	28	6607.17		
Shoulder	Between	2	186.95	93.47	0.44
	Within	26	5484.29	210.93	
	Total	28	5671.21		
Sit and Reach	Between	2	97.71	48.85	3.18
	Within	26	399.50	15.37	
	Total	28	497.21		
Shoulder Elevation	Between	2	120.39	60.19	0.06
	Within	26	25033.35	962.82	
	Total	28	25153.74		
Trunk Extension	Between	2	576.89	288.45	1.95
	Within	26	3847.23	147.97	
	Total	28	4424.12		

* at .05 level of significance, 28 df, $F \geq 3.34$

APPENDIX B

Figure I

Data Card for Individual
Test Results

Group # _____ ID# _____ Subject's Name _____

Endurance Test (yds)

Pre _____ Post _____

Practical Test Worksheet

Pre		Post	
I	F	I	F
____	____	____	____
____	____	____	____
____	____	____	____

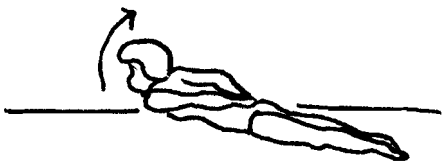
Flexibility

Flexometer:	Pre	Post
Ankle	_____	_____
Hip	_____	_____
Shoulder	_____	_____
Knee	_____	_____
Practical:		
Sit & Reach	_____	_____
S. Eleva.	_____	_____
T. Exten.	_____	_____

Figure 2

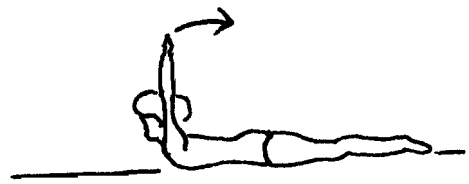
Flexibility Exercises for Upper Extremities

a. Shoulder adductor



b. Chest and shoulder elevation

c. Arm lift



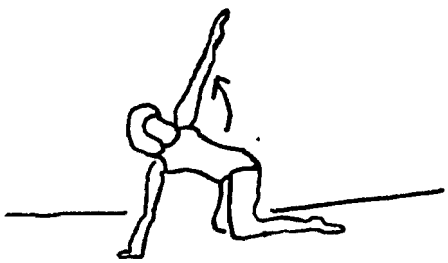
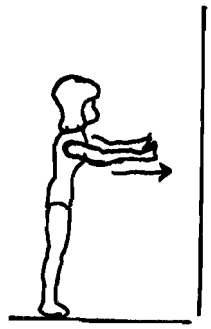


Figure 3

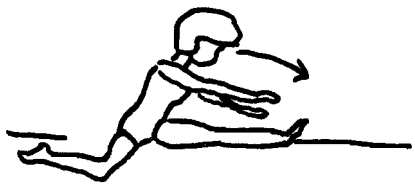
Flexibility Exercises for Lower Extremities

a. Achilles' tendon stretch

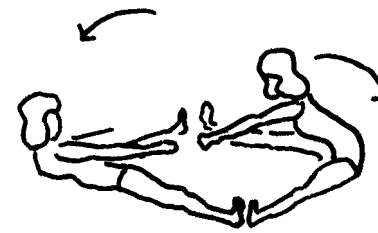


b. Hamstring pull

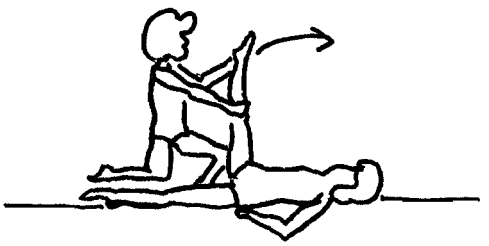
c. Hurdler



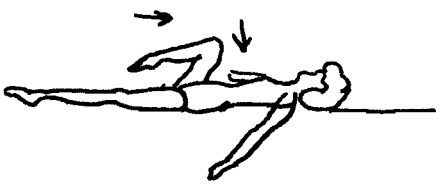
d. Partner stretch



e. Leg lift



f. Knee pull



g. Floor touch