AN ELECTROMYOGRAPHIC STUDY OF THE EFFECT OF PARTICIPATION IN THREE SELECTED GROSS MOTOR ACTIVITIES ON RESIDUAL NEUROMUSCULAR TENSION

A DISSERTATION

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

ORIENTATION TO THE STUDY

Introduction

The capacity to release neuromuscular tension and adjust effort and movement patterns for a smoother efficient functioning of motor response centers around relaxation (63, p. 128). Relaxation by definition means release of tension (75, p. R-17). This does not necessarily imply a complete reduction of tension in the skeletal muscles, but it may involve a redistribution of the tension through which a balance is achieved within the body over a period of time. Steinhaus (73, p. 119) indicates that the mind is at rest when muscular relaxation is attained. Edmund Jacobson, a pioneer in the scientific evaluation of relaxation, made a significant contribution in this area by the demonstration of the value, practicality, and accessibility of relaxation for everyone (43). Cary (19, p. 217) discusses the role of physical exercise in a program of relaxation, pointing out the need for the proper control and direction of muscular activity. She recommends exercises with repetitious rhythm which allow antagonistic muscles to be brought into play. Rathbone (64, p. 79), supporting this position, recommends

rhythmic exercises which involve free and loose swinging movements for the reduction of tonic contractions in localized muscles.

Participation in games, sports, dance, and exercise has long been believed to generate innumerable values and outcomes. The direct relationship of such activities on relaxation is open to doubt because of the lack of scientific research in the area (20, p. 22). According to Moore (57, p. 70), a psychiatrist, play and sports provide a medium for the release of muscular and emotional tensions. Professional physical educators state that muscular activity provides a physical outlet for accumulated muscular and emotional tensions which seem to be relieved by the action of the skeletal muscles (20).

Authorities in tension control have stressed that relaxation is a skill that must be learned (43, p. 64). Thus, the scientific experimentation conducted has primarily been concerned with the effectiveness of the techniques taught and not with the direct effect of the participation in physical activity upon relaxation. Larsson, Linderholm, and Ringqvist (49, p. 310), and deVries (31, p. 1) appear to be the only investigators that have scientifically studied the effect of participation in controlled exercise programs directly upon relaxation. At least one authority contends that the value of participation in physical exercise as a

tension-releasing medium cannot be denied, but objective evidence is incomplete (68, p. 129).

Statement of the Problem

The present investigation entailed a study of sixty women enrolled at the Texas Woman's University during the academic year of 1969-1970, to determine the effect of participation in light, moderate, and heavy levels of gross motor activity upon residual neuromuscular tension as measured by quantitative electromyography. The recreational activities selected for the purpose of the study were bowling, swimming, and modern dance. The amount of residual tension in the elbow flexor muscle group and the rectus femoris muscle was measured by electromyographic techniques before, during, and after an experimental period of nine weeks participation in the selected activities. During the initial and final testing periods, electromyographic measurements were made approximately one hour after the activity, repeated six hours later, and after twenty-four hours. Upon the basis of the findings, a conclusion was drawn concerning the effect of participation in light, moderate, and heavy levels of recreational type motor activities on residual neuromuscular tension.

Rationale for the Study

The importance of learning how to provide a physiological decrease in nervous activity and the accompanying

release of muscular tension cannot be over emphasized. According to deVries (29, p. 251), residents of the United States spend more than three hundred million dollars on sedatives for the release of undue neuromuscular tension. Cary (19, p. 219) predicted a rise in neuromuscular tension conditions on the basis of vital statistics. Many individuals are unable to relax naturally. This has prompted a concern for the selection of activities which could contribute to a desired state of neuromuscular tension for efficient movement.

A popular belief expressed by several coaches and physical educators (29, 5, 61), as well as physicians (18), is that participation in physical activity and sports can contribute to the relief of tension. A joint committee of the American Medical Association and the American Association for Health, Physical Education and Recreation (38, p. 5) stated that the relationship of physical activity to mental health merited consideration and that exercise of a pleasurable nature will be more apt to foster continued participation. This statement suggests that recreational type activities should be studied scientifically to determine values of participation.

The proposed investigation is concerned with the influence of participation in three levels of motor activity of a recreational type, a highly active level, a moderate level, and a relatively sedentary level, upon residual

neuromuscular tension in subjects may be lowered by participation in motor activities through which physical conditioning occurs, and that the benefits gained are dependent upon the physiological intensity level of the activity in which one participates.

Definitions and/or Explanations of Terms

For the purpose of clarification, the following definitions and/or explanations of terms were established for use throughout the study:

Tension: ". . . a rigid state of contractile muscle . . ."(6, p. 25).

Residual Tension: ". . . a fine tonic contraction along with slight movement or reflexes" (43, p. 87).

Levels of Motor Activity: For the purpose of this study levels of motor activity refer to a classification of motor activities as light, moderate or heavy. Upon the basis of previous studies (70, 72, 86), the recreational type activities of bowling, swimming, and modern dance were empirically placed into the respective categories of light, moderate, and heavy levels of activity. The classification of these specific activities also was based upon the knowledge that they were taught at the beginner level in a required physical education program for college women. The classes met approximately forty-five minutes per day, three days a week, with the experimental period extending for a period of nine weeks.

Delimitations of the Study

The study was subject to the following delimitations:

A. The purposeful selection of the motor activities of bowling, swimming, and modern dance as representing three different levels of energy expenditure, light, moderate, and heavy.

B. The selection of freshman and sophomore women enrolled in the activity classes of bowling, swimming, and modern dance of the required physical education program at the Texas Woman's University. Approximately fifteen women enrolled in each of the designated classes participated in the study.

C. The participation of fifteen women volunteers, junior and senior students who were not enrolled in the required physical education program or in the College of Health, Physical Education and Recreation, as a control group. The subjects in the control group participated in no scheduled program of physical activity for nine weeks.

D. The equation of the four groups in the best possible manner with respect to previous background, American College Test or Scholastic Aptitude Test scores, and age. Specifically, the subjects in the swimming group, and the control group had not competed or performed in organized competition,

and the subjects in the modern dance group had received no formal dance lessons during the previous four years.

E. The participation of the subjects in a swimming group, a bowling group, and a modern dance group in the regular physical education program, with the experimental period extending for a period of nine weeks. The swimming class and the modern dance class met approximately forty-five minutes each day, three days a week, and a bowling class met approximately sixty-five minutes each day, two days a week.

F. The objectivity, reliability, and validity of the selected instruments in the measurement of the desired characteristics for each subject.

Purposes of the Study

The purpose of the study was to determine the influence of the participation in nine weeks of recreational types of light, moderate or heavy levels of gross motor activity on residual neuromuscular tension as measured by quantitative electromyography of the elbow flexor muscle group and rectus femoris muscle. Specifically, the following null hypotheses were tested.

A. There is no significant difference between the influence of participation in the motor activity of bowling and non-participation in the motor

activity upon the residual neuromuscular tension in the elbow flexor muscle group and the rectus femoris muscle as measured approximately one hour after the activity, repeated six hours later, and after twenty-four hours.

B. There is no significant difference between the influence of participation in the motor activity of swimming and non-participation in motor activity upon the residual neuromuscular tension in the elbow flexor muscle group and the rectus femoris muscle as measured approximately one hour after the activity, repeated six hours later, and after twenty-four hours.

C. There is no significant difference between the influence of participation in the motor activity of modern dance and non-participation in motor activity upon the residual neuromuscular tension in the elbow flexor muscle group and the rectus femoris muscle as measured approximately one hour after the activity, repeated six hours later, and after twenty-four hours.

D. There is no significant difference between the influence of participation in the motor activities of bowling, swimming, and modern dance upon the residual neuromuscular tension in the elbow flexor muscle group and the rectus femoris

muscle as measured approximately one hour after the activity, repeated six hours later, and after twenty-four hours.

Summary

The capacity to release neuromuscular tension and adjust effort and movement patterns of motor response centers around relaxation. The utility and attainable degree of relaxation has been scientifically demonstrated, but the direct relationship of participation in physical education activities on relaxation is open to doubt because of the lack of scientific verification. Professional leaders in physical education and medicine, however, support the belief that muscular activity provides a physical outlet for the release of emotional and muscular tension.

The purpose of the present investigation was to determine the influence of participation in recreational types of light, moderate or heavy levels of gross motor activity on residual neuromuscular tension in the elbow flexor muscle group and the rectus femoris muscle of measurements taken approximately one hour after the activity, repeated six hours later, and after twenty-four hours as determined by quantitative electromyography. Sixty female subjects were selected to participate in the study. Tests were administered before, during, and after an experimental period of nine weeks participation or non-participation in

the selected activity classes of bowling, swimming, and modern dance.

Chapter II presents the review of literature that was found pertinent to this investigation.

CHAPTER II

REVIEW OF SELECTED RELATED LITERATURE

Introduction

A survey of the literature disclosed that the therapeutic value of participation in motor activities of a recreational type upon residual neuromuscular tension is questionable because of the limited objective research that has been conducted. The possible relationship between participation in physical activity and relaxation and/or mental health has been projected from empirical and clinical evaluation. According to Bucher (15, p. 491), leisure time activities of a recreational type are considered an excellent means for the alleviation of tension and boredom, and are vehicles to relaxation. Menninger (55, p. 343) indicates that physical exercise provides an outlet for instinctive aggressive drives, relaxation, and supplements daily work by allowing the individual a change from the regular work in the redirection of emotional tensions. Moore (57, p. 70) suggests that the more valuable play will be found in sport forms where there is actual competition than mere forms of calisthenics. Beisser (7, p. 69) states that the sports arena affords an opportunity to allow the participant to

enact a personal drama within acceptable norms of society. Tutko (76, p. 12) states that individuals participate in athletics for different personal reasons, examples being prestige, feelings of inadequacy, to create havoc, or sadistic tendencies.

The related literature pertinent to the investigation centers around writings which have resulted from observations and clinical evaluation, and the objective analysis of relaxation or residual neuromuscular tension by electromyographic techniques. A review of selected literature considered important to the design of the study is presented in this chapter under the following topics: (1) Relaxation, (2) Relationship between Exercise and Resting Muscle Action Potential, (3) Relationship between Exercise, Physical Activity, Dance, and Tension, and (4) Selected Factors Which May Influence the Study.

Relaxation

Jacobson (40) has spent almost one-half a century studying methods of determining tension and relaxation. The earliest reported measurements were determined by an analysis of the knee-jerk reflex. In 1925, Jacobson and Carlson (44, p. 324) conducted a study to determine the knee-jerk reflex action of seven subjects while resting quietly in a normal state of relaxation followed by a deep relaxation state in which a concerted effort was made to consciously relax all muscles of the body more completely.

Four of the subjects had received previous training in progressive relaxation. Control tests were administered while the subject relaxed in a natural manner in a semi-reclining chair. Following the control tests, the subject was instructed to relax completely all of the muscles of the body. Approximately fifteen minutes were allowed for each subject to achieve the desired state. Some subjects attained a degree of relaxation in which the knee-jerk reflex was abolished. This indicated to the investigators that voluntary relaxation while awake may produce a degree of tension lower than that of light sleep. Jacobson and Carlson concluded that the knee-jerk action decreases with advanced relaxation.

Jacobson (39, p. 98), using electromyographic equipment, analyzed the ability of ten athletes from the University of Chicago to relax from quantitative measurements taken of the forearm flexor muscles. A comparison was made of the athletes as a group in relation to a group of students trained in relaxation techniques, and to a group of students untrained in techniques of relaxation. Measurements were taken and recorded with an amplifier galvanometer assembly. Each subject was instructed to bend the right arm upon hearing a telegraph key click and then to relax following a second click. Jacobson concluded that the athletes succeeded in relaxing a particular muscle group to a greater extent than subjects untrained in relaxation techniques. Jacobson cites that individual athletes can be selected who attained

the level of relaxation achieved by individual subjects trained in relaxation techniques. Although the ability to relax was analyzed, the investigator did not evaluate the effect of the participation in athletics directly upon residual neuromuscular tension.

The accuracy of the measurement of muscle tension was enhanced with the development of the Integrating Neurovoltmeter by Jacobson (41, p. 415). Voltage changes in muscles as low as one-millionth of an electrical volt can be recorded. The Neurovoltmeter allowed rectified action potentials to be averaged over a period of time (41, p. 418).

Haverland (37) conducted a study of eighty-four women enrolled at the University of Illinois, to determine whether a six weeks training period in Jacobson's techniques of relaxation or in conditioning principles, advocated by Rathbone (63), could bring about significant improvements in coordination, steadiness, or reaction time. The subjects in the control group, and the experimental group which received relaxation training, were volunteer subjects who were enrolled in the regular physical education classes in the areas of dance, swimming, individual sports, and team sports. In addition to attending regular classes, the subjects in the experimental group participated in two forty-minute periods of instruction in relaxation training each week. The third group, which followed conditioning principles advocated by Rathbone, was a class receiving instructions in Danish

gymnastics for two forty-minute periods each week. The experimental period extended for six weeks.

Haverland found that the relaxation training group improved performance significantly in reaction time, aiming tests, and in the tracing and steadiness of motor control tests. The control group and the conditioning group also improved performance significantly on the tracing and steadiness of motor control tests. Haverland concluded that performance in certain areas of motor skills involving smoother, coordinated, and precise movements may be enhanced by relaxation training, and that Jacobson's techniques of relaxation were superior to the Danish method.

Watson (81) conducted a study of sixty-four undergraduate college women enrolled at the University of Oregon, to determine whether or not the ability to relax is related to athletic ability. Electromyographic techniques were used to determine the level of muscle action potential in each subject of the trapezius, biceps, quadriceps femoris, and hamstring muscles. Measurements of each subject's tension were taken on three occasions during a period of two and one-half weeks. Each subject was instructed to relax while making simple movements involving the arms and legs, following the directions given by the investigator. Watson concluded that there was no significant difference in the ability to relax between the women who demonstrated high athletic skill and those who demonstrated low athletic skill.

Paben (60) compared the learning of a novel gross motor skill by the subjects in the experimental group who were taught techniques of relaxation and tension control to the subjects in the control group who were not trained in techniques of relaxation and tension control. Each group was comprised of fifteen college women enrolled at the Texas Woman's University. Electromyographic techniques were used to determine the state of tension control each subject achieved in the wrist and forearm flexors and extensors. Paben concluded that the program in relaxation and muscular tension control was of significant value in learning a novel gross motor skill.

Benson (9) conducted a study of twenty male students at the University of California, Los Angeles, to determine the effects of relaxation instructions on swimming improvement. The subjects comprised two groups, a control group and an experimental group. The subjects in the control group received twelve weeks of swimming instruction in a regular scheduled class which met three times a week, whereas, the subjects in the experimental group received twelve weeks of swimming instruction, meeting twice each week for swimming and once each week for training in relaxation. The subjects were selected on a voluntary basis, and on the amount of residual neuromuscular tension before and after the experimental period. Three swimming tests were administered to

each subject to evaluate speed in swimming, before and after the experimental period.

Each extremity was tested for four types of tension during the designated testing sessions in the manner of Rathbone (63, p. 175), that is (1) assistance used by the subject in raising extremity, (2) resistance or the opposition by the subject to movement of the extremity, (3) the manner the limb positioned itself posturally when moved up or down and (4) the manner the extremity continued in the motion started by the experimenter. Each movement was rated according to a numerical value assessment. The results indicated that relaxation training was an asset to beginner swimmers. Benson concluded that training in relaxation techniques results in an increased ability to consciously relax and facilitates swimming speed improvement among individuals who are extremely tense.

Walton (80) conducted a study of eighteen college women enrolled in a beginning tennis class at the Texas Woman's University, to determine the relationship between the ability of individuals to consciously relax the muscular tension in selected muscles of the upper extremity and success in tennis. A one group design was used. The subjects were taught selected gross motor skills in tennis. Skill tests were used to evaluate the proficiency levels each subject achieved. Each subject then participated in a round-robin type tournament. The percentage of games each subject

won was calculated. Electromyographic techniques were used to determine the ability of each subject to consciously relax specific muscle groups. Walton concluded that the more efficient learners, as measured in the study, were unable to relax specific muscle groups to a higher degree than the subjects who demonstrated less efficiency in the learning of selected tennis skills.

Chaney (21) conducted a study of forty-eight female students at the Texas Woman's University, to determine the relationship between specific relaxation ability and changes in the performance of a novel motor skill and a novel mental skill under induced tension. Electromyographic techniques were used in the collection of data. The subjects comprised three groups, a control group in which the subjects participated in a program of body mechanics for a period of six weeks, a placebo control group in which the subjects took a sugar tablet daily for a period of six weeks, and the experimental group in which the subjects received daily instructions and practice in Jacobson's techniques of relaxation for six weeks. Chaney found that the subjects in the experimental group did not demonstrate a significant change in the performance of a novel motor skill nor in the ability to relax while performing when compared with the two other groups who were subjected to different experimental treatments.

Jacobson (40) has demonstrated the occurrence of muscle tension, evidenced by the electromyograph, in

emotional states. Sainsbury and Gibson (67, p. 216), using electromyographic techniques, conducted a preliminary investigation of twenty-six patients diagnosed as possessing anxiety states, and of thirty healthy soldiers measured in a relaxed state, to determine if an increased innervation of the voluntary muscles is a physiological accompaniment. The muscle tension of the anxious patients was found to be significantly higher than the muscle tension of the healthy subjects.

An inventory was filled out on thirty anxious and tense patients, recording symptoms, feelings, and bodily complaints. Electromyographic observations indicated that those with the most clinical manifestation of anxiety and tension displayed the greatest muscle tension. Sainsbury and Gibson found a significant relationship between the concordance of tension levels in four muscle groups. Upon the basis of the findings, the investigators concluded that the body musculature as a whole receives increased innervation in patients who are anxious. Sainsbury and Gibson suggested that an increase in bodily tension in one area can be reliably associated with tension in other areas of the body.

Relationship between Exercise and Resting Muscle Action Potential

A survey of studies on the effect of the participation in exercise directly upon residual neuromuscular

tension, determined by electromyography, revealed that limited research had been conducted to evaluate its status. Larsson, Linderholm, and Ringqvist (49, p. 310) analyzed the changes in the electromyograph of subjects after various types of standardized muscular work. Subjects were four females and sixteen males of the University of Umea, Sweden, with a median age of twenty-four years. Electromyographic observations were made before the exercise and for approximately twenty minutes after the exercise. The work consisted of: (1) cycling of maximal intensity on a bicycle ergometer for six minute periods, the resistance increased 200 or 300 kiloponds each minute until resistance became intolerable, (2) exhausting sustained contractions of elbow flexors repeated after pauses of thirty seconds holding a ten kilogram weight as long as each subject was able to maintain the weight for a period of fifteen seconds on each trial, and (3) rhythmic isometric muscle contractions of two seconds duration alternated with two second pauses continued until the total time was equal to the time of contraction attained during static work. A three channel electromyograph and needle electrodes were utilized to measure the tension of the brachial biceps muscle and the quadriceps muscle (vastii lateralis and medialis).

An increased number of polyphasic action potentials appeared after the sustained muscular contractions and to a lesser degree after the rhythmic contractions of the cycling,

suggesting that the participation in exercise may provide a therapeutic effect in reducing muscle tension. The duration of all action potentials decreased after exercise with no significant change in amplitude. The investigators stated that the knowledge that a reversable increase of polyphasic action potentials and a decreased duration potential can be induced by sustained muscular contractions facilitates further studies.

In a pilot study of eight college male subjects, deVries (27) found that the participation in exercise lowered residual neuromuscular tension, but that the tension levels became progressively larger with increasing periods of time after the exercise period. The exercise consisted of riding the bicycle ergometer for thirty minutes. Electromyographic observations were made immediately before the exercise, immediately after the exercise, forty-five minutes after the exercise, and ninety minutes after the exercise. deVries stated that the differences favoring the exercises were not statistically significant because of the small number of subjects.

deVries (31, p. 1) conducted a study of twenty-nine physical education major students, twelve females and seventeen males, at the University of Southern California, to determine the effect of exercise upon the resting muscle action potential. The standard exercise consisted of bench stepping for five minutes at a cadence of thirty steps per

minute. Each subject made two visits to the laboratory. On the first visit, electromyographic observations were made before the exercise, immediately after, and one hour after the exercise. The same observations were made on the second visit except a rest period of fifteen minutes was substituted for the exercise.

Neuromuscular tension in the elbow flexor muscle group decreased significantly one hour after the exercise compared with virtually no change on the control day. The tension change amounted to fifty-eight per cent of the pre-exercise measured amount. The electrical activity in the quadriceps muscle group decreased by a mean of thirty-two per cent after exercise, but the difference was not statistically significant. Upon the basis of the findings, deVries concluded that neuromuscular tension can be reduced by a rigorous bout of exercise lasting for five minutes. In support of the findings in the previous study, that exercise contributes to a reduction in muscular tension, deVries (30, p. 123) in a study of the spasm theory of muscle pain measured by electromyographic observations, found that static stretching exercises caused a decrease in muscle action potential following the exercise period.

A study was conducted by deVries (31, p. 1) on the long term effects of exercise on the resting muscle action potential of eighteen male members of the faculty at the University of Southern California, who comprised an

experimental group and a control group. Electromyographic observations were made of the elbow flexor muscle group and the quadriceps muscle group before and after the experimental period. The subjects in the experimental group, faculty members just starting in the faculty conditioning program, were instructed in the use of barbells and other resistance exercises and the use of a progressive interval training plan for alternate walking and running. The group then participated in a planned physical fitness program two or three times a week until each subject had completed a total of seventeen work out sessions. The seven subjects in the control group did not participate in an organized program of exercise but maintained a relatively constant level of physical activity. Maximal oxygen uptakes of each subject were determined to assure that a real conditioning effect had occurred. The experimental group demonstrated a significant mean improvement in physical conditioning in comparison with the control group which did not experience a significant improvement.

Changes in the resting muscle action potential of the control group were small and were considered as normal variability. The total electrical activity for the experimental group decreased by twenty-five per cent which was statistically significant. Upon the basis of the findings, deVries concluded that vigorous exercise may provide significant relief from hyperactive neuromuscular states.

Relationship between Exercise, Physical Activity, Dance and Tension

Handlon, Byrd, and Gaines (36) conducted a study to discover whether a reduction in muscular tension occurs when subjects who are in a measured state of anxiety participate in the physical activity of bowling. A total of 258 persons who entered the Palo Alto Bowl, Palo Alto, California, and the Saratoga Lanes, San Jose, California, bowling establishments for the purpose of bowling agreed to participate in the study. A paper and pencil psychometric test was administered to the subjects before and after bowling to determine levels of anxiety. The top ten per cent of the 258 bowlers, in terms of the presence of anxiety before bowling, were selected for further study. The post-bowling scores of the "tension bowlers" were then compared statistically with the pre-bowling scores and the psychometric test results to discover whether a reduction in muscular tension and anxiety had occurred. All but five of the selected subjects showed a post game drop in tension. Upon the significance of the results, the team of investigators from Stanford concluded that support was obtained for those physicians and psychiatrists who advise tense and anxious patients to engage in physical activities such as bowling to achieve a reduction in muscular tension.

Handlon, Byrd, Gaines, Lloyd, and Campbell (35) conducted a study to determine the tension-reducing qualities of the physical activity of bowling. Forty-one adults, with

a median of five years of bowling experience, who bowled at the Palo Alto Bowl, Palo Alto, California, and the Saratoga Lanes, San Jose, California, volunteered for this study. Structured interview sessions were conducted with each subject upon the completion of a session of bowling. The completed interview forms were later examined and tabulated by the psychologist member of the research team. The team of investigators from Stanford concluded that post-bowling interviews of forty-one subjects suggest that a majority of persons who engage in the moderate activity of bowling will experience reduction of muscular tension and anxieties. Upon the basis of the findings the investigators suggested that the anticipation of a reduction in stress and muscular tension causes some persons to seek bowling in order to obtain a release from their anxieties.

Byrd (16, p. 238) surveyed 826 physicians in San Francisco, California, to determine the medical viewpoints and practices on exercise and tension. Fifty-three per cent of the solicited responses were returned, of which ninety-eight per cent of the respondents stated that they did believe physical activity was valuable in the relief of tension. Ninety-three per cent of the respondents indicated that they had prescribed sports or activities of medium intensity for the relief of tension. Ninety-two per cent of the responding physicians prescribed one or more of the four activities of walking, swimming, golf or bowling. Byrd

speculated that perhaps some activities were recommended for the social element accompanying the physical values.

A survey conducted of the beliefs and practices of eighty-seven psychiatrists in San Francisco, California, in relation to exercise and tension, yielded approximately the same results as the survey conducted of the physicians (17, p. 426). Fifty-four psychiatrists responded to the inquiry, of which ninety-one per cent stated that moderate exercise provides relief from tension. Eighty-three per cent of the respondents had prescribed walking, swimming, bowling or golf, in that order, for the relief of tension. Byrd concluded from the results of the two surveys conducted that the attitudes, opinions, and practices of physicians and psychiatrists should be recognized by physical educators, teachers, and the general public. According to Byrd, the opinions of the medical specialists should not be ignored by those who foster physical education activities.

Alderman (1, p. 1) assessed attitudes toward physical activity of 136 selected male and female championship athletes, representative of ten sport events. Each athlete, on an attitude inventory, was required to rate the meaning of specified concepts with respect to his attitude toward physical activity. The areas investigated were physical activity as a social experience, as catharsis, as health and fitness, as an aesthetic experience, as the pursuit of vertigo, and as an ascetic experience. Physical activity

as catharsis was described as "a characterization of those activities, which provide, through some vicarious means, a release of tension precipitated by frustration" (1, p. 2). The male and female groups differed little in their rating of the areas. Physical activity as an aesthetic experience was ranked as having strongest meaning, with social experience and catharsis in the number two and three positions. The investigator stated that this seems to support some notions that athletics do provide outlets for release of tension. Alderman concluded that male athletes showed a surprising strength of attitude toward physical activity as an aesthetic experience, and that athletes do not necessarily possess a positive attitude toward the long, strenuous, training programs deemed necessary in most sports.

The role of specific exercises in tension control programs has indicated their possible value in the release of muscular and emotional tension. Metheny (54, p. 59) suggests the stretching of various muscle groups to achieve relaxation. The exercises suggested are used in developing a kinesthetic perception of what physical relaxation is, and the exercises are directed to the muscles of the upper back, face, legs, arms, and lower back. Young (87, p. 134) prescribes stretching exercises to patients who complain of an inability to relax. She suggests that rhythmical movements are necessary but must be performed slowly and quietly. Any variation of tempo is dependent upon the individuals'

psychological and physical tension, and the time it takes for the patient to attain full extension. Rathbone (63, p. 93) recommends three methods of reducing tensions, flexibility exercises, rhythmic exercises, and conscious reduction or contraction in specific muscle groups. The suggested exercise is comprised of rhythmic, swinging and stretching movements.

Exercise, physical activity, dance, and movement therapy have been successfully utilized to release tension in treatment of mental patients in hospitals. Knudson and Davis (48, p. 1090), in the observations of several hundred mentally ill patients at the Veterans Hospital in Washington, D. C., found that physical activities provided outlets to alleviate anxiety, release aggressive feeling, reduce guilt feelings, lessen mental confusion, resolve feelings of inferiority, improve social relationships, and stimulate a return to reality. The investigators concluded that corrective therapy has proved its usefulness in the psychiatric field through its application to mental illness as a dynamic aid to psychotherapy.

Davis (25, p. 142) found that physical activities and sports such as golf, tennis, skating, swimming, volleyball, and calisthenics had values in releasing tension in mental patients. For certain patients some judgment had to be exercised in the provision of sports equipment because of their potential use as weapons of assault.

Clark (23, p. 154) found that sports and physical activities were effective in bringing patients out of concentration on specific thoughts and allowing them to face reality. The psychotic patients became more alert and were more cheerful toward others following the participation in such sports as tennis and volleyball. Games and sports were especially valuable in bringing patients out of conditions of indifference. Clark concluded that exercises were noted to have values for all the patients.

Rosen (65, p. 215) conducted a study in dance therapy at a small mental hospital near New York City of two different patient groups. Group one was comprised of twenty closed ward patients, and group two was comprised of the open-ward patients who had full ground privileges. In the closed ward, the patients learned to dance together, never without a leader, on whom they depended for support and encouragement. The open ward sessions were held in the auditorium. The patients participating selected dance among many activities in the recreation program of the hospital. Rosen found, through observations of the patients in the two groups, that dance was used as a medium for acting out fantasies. The particular form and medium for expression which an individual selected seemed to be determined by the individual personality needs, cultural orientation, and education. The mode of expression selected by the patients seemed to provide a means of relief from emotional tensions.

May (51, p. 101) stated that modern dance can be a valuable attribute to psychiatric work. "The use of the tom-tom and of music such as The Dagger Dance or the Bolero serve to release emotional tension and to give free play to pent-up feeling" (51, p. 103). May concludes that a planned program of modern dance to aid in the adaptation of successful outlets for the desired drives can meet the unconscious needs of the neurotic or psychotic patient.

In movement therapy, according to Winston (83, p. 25), the psychological effects of improved body functioning include reduction of anxiety, increased energy, and a sense of poised self-confidence. Free motion stimulates, stretches and relaxes the muscles. Winston concluded that every therapist in the dance and movement therapy field has seen patients respond to treatment, but experimental studies in the area are limited.

Johnson and Hutton (45, p. 49) conducted a study of eight wrestlers, to determine how the participation in a violent sport affects the individual. A personality test was administered before the wrestling season, four to five hours before the first intercollegiate match of the season, and the morning after competition. Several group tendencies were revealed. Decrease of functioning intelligence, increased aggressive feelings, and increased neurotic signs were characteristics noted of the subjects in the before match condition. A return to approximately the status

existing prior to the competitive season, except for considerably less aggressive feelings, was noted the morning after competition whether or not the subjects had won their matches. Johnson and Hutton concluded that the technique used to evaluate the effects of sports competition was deserving of further study.

The types of exercise and conditions under which the exercising is done seem to reflect varied opinions as to the effect directly upon relaxation. Mitchem and Tuttle (56, p. 65) collected data from three groups of thirty subjects each, to show the effects of bouts of exercises, which consisted of arm-curls, knee-bends, and bicycle riding of varying intensities, on neuromuscular tremor magnitude. Mitchem and Tuttle concluded that the neuromuscular tremor varied directly with the strenuousness of the exercise. Slater-Hammel (71, p. 88), in a study of the effect of the order of successive exercise bouts upon neuromuscular tremor measures, failed to find the same results with respect to leg exercises. Twenty male subjects enrolled at the Indiana University participated in the study. Colville (22, p. 7), in a study of fifty-two female subjects of the University of California at Santa Barbara, found that the neuromuscular tremor increases with the duration of exercise.

Selected Factors Which May Influence the Study

The activities of bowling, swimming, and modern dance selected for the present study were empirically placed

into categories of light, moderate or heavy levels of activity because no investigator had objectively evaluated the energy expenditure or strenuousness of the participation in the three activities for women in one investigation. Wessel (84, p. 182) subjectively rated the previously identified activities in the same manner that the activities were classified for the purpose of the present investigation, that is, bowling is a light level of activity, swimming is a moderate level of activity, and modern dance is a heavy level of activity.

Attitude toward physical education was considered a possible factor in the influence of the participation in the three levels of activity upon residual neuromuscular tension. Selected studies which utilized the Wear Physical Education Attitude Inventory to assess the attitudes of college women enrolled in activity classes are presented.

Keogh (46, p. 239), conducted a study to determine if students differed in their attitudes toward general benefits or values of physical education and if men and women differed in this respect. Form A of the Wear Inventory was administered to 136 male and 130 female University of California, Los Angeles, undergraduates enrolled in coed instructional classes in volleyball, badminton, and archery. Keogh found that the men and women were not different in their stated attitude toward physical education. Subjects endorsed the social, physical, and emotional value of

physical education, but they conflicted in opinions concerning the relative value of a physical education program in the school curriculum.

Broer (11, p. 15), in a study of the basic skills curriculum for freshman women of low motor ability at the University of Washington, used the Wear Attitude Inventory to measure the attitude toward physical education activity upon entrance to college and following each activity course. A group of 145 students received instruction in a special program prior to entering the regular service program. After the special instruction, follow-up procedures were employed and then the group was compared to a matched group. Results indicated that the instruction was effective in improving motor ability and attitude toward physical education, and in gaining skill and knowledge in specific activities.

Broer, Fox and Way (13, p. 378), surveyed the attitude toward physical education of 1,149 college freshman and sophomore students enrolled in the activity classes at the University of Washington. The Wear Attitude Inventory was administered to the students enrolled in the activity classes. The investigators concluded from the results that the majority of the students expressed a highly favorable attitude toward physical education as an activity class. Students enrolled in the activity classes of swimming and tennis had a more favorable attitude toward physical education than those enrolled in other activity classes. The

students enrolled in an activity class of archery reacted less favorably toward physical education. Broer, Fox and Way indicated that the results of this study were in agreement with a study conducted at the University of Michigan, in that a high percentage of students endorsed the values of social development, mental and physical health as attributes of participation in physical education (8, p. 379).

Vincent (77, p. 126) determined the attitude toward physical education of 188 freshman and sophomore women enrolled at the University of Georgia, and the relationship between expressed attitudes and success in a variety of physical education activities. The Wear Physical Education Attitude Inventory was administered at the first class meeting. The students participating in the study were enrolled in the activity classes of archery, badminton, basic motor skills, bowling, gymnastics, modern dance, swimming, and tennis. The final grade received for the activity course by each subject was used as the success factor. Attitude scores were analyzed according to the contribution of physical education to four categories, namely, physiological-physical, mental-emotional, social, and general values. The most favorable attitudes toward physical education were expressed by the subjects enrolled in gymnastics, followed closely by tennis, with the students enrolled in swimming and bowling classes exhibiting the least favorable attitudes. Vincent concluded that college women express

appreciation of the contributions of physical education to all the values examined, but the greatest contribution of physical education assessed is the physiological-physical category. A significant relationship was found between expressed attitudes and success in physical education.

Vincent (78, p. 502), in a study of thirty-seven women enrolled in the activity classes of the University of Georgia, assessed the factors of strength, efficiency, and expressed attitudes toward physical education in the prediction of success in physical education classes. Attitudes were evaluated by the Wear Attitude Inventory, strength by dynamometers, and efficiency through calculation of net energy cost of an exercise bout, using an indirect, closed circuit respirometer, and success in physical education was measured by the grade received for the semester in the activity class. All prediction batteries were significant in the prediction of success in physical education activities. Vincent concluded that while the variables studied were factors which could be used as predictive measures, the use of the attitude item alone could be considered as adequate.

Many submaximal tests for predicting maximal work capacity have been suggested but insufficient data are available regarding the reliability and/or validity. This is especially true for women. Available research has prompted investigators to suggest that the tests of submaximal work level can give reliable information about a subject's aerobic capacity (79, p. 45).

Wahlund (79, p. 72), in his investigation of 469 male subjects of various physical fitness levels, found a constant mechanical efficiency when his subjects were working on a bicycle ergometer. The test consisted of a series of work loads beginning with 300 or 600 kilogram meters per minute until the subject could not continue the exercise any longer. Pulse rates were determined with a stethoscope from the beginning of the third, fifth, and seventh minute of each load. Wahlund concluded that the results obtained show the importance of making working tests with varying and sufficiently high loads, with reference to circulatory and respiratory functions.

Astrand (2, p. 45) on the basis of study of a method for prediction of aerobic work capacity for females and males of different ages stated that the prediction of aerobic work capacity can be made from a submaximal test. Doroschuk (33) supplemented this statement by indicating that studies of submaximal work capacity are fairly advanced in European centers. In a study conducted for a safe method to test working capacity, Doroschuk and his co-workers developed a test with continuous increments in resistance. Starting at 200 kilopond meters per minute the resistance was increased by 100 kilopond meters each minute until the subject reached exhaustion. Exhaustion in the legs usually occurred in the tenth or eleventh minute with the heart rate near 170 beats per minute. The findings indicated that the

heart rate increase is linear and therefore it is possible to predict final work capacity from heart rates during the first few minutes of work. The investigators concluded that it is possible to stop the test at any point after at least three heart rates are recorded. As a result of the investigation a shorter test was standardized beginning with an initial resistance of 150 kiloponds, increasing resistance 150 kiloponds per minute for a period of four minutes.

deVries and Klafs (32, p. 207) conducted a study to evaluate some of the more commonly used submaximal tests against maximal oxygen intake as a criterion measure for validity. The tests assessed were the Sjostrand-Wahlund test of physical working capacity, a modification of the Sjostrand-Wahlund test using bench stepping instead of the bicycle ergometer, the Harvard Step test, the Progressive Pulse Ratio test, a three-minute modification of the Delta R. O. test, and the Astrand-Rhyming nomogram. Sixteen male students at Long Beach State College were subjects for the study. Maximal oxygen intake was determined for each subject using a bicycle ergometer. deVries and Klafs indicated that maximal oxygen intake and physical working capacity for college age men can be predicted with a reasonable error or prediction from submaximal tests. The tests using heart rate during measured work loads as a basis of prediction seem to possess greater predictive value than those tests using the heart rate in the recovery period for prediction.

The highest predictive values in this study were attained from Astrand-Rhyming nomogram and the Sjostrand test.

Cumming (24, p. 873), on the basis of a study which revealed that oxygen uptake at PWC_{170} (physical working capacity) was about sixty-five per cent for unfit boys and eighty per cent of maximal for fit boys, stated that the submaximal test can be expected to show a wider difference between fit and unfit subjects than a maximum oxygen uptake test.

Summary

A review of related literature disclosed that limited research has been conducted on the effect of the participation in exercise or physical activity directly upon residual neuromuscular tension. A number of individuals have surmised that the participation in physical exercise provides an outlet for the release of emotional and muscular tension, although objective research to support the belief is limited. Electromyographic equipment has enabled researchers to objectively measure muscle tension within individuals. The bulk of the research in relaxation revolves around the analysis of the teaching of relaxation techniques and its effects on neuromuscular activity. Clinical information concerned with the value of relaxation in psychotherapeutic treatment was also presented.

Jacobson was a pioneer in teaching individuals to relax and in methods of detecting tension and relaxation.

In a comparison of athletes with subjects trained in relaxation techniques, Jacobson revealed that the athlete group was inferior in the attainment of relaxation levels in certain muscle groups. Haverland and, later, Benson, found that subjects trained in relaxation techniques were able to perform designated tasks better than those individuals who had received no training in neuromuscular tension control.

Larsson, Linderholm, and Ringqvist, and deVries found that the participation in repetitious exercise caused the action potential of the muscles measured to diminish, suggesting that the participation in exercise may provide a therapeutic effect in reducing muscle tension. Studies conducted by personnel from Stanford University indicated that the participation in the activity of bowling provides relief in tension. A survey conducted of physicians and psychiatrists concerning their beliefs of the participation in exercise and tension indicated that personnel in the medical profession advocate the participation in exercise as a measure of releasing tension, with walking, swimming, golf, and bowling being the activities predominantly recommended. Exercise, movement therapy, and dance have been used in the treatment of individuals who are mentally ill, and the results indicate their possible therapeutic value in reducing tension.

Studies concerned with attitude toward physical education suggest it is of value in the prediction of success

in activity classes. A significant relationship was found to exist between expressed attitudes and success in physical education. Men and women were not found to be different in their stated attitudes toward physical education.

Many submaximal tests for predicting maximal work capacity have been suggested but insufficient data are available regarding the reliability and/or validity. Available research strongly suggests that tests of submaximal level can give reliable information about the aerobic capacity of an individual.

Chapter III presents the procedures followed in this study.

CHAPTER III

PROCEDURES OF THE STUDY

Introduction

The purpose of the investigation was to determine the influence of the participation in light, moderate, or heavy levels of gross motor activity upon residual neuromuscular tension in the elbow flexor muscle group and the rectus femoris muscle as measured by quantitative electromyography. The recreational type activities selected for the study were bowling, swimming, and modern dance. The study entailed the use of a four group design, each group comprised of fifteen college women, designated as: (1) a light level exercise group, which was a bowling class; (2) a moderate level exercise group, which was a swimming class; (3) a heavy level exercise group, which was a modern dance class; and (4) a control group. The subjects in the motor activity groups participated in the regular classes of the required physical education program during the spring semester of the academic year 1969-1970. The subjects in the control group participated in no scheduled program of physical activity. The experimental period for the study extended for a period of nine weeks. The procedures used

in the development of the study are presented in this chapter.

Preliminary Procedures

A documentary analysis of information pertinent to all phases of the study was conducted before establishing definite procedures. Special emphasis was placed upon (1) the relationship of exercise to relaxation and (2) electromyography. Upon the basis of considerable empirical and limited clinical evidence, it was theorized that participation in physical exercise can play a therapeutic role in the release of tension. Neuromuscular tension is considered to be related to anxiety and other "stresses."

Relaxation has been defined in many different ways and numerous methods of achieving a relaxed state have been recommended. Because of the lack of documentary evidence correlating the participation of recreational activities to the release of neuromuscular tension the present study was undertaken.

A Tentative Outline for the study was developed and presented in a Graduate Seminar conducted in the College of Health, Physical Education and Recreation at the Texas Woman's University in Denton, Texas, during the fall semester of the 1969-1970 academic school year. The Tentative Outline was revised in accordance with suggestions made by the members of the dissertation committee. Upon approval by the committee members, the Tentative Outline was filed in the

form of a prospectus in the office of the Dean of Graduate Studies. Plans were formulated for the data to be collected. Permission was secured from the Dean of the College of Health, Physical Education, and Recreation to conduct the proposed study during the spring semester of the academic year 1969-1970.

Selection of Gross Motor Activities

The motor activities selected for this investigation were bowling, swimming, and modern dance. The activities were selected on the basis that each was: (1) classified as a recreational activity taught in physical education programs for women at the college level of instruction; (2) suitable for all ages; (3) previously rated by an investigator as a light, moderate, or heavy level of motor activity based upon the strenuousness or energy expenditure; (4) popular, that is a recreational leisure time activity participated in by, or appropriate for, large numbers of women; and (5) taught in the required program of the College of Health, Physical Education, and Recreation at the Texas Woman's University during the spring of the academic year 1969-1970.

Selection of Muscle Groups

The muscle groups measured were the elbow flexor muscle group and the rectus femoris. The specific muscles selected were the biceps brachii of the dominant hand and the rectus femoris of the right leg. Upon the basis of

kinesiological analysis, the elbow flexors and the rectus femoris have been determined to be of critical importance to the activities selected, perhaps, the biceps brachii to a lesser degree in the activity of modern dance and the rectus femoris to a lesser degree in the activity of bowling (12). Selection of the specific muscles was based upon the results of previous investigators (39, 59, 4). These investigators indicated that a factor of general tension existed and that during rest this factor is centered around limb musculature. The biceps brachii was found to have a very high loading factor with other muscles throughout the body. The loading factor of the rectus femoris with other muscles of the body was not studied. deVries (31) used the rectus femoris and the biceps brachii in his study of the effects of exercise upon neuromuscular tension. A previous investigation suggests that an increase in bodily tension in one area of the human body is reliably associated with an increase in other areas (67, p. 223).

Instrumentation

Electromyography

The electromyographic instrumentation utilized for quantitative analysis of residual neuromuscular tension in the present study consisted of several separate component parts. A Newport Laboratories Integrating Bio-electric Monitor, Model 100, was used to integrate and sum the muscle action potential input for precise time intervals by voltage

to frequency conversion to pulse counting in an accessory electronic digital counter and conversion into Root Mean Square (RMS) values. The monitor frequency used in this study was set as follows: High Pass hz 10K, Low Pass hz 1.0, and Full Scale 0.1. This allowed maximum acceptance of the frequencies appropriate to muscle action potential while eliminating extraneous frequency response.

The Hewlett-Packard Electronic Counter Model H22 5211B, modified, produced a digital display of the integrated potentials of muscle action over a ten second period. The count, per unit time, is related to mean voltage as:

$$\text{RMS} = \frac{\text{counter reading (total pulses)}}{\text{integration period (in sec.)}} \qquad \text{(30, p. 123)}$$

The muscle action potential input to the monitor was displayed visually on the Hewlett-Packard Oscilloscope Model 120B. The oscilloscope was essential to the pretesting of the equipment and determining artifact or extraneous electrical activity.

Accessory equipment for calibration of the monitor and the entire system included a Hewlett-Packard Low Frequency Generator Model 202A and General Radio Company Audio-Frequency Microvolter, type 546-C. Industrial Medical Instrument (I.M.I.) biopotential skin electrodes were used in testing the subjects. Standard methods for the operation of the electromyograph and accessory instrumentation were followed in the quantitative measurement of residual neuromuscular tension in this investigation (58).

Attitude Toward Physical Education

The Carlos L. Wear Physical Education Attitude Inventory (83, p. 113) was the instrument selected to measure the attitude of each subject toward physical education before and after the experimental period. The instrument was selected on the basis of objectivity, reliability, and validity. The reliability of Form A was 0.94, and the reliability of Form B was 0.96. The product-moment correlation between the scores on the two forms was 0.96. While the validity of this inventory had been established on figures obtained from college men, Dr. Wear states, "Because of the nature of the statements, it is believed that the Inventory would be equally suited for use with girls' and women's classes"(82, p. 122). Broer (10, p. 16) checked the reliability and validity of the inventory with college women and found the results equally valid for women.

Upon the basis of authoritative analysis motivation has been cited as a determinant of performance level (53, p. 39). The measurement of attitude toward physical education was important since attitudes determine much motivated behavior and level of performance (50, p. 94).

Form A of the Wear Physical Education Attitude Inventory was administered to each subject during the initial testing session, and Form B was administered to each subject during the post-test session. The inventory was administered to the subjects in the bowling group, swimming group, and the

modern dance group during a regular class period. The Wear Inventory was administered individually to the subjects in the control group during a testing session in the Human Performance Laboratory.

It was explained to the subjects that the inventory was not a test but simply a measure to determine how each one felt toward physical education. Each one was reassured that it was part of a research project and was to be used only for that purpose. They were told that there were no right or wrong answers. A sincere response based upon previous experience was requested. Directions printed on the inventory were read to the subjects to make sure each one understood the correct procedure to follow in marking responses on the answer sheet.

The response of each subject on each item of the attitude inventory was tabulated by 5-4-3-2-1 or 1-2-3-4-5 depending upon whether the item was worded positively or negatively. A subject's score on the inventory was the sum of the scores made on individual items. The scores of each subject on the pre-test and the post-test were recorded on the appropriate score sheet.

Estimated Measure of Physical Work Capacity

A short test of submaximal working capacity (SWC_{170}) (33, p. 10) was the instrument selected to determine an estimated measure of physical work capacity of each subject

before and after the experimental period. The bicycle ergometer was used for the practical measurement.

A submaximal test was selected because of the ease of administration and the equipment available to the investigator. According to previous investigators, the advantages of a submaximal test are: (1) motivation can be limited as a factor in physical fitness testing, (2) unfit or unconditioned subjects can be tested without the possible hazards attendant upon a maximum work load, and (3) a well equipped laboratory with skilled technicians is not necessary (3, 29).

The bicycle ergometer was selected for the measurement because it was the best instrument available to the investigator. For testing physical work capacity, the bicycle ergometer has the following advantages: (1) the work load is expressed in standard units of work, thus allowing for work comparisons more easily than the treadmill; (2) measurements with various instruments can be easily taken because the subject's upper body remains relatively motionless. Other instruments used to administer the test were a metronome, electronic stethoscope, and a stopwatch.

Preliminary testing, prior to the experimental period, to establish reliability of the submaximal test (SWC_{170}) selected for the purpose of the study, indicated a need to modify the SWC_{170} Test requirements on the bicycle

ergometer as suggested by Doroschuk (33) in the study of college men. The reliability coefficient of the test found for men was 0.72.

The investigator experimented with varying the resistance increments each minute, attempting to select measures that would allow the subject to complete the four minute test. Upon the basis of the tests, it appeared that the majority of the college population to be tested could complete the test requirements starting with an initial work load of 450 kpm and increasing the resistance 150 kpm each minute for four minutes. A pilot study was then conducted to determine the reliability of the test.

Pilot Study of SWC_{170}

The purpose of the pilot study was to determine the test-retest reliability of the modified SWC_{170}. Twenty volunteers enrolled in the activity classes of the required physical education program in the College of Health, Physical Education, and Recreation participated in the pilot study.

The equipment necessary for the administration of the test included (1) a bicycle ergometer, (2) an electronic stethoscope, (3) a stop watch, (4) a metronome, and (5) a phonograph. The electronic stethoscope was connected to the audio speaker of the phonograph for magnification of the heart rate to facilitate counting while the subject rode the bicycle.

Each subject visited the Human Performance Laboratory upon two occasions. Upon arrival the subject was given instructions on the operation of the bicycle ergometer and the purpose of the test.

The bicycle seat was adjusted as required for each subject. The subject was then instructed to be seated on the bicycle. A resting heart rate was taken for fifteen seconds, monitored with the electronic stethoscope. The rate was multiplied by four and recorded as resting rate per one minute. The metronome was set at 100 and the subject was directed to pedal at this frequency. This standardized the work rate and the only deviation was the load imposed by a mechanical brake.

The subject cycled for four minutes starting with an initial work load of 450 kpm and increasing the resistance 150 kpm each minute. At the end of each minute (the last fifteen seconds) the heart rate was monitored and the count was taken prior to increasing the resistance. The rate was multiplied by four and recorded. Upon the completion of the test, each subject was asked to return to the laboratory two days later (forty-eight hours) at approximately the same time for a re-test.

The heart rate was plotted in relation to the work load for each test. A best fit line was drawn and the point at which the heart rate reached 170 was determined. The work load and the time required to reach the work load were

recorded. A Pearson Product-Moment Correlation (47, p. 59) was computed. The test-retest reliability was 0.91. The same test given to fifty-nine college women not previously tested resulted in a reliability coefficient of 0.95 (66). Empirical validity of the test was accepted upon the basis of the suggestions of the previous investigator of the original SWC_{170} Test selected for the present investigation (33). Doroschuk (33) in standardizing the short version of the SWC_{170} Test found the test-retest reliability to be 0.72 in comparison with a long version which was 0.83, indicating the test to be a valid measure to estimate physical work capacity. Justification in the modification of the SWC_{170} Test selected for the purpose of this investigation was felt warranted because the population to be tested could perform the recommended requirements of the test. Upon the basis of the results of the pilot study and approval of the investigator's dissertation advisor, the modified SWC_{170} Test was adopted for the purpose of this investigation.

Selection of Subjects

During the spring semester of the academic year 1969-1970, a total of sixty college women enrolled at the Texas Woman's University in Denton, Texas, ranging in age from seventeen through twenty-two years were selected to participate in the investigation. Forty-five freshman and sophomore women students were enrolled in the required physical education program of the College of Health, Physical

Education, and Recreation in the selected classes of bowling, swimming, and modern dance, and fifteen of the women, junior and senior students, were not enrolled in the required program of the College of Health, Physical Education, and Recreation.

Lottery methods were used to select (1) the specific class of bowling, swimming, and modern dance from the required activity classes offered in the College of Health, Physical Education, and Recreation, and (2) fifteen students enrolled in each of the classes to participate in the groups further designated as the bowling group, the swimming group, and the modern dance group. The criteria established for the selection of subjects in the bowling group and the swimming group were that they had not engaged in organized competition and the subjects in the modern dance group had had no formal lessons in modern dance during the previous four years. The swimming and modern dance classes met approximately forty-five minutes per day, three days each week, and the bowling class met approximately sixty-five minutes per day, two days each week.

Permission was secured from the Dean of Women of the Texas Woman's University to select fifteen volunteers, junior and senior students, from a dormitory which was selected by lottery methods from among the dormitories which housed junior and senior students to participate as a control group. The subjects in the control group were not enrolled

in the required program of physical activity at the University or participating in organized competition during the experimental period.

The four groups were equated in the best possible manner with respect to previous background. The subjects had not participated in organized competition or received formal lessons in modern dance, and their scores on the American College Test or the Scholastic Aptitude Test, and age, that is between ages seventeen and twenty-two years, were comparable. Each subject in the motor activity groups was asked if she had competed in organized competition, and each subject in the modern dance group was asked if she had received formal lessons in modern dance within the previous four years. The American College Test scores and the Scholastic Aptitude Test scores were changed into z, or standard scores, and the mean z scores of the groups were compared with the mean age of the groups.

Procedures Followed Prior to Experimental Period

The investigator established procedures for use throughout the investigation. Preliminary tests were conducted prior to initial testing of the subjects to establish appropriate testing schedules and standardize procedure to be used in the administration of tests before, during (after the fourth week), and after nine weeks of the participation in the selected activities of the required physical

education program or the non-participation in organized activity.

The investigator selected and trained two graduate students as laboratory assistants to aid in the preparation of the subject for each test and the recording of scores on appropriate score cards. Several orientation and practice sessions were conducted. An example of the score card used in the study may be found in Appendix C, page 120.

Collection of Data

The investigator collected data pertaining to residual neuromuscular tension, attitude toward physical education, and an estimated measure of physical work capacity. The data for neuromuscular tension were collected from the subjects identified, through the administration of three testing periods, a pre-test, a mid-point test, and a post-test, the experimental period being of nine weeks duration. The data for the attitude inventory and SWC_{170} Test were collected from the subjects identified, through the administration of a pre-test and a post-test. During the experimental period the subjects in the three motor groups participated in the required physical education program of the College of Health, Physical Education, and Recreation at the Texas Woman's University, and the subjects in the control group did not participate in a program of organized physical activity.

Attitude Toward Physical Education

Form A of the Wear Physical Education Attitude Inventory was administered to each subject during the initial testing session, and Form B was administered to each subject during the post-test session. Procedures adhered to are described on page 46. Copies of Form A and Form B used in this study may be found in Appendix B, pages 114-119.

Estimated Measure of Physical Work Capacity

The modified SWC_{170} Test was administered to each subject during the initial test and at the conclusion of the experimental period to determine if physical conditioning had occurred. It was believed that the reduction of neuromuscular tension was related to the level of activity in which the subject engaged.

Special days during each testing period were designated for each subject to visit the Human Performance Laboratory of the College of Health, Physical Education, and Recreation of the Texas Woman's University. The investigator monitored and counted the heart rate at rest prior to and during the test. An estimated measure of physical work capacity was determined as previously stated.

Residual Neuromuscular Tension

An electromyographic analysis was made of the residual neuromuscular tension in the biceps brachii of the dominant hand and the rectus femoris of the right leg of

each subject in the four groups thus identified. Each subject made three visits to the Human Performance Laboratory for the initial testing period and the final testing period, and one visit for the mid-point testing period. Following the first test during the initial and final test period, each subject returned approximately six hours later, and approximately twenty-four hours later. An attempt was made to schedule appointments for each testing session at approximately the same time of day.

In order to control certain extraneous variables subjects were asked to get an average amount of sleep the night before scheduled appointments, not to smoke at least one-half hour prior to the test, and not to take any drugs or alcohol twenty-four hours before the appointment time.

Prior to each testing session operational tests were conducted. The monitor was turned on one-half hour prior to each test session for a stabilization period. Then the auxillary components were activated. A record of a full scale reading was obtained on the electronic counter for one second (58, p. 2). The temperature in the laboratory was maintained at approximately 72° Fahrenheit.

The monitor was calibrated each day before a testing session and immediately after the testing session. A cable connected to a microvolter was coupled to the monitor which had been set at 0.1 for full scale readout on the visual display unit. A low frequency generator had a setting of

1000 cycles per second and the microvolter was set at 50 to provide a known, calibrated input of 50 microvolts to the monitor. The reading of average voltage on the electronic counter should have been 45 as this monitor converts the actual input to Root Means Square (RMS) units. A value greater or smaller than 45 ± 1/RMS unit indicated an error and was noted for future calculation; however, there was no known error recorded during the testing period.

Each subject, upon arrival at the laboratory, was oriented to testing procedures and instrumentation. A laboratory assistant aided in the preparation of each subject. Electrode placement on the biceps brachii muscle and the rectus femoris muscle was accomplished in a standard manner. Specifically, the placement on the biceps brachii of the dominant hand was accomplished according to the method of Davis (26, p. 29), and the placement on the right rectus femoris muscle according to deVries (31, p. 5).

Following the location and marking of reference points for the placement of electrodes, the skin was cleansed with alcohol and then abraded with fine sandpaper for maximum contact and the lowering of electrical resistance. Adhesive collars were placed on the electrodes and each electrode was filled with electrolytic solution. Electrodes were placed on reference points previously marked.

A test was made for the output offset error, to determine if the error of the output section of the monitor

which resulted from amplification was large enough to distort the recorded value. The monitor was set at 100 microvolts (μv) full scale, the active leads were brought together forming a short circuit where no resistance developed. The recording was repeated with the monitor set at 0.1 μv full scale, the test mode used in the present investigation. The difference in the two values was recorded as the output offset error. A value greater than one microvolt would be considered significant and subtracted from each measurement; however, the output offset error never reached this dimension.

A test was made for impedance or total resistance between the electrodes and the electrical potential in the body. The active cables leading from the electrodes were placed into the input cable connected to the monitor which was set to record the resistance. A recorded value of less than 5000 ohms was required. Any resistance higher than 5000 ohms would tend to generate or pick-up artifacts causing errors in voltage to appear. The wave patterns on the oscilliscope were observed for artifacts. If the minimum acceptable dimension were exceeded, skin preparation was repeated. This measurement was made at each test site.

The ground and active electrodes of the biceps muscle were connected to the input cable to begin measurement of tension levels. The subject was tested in a supine position on a table in a grounded screen cage to eliminate all possible artifact.

The subject was asked to lie still and to relax. She was told that the electrodes of the arm and the leg muscles would be alternately connected and disconnected during the test. The subject was instructed to close her eyes and disregard any noise she might hear during the test.

Electromyographic observations were made of each muscle group being tested. The biceps muscle was tested for one minute, then the rectus femoris muscle for one minute, followed by a rest period of one minute. The testing sequence was repeated. Data were recorded on appropriate score cards. The electrodes were removed and cleansed for the next testing session.

All electromyographic recordings were taken as the one minute integral of muscle action potentials. The values from the electronic counter were recorded as the raw scores. Any output offset error and noise correction factors were determined and subtracted from original data. The output offset error was eliminated from the correctional procedure since the error was never above .0001 microvolt. This procedure was followed on all test scores taken for each muscle group tested and a mean of the individual one minute recordings for each muscle group was determined.

Activity Participation

No control over the teaching of the three activity groups was allowed. Each group had a different teacher and the lesson plans were not monitored. It is believed

that this kind of situation was most appropriate to the basic hypotheses of the study. For the control group, no controls could be exercised except to request that each subject not participate in organized activity during the experimental period. The subjects were not enrolled in any classes in the College of Health, Physical Education, and Recreation, but did continue participating in the normal activities of college students.

Analysis of Data

An analysis of variance technique was used because the nature of the data collected by means of the administration of the Wear Physical Education Attitude Inventory and SWC_{170}, and the quantitative analysis of residual neuromuscular tension had the desired characteristics for this type statistical tool. A two-factor mixed design was selected to determine the significant differences between each group and within each group on the repeated measures of residual neuromuscular tension (three) on the pre-test and post-test (14, p. 282). A one-way classification design was selected to determine the significant differences between each group and within each group on the tests given for each of the identified variables when only one measurement was taken of each subject (34, p. 269). Prior to the collection of the data, it was decided that the five per cent level of confidence would constitute the level for rejection of the null hypothesis in all comparisons. The Duncan's

Multiple Range Test (52, p. 172) was selected to analyze the significance of the F-ratio.

Summary

In this chapter the procedures in the development of the study were outlined. Preliminary procedures involved in the selection of three gross motor activities of a recreational type, selection of muscle groups, instrumentation, and selection of subjects. Collection of data included the administration of measurements to determine attitude toward physical education, an estimated measure of physical work capacity, and residual neuromuscular tension, before, during, and after an experimental period of nine weeks duration.

Subjects for the study were sixty college women enrolled at the Texas Woman's University of Denton, Texas, comprising four groups: a bowling group, a swimming group, a modern dance group, and a control group. The subjects in the specified motor activity groups participated in regular classes of the required physical education program, and the subjects in the control group participated in no program of organized physical activity for nine weeks.

Electromyographic observations were made during each testing session of the biceps muscle group and the rectus femoris muscle with an integrating Bioelectric Monitor coupled with an electronic counter. Each subject was measured in a relaxed supine position.

Analysis of variance was the statistical tool utilized to evaluate the differences between the groups, and within the grcups, on each test administered before, during, and after an experimental period of nine weeks duration.

Chapter IV presents an analysis and interpretation of the findings.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

Introduction

The present chapter contains the presentation of the statistical treatment of the data utilized to test the hypotheses of the study. An interpretation and discussion of the results of the statistical analysis are presented in narrative and tabular form.

The study was designed to determine the influence of the participation in three levels of gross motor activity of a recreational nature upon the residual neuromuscular tension of sixty college women enrolled at the Texas Woman's University during the spring semester of the academic year 1969-1970. A four group design was employed: (1) a light level exercise group, which was a bowling class; (2) a moderate level exercise group, which was a swimming class; (3) a heavy level exercise group, which was a modern dance class; and (4) a control group, which was comprised of subjects participating in no scheduled program of physical activity.

Data were collected from the subjects through the administration of three testing periods, a pre-test, a

mid-point test, and a post-test. The experimental period extended for a period of nine weeks. Electromyographic measurements were made of the residual neuromuscular tension in the biceps brachii of the dominant hand and the rectus femoris of the right leg. A modified test of submaximal physical working capacity was used to estimate the physical fitness of each subject. The Wear Physical Education Attitude Inventory was administered to determine the attitude of subjects toward physical education. It was surmised that attitude toward physical education and the physical fitness level of an individual are factors which could possibly influence the therapeutic effect of the participation in motor activity upon residual neuromuscular tension.

Analysis of variance, a two-factor mixed design of repeated measures of one factor (14, p. 54), was the statistical technique selected to analyze the data. Duncan's Multiple Range Test was used to treat each F ratio in which a significant difference was found at the .05 level of confidence.

Determining the Homogeneity Between Groups on Initial Measurements

Due to variations in scores of the subjects on the initial tests of the study it was necessary to determine if the groups were homogeneous in all measurements taken. A one-way analysis of variance was used to compare the means of the bowling group, the swimming group, the modern dance

group, and the control group upon each of the measurements taken prior to the experimental period.

Electromyographic measurements were made of the resting action potential of the selected muscle groups prior to the experimental period. Measurements were taken once, repeated approximately six hours later, and after twenty-four hours. Table 1, page 66, presents descriptive data with respect to the means, standard deviations, and standard errors of the means of the initial measurements of residual neuromuscular tension in the biceps brachii muscle of the dominant hand and the rectus femoris muscle of the right leg. The measurements are given in units of microvolts for one minute intervals. The testing sessions are identified in the table by numbers with (T_1) being the results of the first measurements taken, (T_2) the second measurement taken approximately six hours later, and (T_3) the third measurement taken approximately twenty-four hours later. The subjects experienced the highest tension levels on the first measurements taken of the biceps brachii and rectus femoris with the exception of the control group on the measurements of the rectus femoris. The higher mean scores recorded for the first testing session on the initial measurements were attributed to the subjects being uncertain as to what to expect during the testing session even though an effort was made to acquaint each subject with the instrumentation and procedures of the test. The control group

experienced the highest tension levels on the measurements of the rectus femoris taken approximately six hours after the initial test. No reason can be found for this phenomenon.

TABLE 1

INITIAL MEASUREMENTS OF THE NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD FOR FOUR ACTIVITY GROUPS IN THE BICEPS BRACHII AND THE RECTUS FEMORIS*

Group	Biceps Brachii			Rectus Femoris		
	M	SD	SEM	M	SD	SEM
Bowling						
(T_1)	145.60	94.69	24.49	100.26	50.99	13.17
(T_2)	124.40	83.87	21.66	89.20	55.09	14.22
(T_3)	130.33	89.45	23.10	94.20	46.67	12.05
Swimming						
(T_1)	128.93	107.41	27.73	87.41	66.04	17.05
(T_2)	113.47	105.84	27.33	76.40	67.28	17.37
(T_3)	113.87	103.41	26.70	73.53	66.68	17.22
Modern Dance						
(T_1)	128.60	116.95	30.20	84.33	81.33	21.01
(T_2)	109.73	90.10	23.26	81.13	69.52	17.94
(T_3)	121.20	99.49	25.69	79.40	67.60	17.45
Control						
(T_1)	120.80	112.79	29.12	90.33	72.73	18.79
(T_2)	118.27	76.70	19.80	92.33	73.50	18.98
(T_3)	119.53	104.36	26.95	87.60	69.98	17.81

*Resting muscle action potential for one minute intervals given in units of microvolts with (T_1) being the results of the first measurement, (T_2) the second measurement taken approximately six hours later, and (T_3) the third measurement taken approximately twenty-four hours later.

The bowling group elicited the highest mean scores in resting tension of the four groups on the initial

measurement with a mean score of 145.60 μv (microvolts) for the biceps, and 100.26 μv for the rectus femoris. The same group experienced the highest tension levels on the measurements of the biceps repeated six hours later, and also on the measurements made twenty-four hours later, mean scores were 124.40 μv and 130.33 μv, respectively. The modern dance group and the swimming group had slightly different mean scores for the initial measurement taken of the biceps and rectus femoris, with the modern dance group ranking slightly lower than the swimming group on the measurements taken of the rectus femoris. The mean scores were: (1) modern dance--123.60 μv for the biceps, 84.33 μv for the rectus femoris; (2) swimming--128.93 μv for the biceps, 87.41 μv for the rectus femoris. The control group displayed the most stable tension levels throughout the three testing sessions in measurements taken of the biceps brachii and the rectus femoris in comparison with the three other groups. The mean scores for the control subjects for the biceps were: (T_1) 120.80, (T_2) 118.27, and (T_3) 119.53, with a range of 2.53 μv; the mean scores for the rectus femoris were: (T_1) 90.33, (T_2) 92.33, and (T_3) 87.60, with a range of 4.63 μv. One might surmise that the control group was the most stable of the groups because the students were better adjusted to college routine than the subjects in the motor activity groups. The control group consisted of junior and senior students who had survived the problems of the lower division

curricula while the subjects in the experimental groups, freshman and sophomore students, were not as experienced in college procedures as the control group.

A one-way analysis of variance was used to determine if there was a significant difference between the means for each group on each of three sets of measurements taken. The analysis was re-evaluated in the analytical procedures of the two factor mixed design for repeated measures of the measurements taken during the experimental period. The F ratio in each analysis was not significant at the .05 level of confidence, indicating that the groups did not differ in residual neuromuscular tension levels taken once, repeated approximately six hours later, and again twenty-four hours later. A summary table of each analysis appears in this chapter near the discussion of each of the measurements taken of the biceps and rectus femoris. Refer to Tables 5, 9, 12, 14, 16, and 18, pages 73, 78, 81, 83, 85, and 87, respectively.

An estimated measure of physical working capacity was determined for each subject through the administration of the SWC_{170} Test. The test was administered prior to the experimental period. A one-way analysis of variance was used to determine if there was a significant difference between the groups on the initial measurements. The groups were found to be homogeneous with respect to estimated measures of physical working capacity. The analysis is evaluated

in the summary table on page 89. Descriptive data relative to the mean, standard deviation, and standard error of the mean for each group in the initial measurements of the SWC_{170} Test appear in Table 2. The results are recorded in kilopond meters. The groups were ranked in the following order beginning with the highest mean score: (1) bowling, (2) swimming, (3) control, and (4) modern dance. No significant difference in the physical fitness of the groups, as measured by the SWC_{170} Test, suggests that the subjects who selected bowling had a fitness level as high as the subjects in the other groups at the beginning of the present investigation.

TABLE 2

INITIAL MEASUREMENTS OF PHYSICAL WORKING CAPACITY TO REACH A HEART RATE OF 170 BEATS PER MINUTE AS ESTIMATED BY THE SWC_{170} TEST FOR FOUR ACTIVITY GROUPS*

Group	M	SD	SEM
Bowling	670.400	74.10	19.13
Swimming	668.600	69.45	17.93
Modern Dance	641.410	67.07	17.32
Control	650.800	60.21	15.55

*Recorded in kilopond meters per minute.

The Wear Physical Education attitude Inventory was administered to the subjects in the four groups. The results indicated that there were no significant differences between

the bowling group, the swimming group, the modern dance group, and the control group in measured attitudes toward physical education. A summary of the analysis is included on Table 22, page 91. Table 3, on this page, presents descriptive data relative to the means, standard deviations, and standard errors of the means for the four groups on the initial measurements of the Wear Physical Education Attitude Inventory.

TABLE 3

INITIAL SCORES ON WEAR PHYSICAL EDUCATION ATTITUDE INVENTORY FOR FOUR ACTIVITY GROUPS*

Group	M	SD	SEM
Bowling	124.47	12.00	3.10
Swimming	116.13	10.68	2.76
Modern Dance	123.00	9.33	2.41
Control	119.87	11.96	3.09

*Recorded in points with 150 possible points.

The means for the four groups varied little with respect to points recorded in this attitude inventory, bowling 124.47, swimming 116.13, modern dance 123.00, and control 119.87, out of a possible 150 points.

Electromyographic Measurements

Electromyographic measurements were taken of the biceps brachii of the dominant hand and the rectus femoris

of the right leg before, after the fourth week, and after the ninth week of participation in the previously designated activity classes for three groups, as well as for the non-participants in organized activity, the control group. During the initial testing period and the final testing period, a single measurement of each subject was taken three times in a twenty-four hour period. An initial recording was taken, a second recording was taken six hours later, and approximately twenty-four hours later a final recording was made. Only one measurement was taken of each subject during the mid-point testing period and this measurement was taken one hour after participation in the selected activity.

Table 4, page 72, presents descriptive data relative to the means, standard deviations, and standard errors of the means for the quantitative measurements of the biceps brachii taken prior to any activity for the initial test, and approximately one hour after participation in the activity for the four groups during the mid-point test and the final test. An analysis of the table reveals that all groups, with the exception of the control group, experienced a decrease in mean scores of residual neuromuscular tension between the initial test and the final test. The control group displayed the greatest stability in recorded tension levels. The modern dance group had the greatest reduction in tension levels between the initial test and final test, from 128.60 μv to 57.12 μv.

TABLE 4

QUANTITATIVE MEASUREMENTS OF THE NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD OF THE BICEPS BRACHII FOR FOUR ACTIVITY GROUPS TAKEN APPROXIMATELY ONE HOUR AFTER PARTICIPATION IN THE ACTIVITY ON THE INITIAL TEST, MID-POINT TEST, AND FINAL TEST

Group	M	SD	SEM
Bowling			
(T_1)	145.60	94.69	24.49
(T_2)	101.00	59.25	15.30
(T_3)	88.27	59.18	15.28
Swimming			
(T_1)	128.93	107.41	27.73
(T_2)	106.07	70.77	50.17
(T_3)	27.73	18.27	12.95
Modern Dance			
(T_1)	128.60	116.95	30.20
(T_2)	95.53	66.20	17.20
(T_3)	57.13	44.32	11.44
Control			
(T_1)	120.80	112.79	29.12
(T_2)	118.27	98.87	25.53
(T_3)	123.53	83.22	21.49

A two factor mixed design analysis of variance of repeated measures was used to determine the significance of the difference between the means of the groups during the experimental period. A summary of this analysis appears in Table 5, page 73.

An analysis of Table 5 reveals that the F-ratio obtained for the differences between the groups was not significant at the .05 level of confidence, indicating that

TABLE 5

ANALYSIS OF VARIANCE OF RESIDUAL NEUROMUSCULAR TENSION OF BICEPS BRACHII FOR FOUR ACTIVITY GROUPS MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD TAKEN APPROXIMATELY ONE HOUR AFTER PARTICIPATION IN THE ACTIVITY ON THE INITIAL TEST, MID-POINT TEST, AND FINAL TEST

Source	df	SS	ms	F
Between Subjects	59	947538.4167	16059.9732	-
Between Groups	3	18906.6833	6302.2278	.3809
$Error_b$	56	928631.7333	16582.7095	
Within Subjects	120	359841.3333	2998.6778	-
Trials	2	64941.3333	32470.8867	13.8516**
Groups x Trials	6	32348.7333	5391.4870	2.2999*
$Error_w$	112	262250.6778	2344.2025	
Total	179	1307379.7500		

*Significant at the .05 level F (6,112) = 2.19.
**Significant at the .01 level F (2,112) = 4.82.

F(3,56)(.05) = 2.78
F(2,112)(.05)= 2.19

the groups did not vary significantly in the reduction of tension in the biceps brachii as a result of the participation in various levels of physical activity in a required physical education program within the delimitations of the study.

The F value for trials within subjects was highly significant. This indicated an overall change in the residual neuromuscular tension level from the initial test to the final test. Residual neuromuscular tension levels of the

groups, according to mean scores, tended to decrease at different levels between the three measurements. The F values for the groups by trials was significant at the .05 level of confidence, indicating that the groups changed at different rates in tension levels between the initial and final measurements. Table 6, below, presents Duncan's Multiple Range Test for a comparison of the significance between trials of the three sets of measurements taken during the experimental period.

TABLE 6

DUNCAN'S NEW MULTIPLE RANGE TEST APPLIED TO THE DIFFERENCES IN NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS BETWEEN THE INITIAL TEST, MID-POINT TEST, AND FINAL TEST ON MEASUREMENTS OF BICEPS BRACHII FOR FOUR ACTIVITY GROUPS APPROXIMATELY ONE HOUR AFTER PARTICIPATION IN ACTIVITY

	(1)	(2)	(3)	(4)
	T_3	T_2	T_1	Shortest Significant Ranges
Means	84.5500	105.2166	130.9833	
T_3 84.5500	-	20.6666*	46.4333*	R_3 = 18.4450
T_2 105.2166		-	25.7667*	R_2 = 17.5261

*Significant at .05 level = (112, 3 = 2.950867; 112, 2 = 2.803867).

$S_{\bar{x}}$ = 6.2505 (Standard error of a single mean).

$(1 - .05)^2$ = .9025 (Possibility of making a Type I error).

T_3 (Final test)
T_2 (Mid-point test)
T_1 (Initial test)

The results indicated that there was a significant decrease in residual neuromuscular tension of the biceps brachii between the initial and mid-point tests, mid-point and final tests, and the initial and final tests, measurements taken one hour after participation in the selected activity.

The F value of the groups by trials for measurements of residual neuromuscular tension taken of the biceps approximately one hour after participation in the activity that was presented in Table 5 was significant at the .05 level of confidence, revealing that the groups performed differently on the final test when compared to the initial test. Duncan's Multiple Range Test was applied to determine which specific groups experienced the greatest dimunition in residual neuromuscular tension between the initial measurements and the final measurements. An analysis of Table 7, page 76, reveals that the range between the means of the initial and final measurements of the modern dance group, the swimming group, and the bowling group was significant at the .05 level of confidence. The range of scores for the control group was not significant. There was a significant difference between the measurements of the final test for the modern dance group and the swimming group in comparison with the final test of the control group. A trend is evident that participation in physical activity of a recreational nature will provide relief in muscular tension approximately one hour after the participation in the

TABLE 7

DUNCAN'S MULTIPLE RANGE TEST APPLIED TO THE NEUROMUSCULAR TENSION DIFFERENCES MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD BETWEEN THE BOWLING GROUP, THE SWIMMING GROUP, THE MODERN DANCE GROUP, AND THE CONTROL GROUP BETWEEN THE INITIAL TEST, MID-POINT TEST, AND FINAL TEST ON MEASUREMENTS OF BICEPS BRACHII APPROXIMATELY ONE HOUR AFTER PARTICIPATION IN ACTIVITY

		Means	Modern Dance T_3	Swimming T_3	Bowling T_3	Modern Dance T_2	Bowling T_2	Swimming T_2	Control T_2	Control T_3	Control T_1	Modern Dance T_1	Swimming T_1	Bowling T_1	Shortest Significant Ranges
		Means	57.1333	69.2666	88.2666	95.5333	101.000	106.0666	118.2666	120.8000	123.5333	126.6000	126.9333	145.6000	
Modern Dance	T_3	57.1333	-	12.1333	31.1333	38.400*	43.8667*	48.9333*	61.1333*	63.6667*	64.1000*	71.4667*	71.8000*	88.4667*	R_{12}=42.0165
Swimming	T_3	69.2666		-	19.0000	26.2667	31.7334	36.8000	49.0000*	51.5334*	54.2667*	59.3334*	59.6667*	76.3334*	R_{11}=41.7165
Bowling	T_3	88.2666			-	7.2667	12.7334	17.8000	30.0000	32.5334	35.2667	40.3334	40.6667	57.3334*	R_{10}=41.4607
Modern Dance	T_2	95.5333				-	5.4667	10.5333	22.7333	25.2667	28.0000	33.0667	33.4000	50.0667*	R_9 =41.1213
Bowling	T_2	101.0000					-	5.0666	17.2666	19.8	22.5333	27.6	27.9333	44.60*	R_8 =40.7172
Swimming	T_2	106.0666						-	12.2	14.7334	17.4667	22.5334	22.8667	39.5334	R_7 =40.2564
Control	T_2	118.2666							-	2.5334	5.2667	10.3334	10.6667	27.3334	R_6 =39.6972
Control	T_3	120.8000								-	2.7333	7.8	8.1333	24.8	R_5 =38.9987
Control	T_1	123.5333									-	5.0667	5.4	22.0667	R_4 =38.1128
Modern Dance	T_1	126.6000										-	.3333	17.00	R_3 =36.8894
Swimming	T_1	126.9333											-	16.6667	R_2 =35.0517
Bowling	T_1	145.6000												-	

*Significant at .05 level. $S_{\bar{X}}$ = 12.5012 $(1 - .05)^{11}$ = .5415

activity. The control group remained relatively constant in tension levels throughout the experimental period.

Quantitative measurements of the rectus femoris muscle approximately one hour after participation in the activities previously designated indicated there was no significant difference between the four groups on measurements taken at the beginning, after the fourth week, and at the end of the experimental period which extended for nine weeks. Table 8, presented below, reveals descriptive data with respect to the measurements.

TABLE 8

QUANTITATIVE MEASUREMENTS OF THE NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD OF THE RECTUS FEMORIS APPROXIMATELY ONE HOUR AFTER PARTICIPATION IN THE ACTIVITY ON THE INITIAL TEST, MID-POINT TEST, AND FINAL TEST

Group	M	SD	SEM
Bowling			
(T_1)	100.26	50.99	13.17
(T_2)	71.33	35.83	9.25
(T_3)	52.00	71.19	18.38
Swimming			
(T_1)	87.41	66.04	17.05
(T_2)	45.73	35.28	9.11
(T_3)	25.73	28.73	7.42
Modern Dance			
(T_1)	84.33	81.33	21.01
(T_2)	53.60	38.24	9.87
(T_3)	34.66	31.02	8.01
Control			
(T_1)	90.33	72.73	18.79
(T_2)	74.73	41.71	10.76
(T_3)	73.26	40.83	10.54

The swimming group obtained the greatest mean loss in tension levels between the initial test and the final test and the lowest mean score for the four groups on the final test, a mean of 87.41 μv for the initial test and a mean of 25.73 μv for the final test, a loss of 61.68 μv. The control group experienced the least mean loss of the four groups, with a mean of 90.33 μv for the initial test and a mean of 73.26 μv for the final test. The tension levels recorded for the rectus femoris are lower than the levels reported for the biceps brachii earlier in this chapter. This is in agreement with the results reported by Steinhaus (74, p. 31), and deVries (31, p. 9). A summary of the analysis of variance, presented in Table 9, revealed there was no significant difference

TABLE 9

ANALYSIS OF VARIANCE OF RESIDUAL NEUROMUSCULAR TENSION OF RECTUS FEMORIS FOR FOUR ACTIVITY GROUPS MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD TAKEN APPROXIMATELY ONE HOUR AFTER PARTICIPATION IN ACTIVITY

Source	df	SS	ms	F
Between Subjects	59	311783.311	5284.4629	-
Between Groups	3	22264.8222	7421.6075	1.4325
$Error_b$	56	289518.4889	5169.9730	
Within Subjects	120	182408.000	1520.0667	-
Between Trials	2	60614.6778	30307.3389	29.9303*
Groups x Trials	6	8384.4778	1397.4130	1.3801
$Error_w$	112	113408.8444	1012.5789	
Total	179	494191.311		

*Significant at the .01 level F (2,112) = 4.82.

F(3,56) (.05) = 2.78; F(1,56)(.05) = 4.02
F(6,112)(.05) = 2.19

between the groups on the final test. The F value indicated a significant difference between the initial test and the final test, but the groups did not vary significantly. A change in tension levels supported the theory that the participation in recreational activities can contribute to a reduction in tension in the rectus femoris muscle. Duncan's Multiple Range Test, Table 10, on this page, reveals that there was a significant change between each of the tests, initial, mid-point, and final, of the rectus femoris taken approximately one hour after the activity.

TABLE 10

DUNCAN'S NEW MULTIPLE RANGE TEST APPLIED TO THE DIFFERENCES IN NEUROMUSCULAR TENSION OF FOUR ACTIVITY GROUPS BETWEEN THE INITIAL TEST, MID-POINT TEST AND FINAL TEST ON MEASUREMENTS OF THE RECTUS FEMORIS APPROXIMATELY ONE HOUR AFTER PARTICIPATION IN ACTIVITY

	(1) T_3	(2) T_2	(3) T_1	(4) Shortest Significant Ranges
Means	46.4167	61.350	90.600	
T_3 46.4167	-	14.9444*	44.1833*	R_3 = 12.1224
T_2 61.350		-	29.2500*	R_2 = 11.5185

*Significant at .05 level = (112,3 = 2.950367; 112,3 = 2.803867)

$S_{\bar{X}}$ = 4.108079 (standard error of a single mean)

$(1 - .05)^2$ = .9025 (protection level)

Table 11, page 80, presents the means, standard deviations, and standard errors of the measurements of the

biceps brachii repeated approximately six hours after participation in the activity. The swimming group experienced the greatest mean reduction in residual tension with a mean of 113.47 μv for the initial test and 65.73 μv for the final test. The control group remained the most stable of the four groups, although a mean gain of 9.73 μv was depicted between the initial and final test. A Runs Test (69, p. 52) indicates that the consistent trend of the activity groups to lower the residual neuromuscular tension after participation in physical education classes is significant at the .05 level of probability. The data may be interpreted to suggest that participation in the recreational activities of swimming and modern dance, within the delimitations of the study, provide a therapeutic effect upon residual tension.

TABLE 11

QUANTITATIVE MEASUREMENTS OF THE NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD OF THE BICEPS BRACHII TAKEN APPROXIMATELY SIX HOURS AFTER PARTICIPATION IN THE ACTIVITY ON THE INITIAL TEST AND FINAL TEST

Group	M		SD		SEM	
	Initial Test	Final Test	Initial Test	Final Test	Initial Test	Final Test
Bowling	124.40	94.33	83.87	63.83	21.66	16.48
Swimming	113.47	65.73	105.81	42.28	27.33	10.92
Modern Dance	109.73	64.93	90.10	53.61	23.26	13.84
Control	118.27	128.00	76.70	85.76	19.80	22.14

However, the statistical analysis presented in Table 12, on this page, indicates that there was no significant difference between the groups on the final trial. The F value between the trials was significant at the .01 level of confidence, indicating a difference between the initial and final tests at this test period, six hours after participation in the activity. The F value between groups by trials was not significant, indicating the groups did not change differently in tension levels from the initial to the final test.

TABLE 12

ANALYSIS OF VARIANCE OF RESIDUAL NEUROMUSCULAR TENSION OF THE BICEPS BRACHII FOR FOUR ACTIVITY GROUPS MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD TAKEN APPROXIMATELY SIX HOURS AFTER PARTICIPATION IN ACTIVITY

Source	df	SS	ms	F
Between Subjects	59	671925.0917	11388.5609	-
Between Groups	3	26077.2917	8692.4306	.7537
$Error_b$	56	645847.8000	11532.9964	
Within Subjects	60	154912.5000	11532.9964	-
Between Trials	1	23885.4083	23885.4083	11.6028*
Groups x Trials	3	15746.4083	5248.8306	2.549
$Error_w$	56	11538.6000	2058.5821	
Total	119	326837.5917		

*Significant at the .01 level $F(1,56) = 7.12$; $F(3,56)(.05) = 2.78$.

Table 13, page 82, reveals that the swimming group experienced the greatest reduction of mean scores (31.15 μv)

for the measurements of residual tension of the rectus femoris taken approximately six hours following the participation in the activity with a mean of 56.40 μv for the initial test and 25.25 μv for the final test. The smallest mean variation (10.78 μv) was recorded for the control group with a mean of 92.33 μv for the initial test and 81.55 μv for the final test. This follows the pattern noted in the results of the measurements already discussed, in that the control group remained the most stable throughout the testing period.

TABLE 13

QUANTITATIVE MEASUREMENTS OF THE NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD OF THE RECTUS FEMORIS APPROXIMATELY SIX HOURS AFTER PARTICIPATION IN THE ACTIVITY ON THE INITIAL TEST AND FINAL TEST

Group	M		SD		SEM	
	Initial Test	Final Test	Initial Test	Final Test	Initial Test	Final Test
Bowling	89.20	61.13	55.09	24.48	14.22	7.35
Swimming	76.40	24.25	67.28	26.74	17.37	6.90
Modern Dance	81.13	40.20	69.52	39.27	17.94	10.14
Control	92.33	81.55	73.50	48.91	18.98	12.63

On measurements of the rectus femoris the control group experienced slight mean gains. Table 14, page 83, presents a summary of the analysis of variance of the mean

variations experienced between the initial test and final test for measurements taken six hours after participation in activity. The F value indicated there was no significant difference between the initial test and the final test scores.

TABLE 14

ANALYSIS OF VARIANCE OF RESIDUAL NEUROMUSCULAR TENSION OF THE RECTUS FEMORIS FOR FOUR ACTIVITY GROUPS MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD TAKEN APPROXIMATELY SIX HOURS AFTER PARTICIPATION IN ACTIVITY

Source	df	SS	ms	F
Between Subjects	59	296577.4250	5026.7360	-
Between Groups	3	22415.7583	7471.9194	1.5262
$Error_b$	56	274161.6667	4895.7441	
Within Subjects	60	89918.5000	1498.6417	-
Between Trials	1	31850.2083	31850.2083	34.6891*
Groups x Trials	3	6651.2917	2217.0972	2.4147
$Error_w$	56	51416.9999	918.1607	
Total	119	386495.9259		

*Significant at the .01 level F(1,56) = 7.12.

F(3,56) (.05) = 2.78
F(1,56) (.05) = 4.02

Quantitative measurements of the neuromuscular tension in the biceps brachii approximately twenty-four hours after participation in the activity before and after the experimental period revealed that the swimming group experienced the greatest mean reduction in residual tension

(48.14 μv), a mean of 113.87 μv for the initial test compared with 65.73 μv for the final test. Descriptive data with respect to the measurements for the biceps brachii are presented in Table 15. The control group remained stable with a slight mean gain (1.20 μv), a mean of 119.53 μv for the initial test and 120.73 μv for the final test.

TABLE 15

QUANTITATIVE MEASUREMENTS OF THE NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD OF THE BICEPS BRACHII TAKEN APPROXIMATELY TWENTY-FOUR HOURS AFTER PARTICIPATION IN THE ACTIVITY ON THE INITIAL TEST AND FINAL TEST

Group	M		SD		SEM	
	Initial Test	Final Test	Initial Test	Final Test	Initial Test	Final Test
Bowling	130.33	89.00	89.45	54.28	23.10	14.01
Swimming	113.87	61.53	103.41	42.62	26.70	11.00
Modern Dance	121.20	75.80	99.49	45.50	25.69	11.75
Control	119.53	120.73	104.36	81.79	26.95	21.18

Table 16 presents a summary of the analysis of variance between the means for measurements of the biceps brachii taken approximately twenty-four hours after participation in the activity before the start of the experimental period and after the completion of the experimental period of nine weeks. The F value indicates there was no significant difference between the groups on the final test of

measurements taken approximately twenty-four hours after participation in the activity. There was a significant difference between the initial test and final test, but the F value between groups by trials was not significant. This indicated that the subjects diminished their neuromuscular tension from the initial test to the final test but that the groups did not differ significantly between the initial test and the final test.

TABLE 16

ANALYSIS OF VARIANCE OF RESIDUAL NEUROMUSCULAR TENSION OF THE BICEPS BRACHII FOR FOUR ACTIVITY GROUPS MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD TAKEN APPROXIMATELY TWENTY-FOUR HOURS AFTER PARTICIPATION IN THE ACTIVITY ON THE INITIAL TEST AND FINAL TEST

Source	df	SS	ms	F
Between Subjects	59	641591.500	10874.4322	-
Between Groups	3	22442.5557	7480.8556	.6766
$Error_b$	56	619148.9333	11055.2310	
Within Subjects	60	187651.000	3127.5167	-
Between Trials	1	45552.0333	44552.0333	20.5488*
Groups x Trials	3	17959.6333	5986.5445	2.7000
$Error_w$	56	124139.3333	2216.7738	
Total	119	829242.500		

*Significant at the .01 level $F(1,55) = 7.12$.

Descriptive data with respect to quantitative measurements of the rectus femoris taken approximately twenty-four

hours after participation in the activity on the initial test and final test are presented in Table 17. An analysis of mean scores reveals that the swimming group experienced the greatest reduction in tension levels during the experimental period (46.90 μv), from a mean score of 73.50 μv to 26.60 μv respectively. The modern dance group ranked second in reduction of tension (42.54 μv), with an initial score of 79.40 μv and a final mean score of 36.86 μv. The control group experienced the least variation in mean score, maintaining a similar pattern to that which was previously reported.

TABLE 17

QUANTITATIVE MEASUREMENTS OF THE NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD OF THE RECTUS FEMORIS TAKEN APPROXIMATELY TWENTY-FOUR HOURS AFTER PARTICIPATION IN THE ACTIVITY ON THE INITIAL TEST AND FINAL TEST

Group	M		SD		SEM	
	Initial Test	Final Test	Initial Test	Final Test	Initial Test	Final Test
Bowling	94.20	49.60	46.67	22.24	12.05	5.74
Swimming	73.53	26.60	66.68	28.75	17.22	7.42
Modern Dance	79.40	36.86	67.60	31.67	17.45	8.18
Control	87.60	76.46	69.98	42.38	17.81	10.94

A summary of the analysis of variance for quantitative measurements of the neuromuscular tension recorded for

the rectus femoris taken approximately twenty-four hours after participation in the activity before and after the experimental period of nine weeks is presented in Table 18. The F ratio indicates there was no significant difference between the groups, and that there was a significant difference between the trials. The F ratio for groups by trials was not significant.

TABLE 18

ANALYSIS OF VARIANCE OF RESIDUAL NEUROMUSCULAR TENSION OF THE RECTUS FEMORIS FOR FOUR ACTIVITY GROUPS MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD TAKEN APPROXIMATELY TWENTY-FOUR HOURS AFTER PARTICIPATION IN ACTIVITY ON THE INITIAL TEST AND FINAL TEST

Source	df	SS	ms	F
Between Subjects	59	252553.3667	4280.5655	-
Between Groups	3	16855.3667	5618.4556	1.3349
$Error_b$	56	235698.0000	4208.8928	
Within Subjects	60	84775.0000	1412.9167	-
Between Trials	1	34273.1999	34273.1999	42.8626*
Groups x Trials	3	5723.8000	1907.9333	2.3861
$Error_w$	56	44778.0000	799.6071	
Total	119	337328.3667		

*Significant at .01 level F(1,56) = 7.12

F(3,56) (.05) = 2.78

One might conclude upon the basis of a summary of the findings of the data presented so far that participation in physical activity of a recreational nature, within the

delimitations of this study, does significantly influence the residual neuromuscular tension in the biceps brachii approximately one hour after participation in the activity. However, no significance was found between the groups for the rectus femoris at any time nor for any other time period for the biceps brachii.

Estimated Measures of Physical Work Capacity

Estimated measures of physical work capacity of each subject were determined before and after the experimental period of nine weeks to determine if there was a change in physical fitness. In Table 19, below, it is revealed that the four groups varied in mean scores of estimated measures of physical work capacity on the final test.

TABLE 19

FINAL MEASUREMENTS OF PHYSICAL WORKING CAPACITY TO REACH A HEART RATE OF 170 BEATS PER MINUTE AS ESTIMATED BY THE SWC_{170} TEST FOR FOUR ACTIVITY GROUPS*

Group	M	SD	SEM
Bowling	656.00	86.26	17.62
Swimming	695.80	88.89	22.95
Modern Dance	686.00	63.71	16.45
Control	632.80	54.41	14.05

*Recorded in kilopond meters.

The modern dance group experienced the greatest mean gain, 44.59 kpm, between the initial test and the final test. On Table 2, page 69, the mean scores of the initial test measurements of the SWC_{170} were presented. The subjects participating in bowling and the control group had a decrement in the performance measured by the SWC_{170} from the initial to the final test. Table 20, presented below, presents a summary of the analysis of variance on initial test and final test measurements. The F value indicates that the groups were not significantly different on the final measurements.

TABLE 20

ANALYSIS OF VARIANCE OF THE ESTIMATED MEASUREMENTS OF SUBMAXIMAL WORKING CAPACITY TAKEN BEFORE AND AFTER A NINE WEEK PROGRAM OF PHYSICAL ACTIVITY FOR THREE GROUPS AND NON-PARTICIPATION FOR THE CONTROL GROUP

Source	df	SS	ms	F
Between Subjects	59	364631.4700	6180.1944	-
Between Groups	3	24550.2000	8183.4000	1.3475
$Error_b$	56	340081.2700	6072.8798	
Within Subjects	60	213156.0000	3552.6000	-
Between Trials	1	2900.8300	2900.8300	.8609
Groups x Trials	3	21566.2400	7188.7466	2.1335
$Error_w$	56	188688.9300	3369.4451	
Total	119	577787.4700		

$F(3,56)(.05) = 2.78$
$F(1,56)(.05) = 4.16$

This reveals that the subjects in the activity groups did not achieve a statistically significant gain in physical conditioning through the participation of the previously designated activities in the required physical education program. The results failed to support the classification of swimming and modern dance as moderate and heavy levels of activity as measured by the SWC_{170} Test.

Attitude Toward Physical Education

The Wear Physical Education Attitude Inventory was administered to each subject before and after the experimental period. Descriptive data relative to initial measurements are presented in Table 3, on page 70. Table 21, below, indicates that the means of the four groups on the final measurements of the Wear Physical Education Attitude Inventory did not differ greatly with a range of 5.73 points.

TABLE 21

FINAL TEST SCORES ON WEAR PHYSICAL EDUCATION ATTITUDE INVENTORY FOR FOUR ACTIVITY GROUPS*

Group	M	SD	SEM
Bowling	125.33	12.65	3.27
Swimming	119.60	12.68	3.28
Modern Dance	123.00	7.68	1.98
Control	120.67	10.10	2.61

*Recorded in points, with a possible of 150 points.

A summary of the analysis of variance of the measurements taken before and after the experimental period appears in Table 22. The F values were not significant, indicating that the expressed attitudes did not change from the initial test to the final test through the participation in the specific activity classes. It is therefore believed that

TABLE 22

ANALYSIS OF VARIANCE OF THE SCORES OF THE WEAR PHYSICAL EDUCATION ATTITUDE INVENTORY TAKEN BEFORE AND AFTER A NINE WEEK PROGRAM OF PHYSICAL ACTIVITY FOR THREE GROUPS AND NON-PARTICIPATION FOR THE CONTROL GROUP

Source	df	SS	ms	F
Between Subjects	59	12635.491667	214.1609	-
Between Groups	3	816.29167	272.0972	1.2892
$Error_b$	56	11819.20000	211.0571	
Within Subjects	60	2184.500000	36.4083	-
Between Trials	1	6.07499	6.07499	.1661
Groups x Trials	3	130.825003	43.60830	1.1927
$Error_w$	56	2047.600000		
Total	119	14819.991667		

$F(3,56)(.05) = 2.78$
$F(1,56)(.05) = 4.02$

the attitudes of the subjects did not influence the results of quantitative measurements of residual neuromuscular tension of the biceps brachii and rectus femoris muscles.

Summary

A description of the statistical treatment of the data collected through the administration of three testing periods, a pre-test, a mid-point test, and a post-test, was presented in narrative and tabular form. Quantitative measurements of residual neuromuscular tension, estimated measures of physical working capacity, and attitude toward physical education were taken during the experimental period of nine weeks. Analysis of variance, a two-factor mixed design with repeated measures on one factor, and Duncan's Multiple Range Test comprised the basic analytical procedures in treatment of the data.

The analysis of data revealed that there was no significant difference between the groups on the quantitative measurements of residual neuromuscular tension of the biceps brachii and rectus femoris taken approximately one hour after participation in the activity, repeated six hours later, and after twenty-four hours. Residual neuromuscular tension levels did change from the initial to the final test. Only on the measurements of the biceps taken one hour after participation in activity did the groups differ significantly in changes of tension levels from the initial to the final test. Duncan's Multiple Range Test applied to the significant F value for groups by trials indicated that the final test for the modern dance group, the swimming group, and the bowling group differed significantly from the initial test.

The change of tension within the control group was not significant.

The results of the analysis of variance for quantitative measurements of estimated measures of physical working capacity and attitude toward physical education indicated that the groups were not significantly different. The measures did not change significantly from the initial to the final test, but the groups did not vary significantly from the initial test to the final test.

Chapter V presents the summary, findings, conclusion, and recommendations for future studies.

CHAPTER V

CONCLUSION OF THE STUDY

Introduction

The present chapter contains a review of the study with a presentation and discussion of the hypotheses. A conclusion to the study is drawn and recommendations for further studies are cited.

Summary of the Investigation

There is controversy over the therapeutic effects of participation in recreational type activities. Physical educators, physicians, psychiatrists, and psychologists have offered favorable remarks in relation to the benefits of participation in physical activity upon the release of emotional and muscular tensions, although objective evaluation through research on this point has been sparse.

Authorities in tension control contend that relaxation is a skill which may be learned in much the same manner as any other neuromuscular skill. Thus, the limited amount of research conducted in the area of relaxation is principally concerned with an analysis of the teaching of relaxation techniques and its effects upon neuromuscular activity.

Larsson, Linderholm, and Ringqvist (49), in the analysis of changes in the electromyograms of subjects after various types of standardized muscular work, found that the duration of all action potentials decreased after exercise with no significant change in amplitude. This finding was interpreted that participation in exercise may provide a therapeutic effect in reducing muscle tension. deVries (31) found that neuromuscular tension can be reduced by participation in a rigorous bout of exercise. Exercise, movement therapy, and dance have been successfully utilized in the treatment of individuals who are mentally ill, indicative of the possible therapeutic value of the participation in physical activity in the release of emotional and muscular tension.

The present investigation was designed to determine the effect of participation in nine weeks of selected recreational types of activities, classified as light, moderate, and heavy levels of activity, upon residual neuromuscular tension in the biceps elbow flexor muscle group and the rectus femoris muscle as determined by quantitative electromyography. The specific muscles were selected because previous literature suggested that the selected muscles were indicative of the body tension and could be appropriately measured as well as of obvious use in the recreational type activities the subjects of this study participated in.

The hypotheses tested in this study were: (1) There is no significant difference between the influence of participation in the motor activity of bowling, swimming, and/or modern dance and non-participation in the motor activity upon residual neuromuscular tension in the biceps brachii and the rectus femoris as measured approximately one hour after the activity, when repeated six hours later, and again after twenty-four hours. (2) There is no significant difference between the influence of participation in the motor activities of bowling, swimming, and modern dance upon the residual neuromuscular tension in the biceps brachii and the rectus femoris as measured approximately one hour after the activity, when repeated six hours later, and after twenty-four hours.

To test the hypotheses, a research design of four groups was employed. Each group was comprised of fifteen college women. One group, which was a bowling class, was designated as a light level exercise group. Another group, which was a swimming class, was designated a moderate level exercise group. A third group, which was a modern dance class, was designated a heavy level exercise group. The final group was a control group. The designations as to level of activity were based upon the literature. The subjects in the motor activity groups participated in the regular classes of the required physical education program during the spring semester of the academic year 1969-1970. The subjects in the control group did not participate in a

scheduled program of physical activity. The experimental period for the study extended for a period of nine weeks. Data were collected from the subjects identified, through the administration of three testing periods, a pre-test, a mid-point test, and a post-test. Residual neuromuscular tension in the biceps brachii and the rectus femoris was measured with a Newport Laboratories integrating Bio-electric Monitor coupled with an electronic counter which gave a digital readout. During the initial and final testing periods, measurements were taken approximately one hour after the activity, repeated six hours later, and after twenty-four hours. Measurements were taken approximately one hour after the activity during the mid-point testing period.

The Wear Physical Education Attitude Inventory was administered to each subject before and after the experimental period to determine attitude toward physical education. It was initially theorized that if any differences occurred they might be due to basic attitudes of the subjects toward physical activity.

An estimated measure of physical working capacity was determined through the administration of a modified SWC_{170} Test to each subject before and after the experimental period. It was believed that the recreational activities required different levels of physical activity and, since strenuous activity had previously been shown to lower neuromuscular tension immediately after exercise, a simple measure

of basic fitness was used to see if the recreational activities did, in fact, alter fitness levels.

Analysis of variance, a mixed factor design of repeated measures, was the statistical tool selected to evaluate the differences between each group and within each group on the measurements taken during each period. The Duncan Multiple Range Test was selected to analyze the significance of the F-ratio.

Findings of the Study

An analysis of the data revealed the following findings:

A. The bowling group, the swimming group, the modern dance group, and the control group did not vary significantly in residual neuromuscular tension of the biceps brachii and rectus femoris following a nine week period of participation or non-participation in the selected activity classes of the required physical education program at the Texas Woman's University.

B. The overall change in residual tension levels of the biceps brachii and the rectus femoris was noted between the initial test and the mid-point test, the mid-point test and final test, and the initial test and final test of measurements taken approximately one hour after the participation in the activity. An overall change was also

noted between the initial test and final test of measurements taken approximately six hours and twenty-four hours after the participation in the activity. The changes were in the direction of a decrease in neuromuscular tension.

C. A significant decrease of the residual neuromuscular tension of the biceps brachii for the modern dance group, the swimming group, and the bowling group was observed one hour following the participation in the selected activity classes of a required physical education program for a nine week experimental period.

D. The residual neuromuscular tension of the biceps brachii and rectus femoris for the four groups did not differ significantly in changes between the initial test and the final test of measurements taken approximately six hours and twenty-four hours following the participation in the activity during the experimental period of nine weeks.

E. The four groups did not initially vary in measured attitudes toward physical education as measured by the Wear Physical Education Attitude Inventory, and the attitudes did not change significantly during the experimental period.

F. The physical fitness levels of the four groups, as measured by the SWC_{170} Test, were initially comparable and did not change significantly as a result of the participation in the selected activity of the required physical education program for the three experimental groups and the non-participation in organized activity for the control group.

Discussion of the Findings

The findings will be discussed in relation to the hypothesis. Possible implications will be included.

Hypothesis 1

The first hypothesis of the present investigation was:

> There is no significant difference between the influence of the participation in the motor activity of bowling and non-participation in motor activity upon residual neuromuscular tension in the elbow flexor muscle group and the rectus femoris muscle as measured approximately one hour after the activity, repeated six hours later, and after twenty-four hours.

The F values for the analysis of variance between the groups of the quantitative measurements of the biceps brachii and rectus femoris taken before, during, and after the experimental period of nine weeks within the prescribed times were not significant. The F values for groups by trials were not significant in all instances except for the measurements of the biceps brachii taken approximately one hour after the

participation in the activity during the three testing periods. Duncan's Multiple Range Test indicated that the bowling group did not differ significantly between the initial and final test, and the control group did not differ significantly between the initial and final test. Since the change was not observed for all the measurements taken there was a failure to reject the null hypothesis.

It may be assumed, therefore, that the experimental period of a nine weeks participation in the activity of bowling did not significantly lower residual neuromuscular tension in the biceps brachii and rectus femoris. This does not seem to coincide with the findings of the studies conducted by Handlon, et al. (35, 36), which indicated that participation in bowling significantly lowered tension. However, it should be noted that these studies did not use electromyograph techniques nor were the studies by Handlon, et al., objective in nature. Further research involving additional or completely different muscle groups, and perhaps analysis of the muscles as a composite unit, could provide better insight as to the effect of the participation in the activity of bowling upon residual neuromuscular tension. The physical intensity of bowling is generally believed to be low, thus, the physiological benefits are thought to be small and, therefore, the rationale of a possible relationship between the physical intensity of the recreational activity and a reduction in tension may still hold.

Hypothesis 2

The second hypothesis of the present investigation was:

> There is no significant difference between the influence of the participation in the motor activity of swimming and non-participation in motor activity upon residual neuromuscular tension in the elbow flexor muscle group and the rectus femoris muscle as measured approximately one hour after the activity, repeated six hours later, and after twenty-four hours.

There was a failure to reject the null hypothesis. The F values for the quantitative measurements between the groups taken of the two muscle groups before, during, and after the experimental period were not significant. In an analysis of groups by trials, the swimming group experienced a significant decrease in tension between the initial test and final test only for the measurements of the biceps brachii taken approximately one hour after participation in activity. A discernable trend seemed to support the results revealed by deVries who found that: (1) a five minute bout of rigorous exercise did contribute to a significant reduction in tension of the biceps brachii up to approximately one hour after participation, and (2) an exercise program of conditioning exercises performed two or three days each week for seventeen sessions, through which conditioning occurred, significantly lowered residual neuromuscular tension of the biceps brachii (31). deVries (31) stated that the diminution of residual tension in the rectus femoris was not significant in either case. In combining the results of the measurements of both

muscle groups in the long term program, a significant reduction in tension was noted by deVries (31).

The F values for the physical fitness measurements in the present investigation were not significant. The physical fitness level of the swimming group did not change significantly as indicated by the SWC_{170} Test. Perhaps, a longer experimental period with guided levels of instruction would provide additional information to the effect of the participation in a recreational activity such as swimming upon residual neuromuscular tension.

Hypothesis 3

The third hypothesis of the present investigation was:

> There is no significant difference between the influence of participation in the motor activity of modern dance and non-participation in motor activity upon residual neuromuscular tension in the elbow flexor muscle group and rectus femoris muscle as measured approximately one hour after the activity, repeated six hours later, and after twenty-four hours.

The F values indicated that the four groups did not vary significantly on quantitative measurements of the biceps brachii and rectus femoris, but an analysis of groups by trials indicated that the modern dance group differed significantly between the initial test and the final test on the measurements of the biceps brachii taken approximately one hour after participation in the activity. Therefore, there was a failure to reject the null hypothesis. Implications discussed for the previous hypothesis can also be

applied in this instance. The problem of the effect of participation in physical activity through which conditioning occurs seems to warrant further study.

Hypothesis 4

The fourth hypothesis of the present investigation was:

> There is no significant difference between the influence of the participation in the motor activities of bowling, swimming, and modern dance upon the residual neuromuscular tension in the elbow flexor muscle group and the rectus femoris muscle as measured approximately one hour after the activity, repeated six hours later, and twenty-four hours.

The F values between the groups of the quantitative measurements taken of the biceps brachii and rectus femoris during the three testing periods within the designated time intervals were not significant. An analysis of groups by trials indicated that only on the measurements of the biceps brachii taken approximately one hour after participation for the swimming group, the modern dance group, and the bowling group was a significant change noted between the initial test and the final test. The control group did not change significantly on the same measurements. Since the trend was not noted for the other measurements there was a failure to reject the hypothesis.

In general a trend was noted suggesting that participation in the recreational activities of bowling, swimming, and modern dance lowers the neuromuscular tension level of participants. The lowered tension level, as measured by

electromyographic methods, was transitory and while it may be of sufficient value for therapeutic purposes it was not statistically significant.

Conclusion of the Study

Based upon the results of the study, it was concluded that the participation in the recreational activities of bowling, swimming, and modern dance of a required physical education program for a period of nine weeks does not significantly lower residual neuromuscular tension beyond a short, transitory period.

Limitations of the Study

The present study was subject to the following limitations:

A. The inability to test all subjects during the designated time periods of one hour, six hours, and twenty-four hours following participation in activity because of conflicting schedules or failure to keep designated appointments.

B. The measurement of physical fitness levels through the administration of a modified SWC_{170} Test is not sufficiently accurate enough to discover all the changes that may have occurred.

Recommendations for Further Studies

The following recommendations for further studies are offered:

A. The effect of the participation in vigorous physical exercise upon relaxation of the hypertense individual as determined by electromyography.

B. The influence of the participation in recreational types of activities upon residual neuromuscular tension of the hypertense individual as measured by electromyography.

C. The therapeutic value of the participation in physical activities of varying levels upon release of emotional and muscular tensions for the aged.

D. A comparison of the psychological analysis of the therapeutic values of the participation in physical activity of various levels of intensity of different ages upon relaxation as an electromyographic analysis.

E. The influence of the participation in physical activity of a recreational type upon residual neuromuscular tension of individuals with varying skill levels, as the highly skilled individual in contrast to the beginner.

APPENDIX A

TABLE 23

DATA OF THE NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD OF THE BICEPS BRACHII AND THE RECTUS FEMORIS FOR THE BOWLING GROUP BEFORE, AFTER THE FOURTH WEEK, AND AFTER A NINE WEEK PARTICIPATION IN THE ACTIVITY

Subject	Age	Initial Test						Mid-Point Test		Final Test					
		T_1		T_2		T_3		T_1		T_1		T_2		T_3	
		B*	R**	B	R	B	R	B	R	B	R	B	R	B	R
1	20	120	117	110	114	115	118	98	135	115	45	119	68	110	44
2	18	279	136	225	128	236	115	136	81	161	87	182	93	165	76
3	20	18	78	10	64	16	60	18	125	10	30	8	43	21	56
4	18	50	46	35	38	43	41	86	51	10	36	27	58	18	29
5	19	74	78	85	73	56	69	65	49	48	28	46	35	49	32
6	20	0	38	0	0	0	0	0	0	0	0	0	0	12	0
7	20	223	143	198	71	231	88	140	83	136	90	131	107	133	74
8	18	60	39	56	33	58	38	53	26	51	28	58	23	65	26
9	20	183	112	173	153	162	85	93	62	65	53	71	58	69	68
10	19	138	72	122	65	129	70	63	46	84	51	63	56	76	46
11	20	136	45	133	38	141	41	112	49	107	56	117	63	97	46
12	18	206	134	141	159	200	131	234	93	200	61	221	73	195	52
13	18	352	210	316	203	320	189	139	88	143	82	149	93	138	76
14	18	119	96	137	106	121	111	169	93	73	51	87	58	71	43
15	19	226	160	115	93	127	107	109	89	121	82	136	89	116	76

*Measurements taken of biceps brachii.

**Measurements taken of rectus femoris.

TABLE 24

DATA OF THE NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD OF THE BICEPS BRACHII AND THE RECTUS FEMORIS FOR THE SWIMMING GROUP BEFORE, AFTER THE FOURTH WEEK, AND AFTER A NINE WEEK PARTICIPATION IN THE ACTIVITY

Subject	Age	Initial Test						Mid-Point Test		Final Test					
		T_1		T_2		T_3		T_1		T_1		T_2		T_3	
		B*	R**	B	R	B	R	B	R	B	R	B	R	B	R
1	18	113	63	98	71	111	62	70	17	6	0	20	0	8	0
2	18	210	85	212	90	187	70	130	24	109	38	117	27	108	23
3	20	0	0	0	0	0	0	48	0	24	0	14	0	15	0
4	19	25	0	18	0	17	0	34	16	32	0	11	0	38	0
5	19	0	26	0	15	0	13	22	0	22	0	57	0	21	0
6	18	341	250	344	243	336	251	118	96	126	93	96	68	90	86
7	19	129	111	136	115	120	108	86	34	97	31	86	55	91	42
8	18	110	63	40	21	38	29	88	32	31	0	39	28	32	31
9	18	46	68	33	41	42	37	152	98	49	0	36	0	41	0
10	18	155	86	116	74	133	60	166	44	84	39	67	59	73	46
11	18	263	146	236	124	260	110	278	87	176	76	144	66	156	73
12	20	63	50	98	26	87	22	39	23	26	38	48	19	34	21
13	20	43	146	36	133	34	131	33	86	37	26	44	17	39	10
14	20	296	155	266	142	253	138	159	43	122	19	134	49	114	59
15	18	140	63	69	46	90	72	168	86	98	26	73	0	63	8

*Measurements taken of biceps brachii.

**Measurements taken of rectus femoris.

TABLE 25

DATA OF THE NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD OF THE BICEPS BRACHII AND THE RECTUS FEMORIS FOR THE MODERN DANCE GROUP BEFORE, AFTER THE FOURTH WEEK, AND AFTER A NINE WEEK PARTICIPATION IN THE ACTIVITY

Subject	Age	Initial Test						Mid-Point Test		Final Test					
		T_1		T_2		T_3		T_1		T_1		T_2		T_3	
		B*	R**	B	R	B	R	B	R	B	R	B	R	B	R
1	19	110	68	90	70	115	98	90	56	83	41	89	48	82	43
2	19	64	10	93	14	120	8	33	0	75	24	71	0	76	0
3	20	350	110	115	103	223	126	220	86	69	62	71	86	54	87
4	19	336	306	241	243	324	223	76	23	33	99	20	122	28	79
5	20	280	116	287	123	276	119	145	43	114	34	176	26	128	28
6	19	0	0	0	0	0	0	110	67	0	0	0	0	0	0
7	18	223	193	237	186	228	187	161	104	158	93	165	103	152	86
8	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	20	30	15	28	11	34	13	16	0	18	0	29	0	16	0
10	19	85	49	99	46	53	44	74	38	46	9	56	13	41	22
11	18	110	90	120	102	112	88	150	57	67	43	58	58	73	52
12	20	135	78	128	67	102	62	112	65	45	27	65	15	85	63
13	19	82	75	79	81	87	73	74	63	81	24	96	52	76	38
14	21	121	34	113	43	119	31	172	59	68	16	78	23	56	12
15	20	3	121	16	128	20	119	0	143	0	48	0	57	0	43

*Measurements taken of biceps brachii.

**Measurements taken of rectus femoris.

TABLE 26

DATA OF THE NEUROMUSCULAR TENSION MEASURED IN MICROVOLTS DURING A ONE MINUTE PERIOD OF THE BICEPS BRACHII AND THE RECTUS FEMORIS FOR THE CONTROL GROUP BEFORE, AFTER THE FOURTH WEEK, AND AFTER NON-PARTICIPATION IN ORGANIZED ACTIVITY FOR AN EXPERIMENTAL PERIOD OF NINE WEEKS

Subject	Age	Initial Test						Mid-Point Test		Final Test					
		T_1		T_2		T_3		T_1		T_1		T_2		T_3	
		B*	R**	B	R	B	R	B	R	B	R	B	R	B	R
1	22	124	64	159	71	182	67	136	66	97	56	107	72	96	58
2	22	0	0	13	0	63	0	57	16	42	45	77	55	67	51
3	22	24	112	26	148	28	108	255	102	110	126	161	161	141	102
4	20	125	96	118	86	127	91	88	63	121	98	102	78	124	86
5	20	148	60	136	64	133	66	140	72	177	79	182	81	107	75
6	20	311	210	336	196	320	189	252	133	280	104	296	139	293	129
7	20	19	43	22	33	16	42	16	49	47	56	67	63	47	64
8	21	31	104	29	116	24	109	23	101	188	85	145	93	103	91
9	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	21	325	208	319	210	321	207	317	134	247	136	257	146	239	152
11	21	60	0	48	0	57	0	30	68	57	10	26	13	53	15
12	19	263	142	238	156	190	153	187	96	215	111	230	143	218	126
13	21	22	18	18	17	19	14	25	13	30	23	38	31	31	28
14	21	210	181	185	175	165	146	136	110	121	84	96	92	113	87
15	20	150	118	136	113	148	117	112	98	121	86	136	56	179	83

*Measurements taken of biceps brachii.

**Measurements taken of rectus femoris.

TABLE 27

DATA OF ESTIMATED MEASURES OF PHYSICAL WORKING CAPACITY ON THE INITIAL TEST AND FINAL TEST OF SWC_{170} ADMINISTERED BEFORE AND AFTER A NINE WEEK PARTICIPATION IN SELECTED ACTIVITY FOR THE THREE EXPERIMENTAL GROUPS AND NON-PARTICIPATION FOR CONTROL GROUP*

Subject	Initial	Final	Subject	Initial	Final
Bowling			Modern Dance		
1	732	681	1	582	633
2	723	678	2	627	690
3	624	618	3	717	729
4	564	597	4	690	714
5	771	783	5	567	579
6	577	594	6	591	674
7	717	633	7	579	630
8	753	724	8	627	660
9	669	708	9	570	615
10	630	597	10	603	675
11	568	549	11	804	819
12	615	635	12	615	690
13	729	681	13	687	789
14	629	597	14	687	705
15	756	765	15	675	687
Swimming			Control		
1	702	693	1	642	648
2	654	657	2	543	564
3	714	864	3	657	685
4	768	732	4	717	690
5	705	852	5	675	669
6	561	558	6	594	573
7	555	564	7	702	642
8	708	714	8	570	507
9	675	678	9	612	603
10	612	660	10	648	663
11	783	759	11	678	675
12	657	720	12	639	642
13	714	732	13	639	657
14	582	600	14	657	687
15	639	654	15	789	687

*Recorded in kilopond meters per minute.

TABLE 28

DATA OF TOTAL POINTS SCORED ON PRE-TEST AND POST-TEST OF WEAR PHYSICAL EDUCATION ATTITUDE INVENTORY ADMINISTERED BEFORE AND AFTER A NINE-WEEK PARTICIPATION IN SELECTED ACTIVITY FOR THE THREE EXPERIMENTAL GROUPS AND NON-PARTICIPATION FOR CONTROL GROUP*

Subject	Pre-Test	Post-Test	Subject	Pre-Test	Post-Test
Bowling			Modern Dance		
1	132	130	1	106	108
2	119	118	2	118	104
3	123	128	3	121	117
4	128	132	4	132	134
5	138	135	5	119	121
6	130	115	6	121	118
7	93	103	7	119	120
8	129	139	8	120	123
9	135	124	9	128	126
10	117	109	10	118	107
11	120	145	11	137	127
12	122	112	12	125	127
13	106	127	13	121	115
14	142	125	14	126	129
15	133	138	15	134	134
Swimming			Control		
1	129	124	1	111	109
2	126	120	2	120	129
3	131	131	3	130	133
4	84	102	4	109	98
5	129	135	5	140	132
6	126	127	6	120	120
7	110	112	7	140	143
8	129	120	8	117	104
9	121	118	9	115	114
10	110	123	10	115	113
11	113	123	11	113	119
12	95	98	12	114	116
13	115	132	13	128	130
14	109	108	14	110	119
15	115	121	15	116	116

*A possible 150 points.

APPENDIX B

CARLOS B. WEAR--PHYSICAL EDUCATION ATTITUDE INVENTORY

FORM A

Directions--Please read carefully: Below you will find some statements about physical education. We would like to know how you feel about each statement. You are asked to consider physical education only from the standpoint of its place as an activity course taught during a regular class period. No reference is intended in any statement to interscholastic or intramural athletics. People differ widely in the way they feel about each statement. There are no right or wrong answers.

You have been provided with a separate answer sheet for recording your reaction to each statement. (a) Read each statement carefully, (b) go to the answer sheet, and (c) opposite the number of the statement place a circle around the word (or words) which best expresses your feeling about the statement. If you agree, then decide whether to place a circle around "agree" or "strongly agree." If you disagree, then decide whether to place the circle around "disagree" or "strongly disagree." In case you are undecided (or neutral) concerning your feeling about the statement, then place a circle around "undecided." Try to avoid placing a circle around "undecided" in very many instances.

Wherever possible, let your own personal experience determine your answer. Work rapidly, do not spend much time on any statement. This is not a test, but is simply a survey to determine how people feel about physical education. Your answers will in no way affect your grade in any course. Please answer each statement as you actually feel about it. Be sure to answer every statement.

Statements

1. If for any reasons a few subjects have to be dropped from the school program, physical education should be one of the subjects dropped.

2. Physical education activities provide no opportunities for learning to control the emotions.

3. Physical education is one of the more important subjects in helping to establish and maintain desirable social standards.

4. Vigorous physical activity works off harmful emotional tensions.

5. I would take physical education only if it were required.

6. Participation in physical education makes no contribution to the development of poise.

7. Because physical skills loom large in importance in youth, it is essential that a person be helped to acquire and improve such skills.

8. Calisthenics taken regularly are good for one's general health.

9. Skill in active games or sports is not necessary for leading the fullest kind of life.

10. Physical education does more harm physically than it does good.

11. Associating with others in some physical education activity is fun.

12. Physical education classes provide situations for the formation of attitudes which will make one a better citizen.

13. Physical education situations are among the poorest for making friends.

14. There is not enough value coming from physical education to justify the time consumed.

15. Physical education skills make worthwhile contributions to the enrichment of living.

16. People get all the physical exercise they need in just taking care of their daily work.

17. All who are physically able will profit from an hour of physical education each day.

18. Physical education makes a valuable contribution toward building up an adequate reserve of strength and endurance for everyday living.

19. Physical education tears down sociability by encouraging people to attempt to surpass each other in many of the activities.

20. Participation in physical education activities makes for a more wholesome outlook on life.

21. Physical education adds nothing to the improvement of social behavior.

22. Physical education class activities will help to relieve and relax physical tensions.

23. Participation in physical education activities helps a person to maintain a healthful emotional life.

24. Physical education is one of the more important subjects in the school program.

25. There is little value in physical education as far as physical well-being is concerned.

26. Physical education should be included in the program of every school.

27. Skills learned in a physical education class do not benefit a person.

28. Physical education provides situations for developing desirable character qualities.

29. Physical education makes for more enjoyable living.

30. Physical education has no place in modern education.

CARLOS B. WEAR--PHYSICAL EDUCATION ATTITUDE INVENTORY

FORM B

Directions--Please read carefully: Below you will find some statements about physical education. We would like to know how you feel about each statement. You are asked to consider physical education only from the standpoint of its place as an activity course taught during a regular class period. No reference is intended in any statement to interscholastic or intramural athletics. People differ widely in the way they feel about each statement. There are no right or wrong answers.

You have been provided with a separate answer sheet for recording your reaction to each statement. (a) Read each statement carefully, (b) go to the answer sheet, and (c) opposite the number of the statement place a circle around the word (or words) which best expresses your feeling about the statment. If you agree, then decide whether to place a circle around "agree" or "strongly agree." If you disagree, then decide whether to place the circle around "disagree" or "strongly disagree." In case you are undecided (or neutral) concerning your feeling about the statement, then place a circle around "undecided." Try to avoid placing a circle around "undecided" in very many instances.

Wherever possible, let your own personal experience determine your answer. Work rapidly, do not spend much time on any statement. This is not a test, but is simply a survey to determine how people feel about physical education. Your answers will in no way affect your grade in any course. Please answer each statement as you actually feel about it. Be sure to answer every statement.

Statements

1. Associations in physical education activities give people a better understanding of each other.

2. Engaging in vigorous physical activity gets one interested in practicing good health habits.

3. The time spent in getting ready for and engaging in a physical education class could be more profitably spent in other ways.

4. A person's body usually has all the strength it needs without participation in physical education activities.

5. Participation in physical education activities tends to make one a more socially desirable person.

6. Physical education in schools does not receive the emphasis that it should.

7. Physical education classes are poor in opportunities for worthwhile social experiences.

8. A person would be better off emotionally if he did not participate in physical education.

9. It is possible to make physical education a valuable subject by proper selection of activities.

10. Developing a physical skill brings mental relaxation and relief.

11. Physical education classes provide nothing which will be of value outside the class.

12. There should not be over two one-hour periods per week devoted to physical education in schools.

13. Belonging to a group, for which opportunity is provided in team activities, is a desirable experience for a person.

14. Physical education is an important subject in helping a person gain and maintain all-round good health.

15. No definite beneficial results come from participation in physical education activities.

16. Engaging in group physical education activities is desirable for proper personality development.

17. Physical education activities tend to upset a person emotionally.

18. For its contributions to mental and emotional weel-being physical education should be included in the programs of every school.

19. I would advise anyone who is physically able to take physical education.

20. As far as improving physical health is concerned a physical education class is a waste of time.

21. Participation in physical education class activities tends to develop a wholesome interest in the functioning of one's body.

22. Physical education classes give a person an opportunity to have a good time.

23. The final mastering of a certain movement or skill in a physical education class brings a pleasurable feeling that one seldom experiences elsewhere.

24. Physical education contributes little toward the improvement of social behavior.

25. Physical education classes provide values which are useful in other parts of daily living.

26. Physical education should be included in the program of every school.

27. Physical education should be required of all who are physically able to participate.

28. The time devoted to physical education in schools could be more profitably used in study.

29. The skills learned in a physical education class do not add anything of value to a person's life.

30. Physical education does more harm socially than good.

APPENDIX C

SCORE CARD

Name_____ Age_____ Dormitory_____

Group_____ ACT/SAT_____ Phone _____

SWC_{170} Initial

Resting Rate

1._____
2._____
3._____
4._____

Final

Resting Rate

1._____
2._____
3._____
4._____

Wear Physical Education

Initial Test_____

Final Test _____

RESIDUAL TENSION

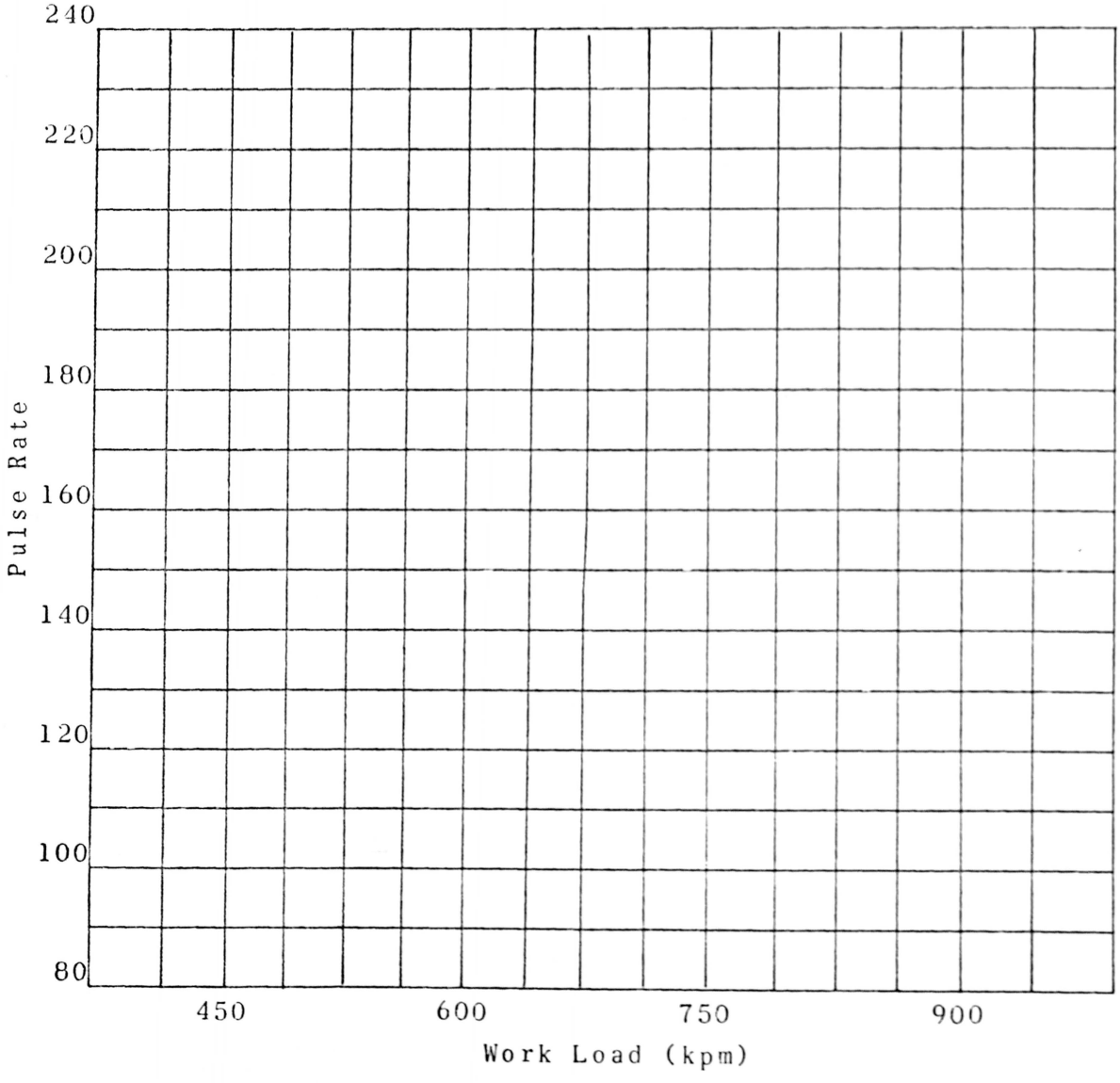
	Initial						Mid-Point						Final					
	Biceps			Femoris			Biceps			Rectus Femoris			Biceps			Rectus Femoris		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Imp.																		
N-E																		
Total																		
Mean																		

SWC_{170}

Name_____ Group_____

Resting Rate:_____ SWC_{170}_____

Submaximal Working Capacity (Modified)



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