A COMPARISON OF STATIC AND BALLISTIC STRETCHING TECHNIQUES FOR IMPROVING THE RANGE OF MOTION ABOUT SELECTED ANATOMICAL JOINTS OF 55 TO 75 YEAR OLD FEMALES

by

DENIS ELLWOOD SMITH

B.Ed., University of Victoria, 1977

A THESIS SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in the Faculty

of

Education

ACCEPTED

FACULTY OF GRADUATE STUDIES

DEAN

DATE 29th March 81

We accept this thesis as conforming
to the required standard

[redacted]

Robert D. Bell, Ph.D.

[redacted]

Martin C. Collis, Ph.D.

[redacted]

Roger Ruth, Ph.D.

[redacted]

UNIVERSITY OF VICTORIA

December 1980

Supervisor: Dr. Robert D. Bell

ABSTRACT

The purpose of this investigation was to compare static and ballistic stretching techniques for improving the flexibility, or range of motion, about selected anatomical joints of 55 to 75 year-old females. Forty-four women who regularly attended swimming pool sessions at three Greater Victoria aquatic centers were classified into three groups: Experimental Group A, Experimental Group B, and Control Group. Experimental Group A received a three-week treatment program of static stretch exercises, whereas Experimental Group B received a three-week program of ballistic stretch exercises. The Control Group received no specific flexibility training. The treatment for both experimental groups was designed to improve the range of motion in the subjects' shoulders, elbows, trunk, hips, knees, and ankles. Subjects were tested on ten measures of flexibility prior to and following the three-week exercise programs. The data from the test sessions were subjected to correlated t-tests, analysis of covariance, and Scheffé multiple comparison of means.

The results showed that a defined program of either static or ballistic stretching may significantly improve the range of motion

of older adults for selected flexibility measures. Further, while general physical activity such as swimming is capable of maintaining flexibility for the older person, in order to significantly improve joint range of motion specific flexibility training must be applied.

Examiners:

[redacted]

Robert D. Bell

[redacted]

Martin C. Collis

[redacted]

Roger Ruth

[redacted]

Frank P. Robinson

TABLE OF CONTENTS

Page

LIST OF TABLES

ACKNOWLEDGEMENT

I would like to express my sincere appreciation to the individuals who have assisted me, directly and indirectly, in this study. My adviser, Dr. R. D. Bell, was a constant source of academic and motivational support. His openness and concern for my work are things for which I will always be grateful.

My thanks to the other members of my thesis committee, Dr. M. Collis and Dr. R. Ruth, in acknowledgement of their input and interest in this study.

I wish to express gratitude to Dr. W. Muir for his assistance with the statistical procedures, and to Dr. B. Hoshizaki for his helpful suggestions and the sharing of his enthusiasm and friendship.

My thanks also to the women who acted as subjects for this study, without whose involvement the study would not have been done.

Finally, I am forever grateful to my father and mother for their endless moral support, and for having always shown, by example, the value of honesty and hard work. And, to my wife Willow, I recognize now the countless little things she did to help, always without question, and which really did make a difference. I owe these three people much.

D.E.S.

CHAPTER I

INTRODUCTION

Physical educators and health professionals alike would contend that three important parameters of physical fitness are cardiovascular endurance, muscular strength and endurance, and flexibility (Collis, 1977; Corbin, 1980; Cureton, 1973; and Sinclair, 1977). They would also acknowledge that acceptable levels of each are necessary for optimum health, implying a state of well-being which is more than the mere absence of disease or infirmity. Physical fitness denotes a degree of physical condition that manifests itself in dependable and versatile body function, rewarding the individual with the ability to respond effectively to physical tasks. It generates independence, confidence, and the vigor to participate in life rather than just spectate. Physical fitness can be a lifelong commodity and, in turn, warrants the attention of all individuals.

The concern for maintaining appropriate fitness levels to enhance individual health and quality of life is especially relevant for the older populace. Fitness is not a commodity that can be "stored" during an individual's younger years to be utilized later in life. In fact, it is something which requires regular, systematic maintenance during each stage of life. Research indicates that when this maintenance func-

tion is not realized, fitness parameters will normally decrease more quickly with advancing age (Kraus, 1977). The heart and lungs experience physiological changes which diminish their combined capacity for producing energy by distributing oxygen-rich blood throughout the body (Clarke, 1977). Muscle cells have been shown to decrease in size and number, leading to a decline in muscular strength (Harris, 1977) and the relationship between joint connective tissue and advancing years is such that the older one gets, the less flexible one may become (Age and Joint Mobility, 1968). Indeed, it is the maintenance of this latter fitness parameter which may be the more trenchant concern for the older person. Flexibility, or the lack of it, may be a major determinant of movement capacity, that very basic ability to climb stairs, to reach high shelves, to bend down, to dress oneself, and to successfully perform all other activities requiring the efficient movement of the joints. In short, it may well be the salient factor that determines an individual's freedom to move.

Considerable research has been accumulated on cardiovascular fitness (Knuttcken, 1967; Roberts, 1971) and strength fitness (Carlson, 1969; McGraw, 1966) such that their role in physical fitness is clearly defined. This research, in turn, has provided credible evidence of the relationship between these fitness parameters and training techniques. The result of the above research undertakings has been a sound base of practical guidelines for most ages regarding the quality and quantity of physical activity needed for enhancing cardiovascular and strength fitness (American College of Sports Medicine, 1975; Cooper, 1970; O'Shea, 1969; Reynolds, 1976). Conversely, there is a dearth of information on

the role of the third parameter, flexibility, in total fitness. In particular, the relationship of flexibility to training techniques, especially for the older population, is lacking. Scientific research has yet to identify the optimum method of stretching for enhancing the freedom of joint movement. The present study was undertaken to provide additional insight into the relationship between flexibility and training techniques.

Statement of the Problem

The purpose of this study was to compare static and ballistic stretching techniques for improving the flexibility, or range of motion, about ten selected anatomical joints of 55 to 75 year old females.

Definitions of Terms

A review of the literature for this study indicated the need for a uniform nomenclature when studying flexibility and a precise description of the different stretching methods for improving flexibility. The following definitions were utilized in this study:

Flexibility: A component of physical fitness also known as suppleness or range of joint motion. It is the possible range of motion of an anatomical segment about a joint or a series of joints.

Static Stretching: A technique involving holding a stationary position for a period of time, whereby the body segment to be stretched is placed in a position of greatest possible length. This method is also referred to as slow, hold, or smooth stretching.

Ballistic Stretching: A technique involving quick movements characterized by jerks and pulls, whereby the momentum of a body seg-

ment exerts force against the resistance of the opposing muscle groups that are to be stretched. This method is also referred to as active, fast, dynamic, spring, rebound, or bounce stretching (Wessel, 1970).

For the purposes of this study, the above definitions of static and ballistic stretching were modified to facilitate the overall content of the individual treatment sessions. The term "static stretching" was expanded to include exercises involving the slow, deliberate rotation of a body part or parts about a joint. Each rotation was performed through as large an arc as possible. The term "ballistic stretching" was expanded to include exercises involving the rapid rotation of a body part or parts about a joint. As with static stretching, each ballistic rotation movement was executed through as large an arc as possible.

In the context of this study, the term "bounce stretch" was used in reference to all ballistic stretching other than that involving rotational movements. As identified by Wessel (1970), bounce stretching refers to the jerks and pulls made while exerting force against joint resistance. The extent or limit of each bounce was the point of maximum stretch.

Overview of the Remaining Chapters of the Study

In brief overview, the second chapter of this thesis contains a review of the literature on flexibility; chapter three describes the methodology used when pursuing the problem; chapter four contains the treatment and analysis of the data and discussion of findings; the fifth and final chapter is devoted to conclusions and suggestions for further research of this type.

CHAPTER II

REVIEW OF THE LITERATURE

The pertinent literature on flexibility may be classified under the following five categories:

1. The importance of flexibility.
2. The relationship of flexibility to age and aging.
3. The relationship of flexibility to inactivity.
4. The modifiability of flexibility.
5. The relationship of flexibility to stretching technique.

The Importance of Flexibility

It was recognized early in history that flexibility is an important parameter of physical well-being. For example, Holland (1968) cited writings by sixteenth-century Tuccaro that extolled the benefits of maintaining a supple body, and described a technique for increasing flexibility of the spine and hamstring muscles.

Contemporary physical educators have stated that good flexibility is necessary for total fitness (Corbin, 1980; Cureton, 1941; de Vries, 1961; Kraus, 1961; and Logan, 1961). They contend that a desirable level of suppleness may help avoid such undesirable maladies as low back pain and joint stiffness which usually accompany decreased physical activity and/or aging (Kraus, 1961). Good flexibility may also contribute benefits such as improved athletic performance (Weiskoph, 1974)

and greater mobility (Lesser, 1978).

Kraus and Hirschland (1954) tested over 4,000 American and 2,500 European children to appraise the strength and flexibility of their trunk and leg muscles. Their results indicated that American children had poor flexibility in the lower back and hamstring muscles as compared to European children of the same age. It has been suggested that such a condition may predispose a person to low back pain, especially if accompanied by weak abdominal muscles (Cureton, 1941; Kraus, 1961).

de Vries (1961a, 1961b, 1975) postulated that stretching exercises for improving suppleness could also retard joint and muscle stiffness that frequently follows rigorous physical activity. Such muscular discomfort was felt to be the localized spasm of muscle motor units. It was suggested that stretching the muscles and surrounding connective tissue would negate or substantially reduce such muscle spasms (de Vries, 1975).

It has been stated that old age is frequently accompanied by joint stiffness and pain (Age and Joint Mobility, 1968; Robert, 1974). Wessel (1970:85) stated that "considerable evidence has been accumulated to indicate that maintenance of optimal range of motion about the joints may prevent and/or to a large extent remove vague aches and pains that seemingly become more common with old age." The value of such evidence is obvious in that movement without pain or discomfort is of paramount importance for normal daily living.

Lesser (1978) indicated that flexible joints may enhance a person's general mobility. With regard to the elderly, mobility is necessary for the successful performance of such daily tasks as bending, sitting,

reaching, and climbing stairs. Inability to perform these actions may mean increased dependency on others and may thus contribute to emotional deterioration.

The Relationship of Flexibility to Age and Aging

There exists some controversy in the literature regarding the question of changes in flexibility as a function of the aging phenomenon. Kendall and Kendall (1948) tested over 5,000 students from kindergarten to grade 12 for lower back and hamstring suppleness. Examining their results, they postulated that flexibility declines from ages six to twelve for boys and six to thirteen for girls, then increases through age twenty-two.

Hupperich and Sigerseth (1950) conducted twelve flexibility tests on 300 girls ranging in age from six to eighteen years. Their results showed that for nine of the twelve measurements taken, the girls increased in flexibility from age six to twelve and then showed a decline. Their major conclusion was that girls' bodies become progressively more flexible from childhood to adolescence and then become progressively less supple after adolescence.

Downie (1965) surveyed the flexibility of 140 girls, six through ten years of age. Nineteen tests of suppleness using the Leighton Flexometer were administered to determine if significant differences in flexibility existed between the age groups. Results of the study showed no significant differences between ages for eleven of the measures. For six of the remaining eight tests, the ten-year-old girls

were found to be the most flexible.

In two studies with pre-pubescent and adolescent boys as subjects, flexibility appeared to increase to puberty and then decrease during adolescence. The first study, by Forbes in 1950, administered 19 flexibility measures using the Leighton Flexometer to 400 boys between the ages of 10 and 18 (Clarke, 1975). Results showed that decreases occurred for 12 of the 19 tests from 10 to 16 years of age. The other study, by Odgers in 1968, involved administering the same 19 flexibility measures to 160 boys ranging from 6 to 13 years of age (Clarke, 1975). Results of this study showed that suppleness gradually increased until the age of 12 and then appeared to decline at the age of 13.

Harris (1969) cited two studies which dealt with investigating the relationship between flexibility and age for older adults. The first study, by Greey in 1955, involved assessing the suppleness levels of 510 males ranging in age from 18 to 71. Results tended to show that flexibility decreased with age for most movements. The study also indicated that flexibility was the greatest in most joints at age 23.5, and for some measurements values were as high at age 65 as they were at age 34.5. The other investigation, by Jervey in 1961, measured the flexibility status of 410 females ranging in age from 18 to 74. The study produced similar results to those of Greey's investigation, whereby females were shown to possess their greatest flexibility, for most joints, between the ages of 25 and 29.

More recent evidence (Walls, 1970; Wright, 1973) would appear to support the position that, following adolescence, flexibility decreases with age. This is mainly considered to be due to age-related changes in the body's connective tissue. Collagen is said to be the major con-

stituent that provides connective tissue with its tensile or stiffness quality (Booth and Gould, 1975). This would suggest that the greater the collagen content, the greater the joint stiffness or lack of flexibility. Walls (1970) and Wright (1973) have confirmed this and have also implied that the quantity of collagen in connective tissue increases with age. This evidence would seem to suggest that the physiological makeup of joints is such that the range of motion about a joint may normally be expected to decrease with age.

The Relationship of Flexibility to Inactivity

Leighton (1960) stated that flexibility seemed to vary more with habitual activity patterns than with other factors such as age. Clarke (1975) supported this, suggesting that the lack of consensus regarding the relationship between flexibility and age differences was "probably due to the type and extent of participation in physical activities by the two sexes, and by individuals of the same sex at the same age."

Booth and Gould (1975) found support for the hypothesis that inactivity may decrease flexibility. They indicated that muscle atrophy accompanied muscle disuse. They also suggested that collagen synthesis increased during skeletal muscle atrophy. As previous evidence has indicated, increased collagen in connective tissue would appear to be a causative factor in decreased range of motion.

A study by Cureton and Jetté (1976) revealed an increased inactivity-decreased flexibility relationship. Seventy-five male subjects were classified into three groups: those who had exercised regularly; those

who had not exercised regularly; and those who had not participated in a physical activity program for the previous eight years. Results indicated that over an average of eight years the non-exercisers demonstrated the greatest decrease in range of motion about the joints tested.

The probability that prolonged inactivity may be concomitant with decreased flexibility is a salient problem in the light of existing evidence concerning contemporary older Canadians and low-activity living patterns. A recent federal government report by the Minister of State for Fitness and Amateur Sport (1977) surveyed the exercise habits of Canadians. Respondents were queried as to whether or not they, during the preceding month, had engaged in one or more of eight given exercise activities. The activities included walking for exercise, jogging, swimming, calisthenics, bicycling, skipping rope, yoga, and weight training. It was concluded that over 40 percent of the Canadian population 14 years of age and over were physically inactive.

The Modifiability of Flexibility

There is considerable evidence that the range of motion about a given joint may be improved through physical activity (Cureton, 1976; Lesser, 1978; Logan, 1961; Weber, 1949). Frekany and Leslie (1976) studied 15 female volunteers ranging in age from 55 to 91 who, as a result of their participation in a seven-month exercise program, experienced changes in ankle, hamstring, and lower back flexibility. The exercise program was administered twice a week and featured activities for muscle toning as well as flexibility development. Results of the study indicated an improvement at the .01 level of confidence for ankle

flexibility and at the .05 level of confidence for hamstring and lower back range of motion.

McCue, in 1952, conducted a study which indicated the modifiable quality of flexibility (Clarke, 1975). Her study involved 130 college women who participated in a three-week program of daily stretching exercises designed to improve flexibility of the trunk, hip, and ankle joints. Results of the study indicated that all movements but ankle dorsiflexion and plantarflexion improved substantially during the exercise period. As stated by Clarke (1975:14), "the modifiability of joint flexibility through exercise and physical activity has been demonstrated . . ., it is reasonable to expect that stretching exercises designed to produce greater range of movement would be effective."

The Relationship of Flexibility to Stretching Techniques

Two basic stretching techniques have been identified for improving the range of motion about a joint (Wessel, 1970). The first technique, known as static stretch, has also been referred to as slow or hold stretch. Static stretch involves assuming a position of maximum stretch and holding the position for a few seconds. The second training technique, known as ballistic stretch, has also been referred to as active, dynamic, fast, or bounce stretch. Ballistic stretch involves a bouncing or jerking movement designed to gain momentum in one body part so as to achieve greater stretching in an opposing body part (Corbin, 1978; Wessel, 1970).

A review of flexibility literature by Holland (1967) indicated that insufficient data existed for comparing the efficacy of static and ballis-

tic stretching for improving flexibility. The review of literature for the present study indicated that such a situation had not greatly improved over the past decade. To date, some investigators have implied that static stretching may be the optimum training technique while others have indicated that ballistic stretching was to be preferred.

Weber and Kraus (1949) conducted a study comparing static stretching to an abbreviated ballistic-type which they termed "bobbing". This method involved a slight bounce added to a normal static stretch. Results showed a 200 percent greater improvement in hamstring flexibility with the ballistic-type method.

Riddle, in 1956, investigated the relative effects of three methods of stretching on trunk and hip flexibility (Clarke, 1975). A group of college women were assigned to each of the following stretching methods: static stretch, ballistic stretch, and a combination of the two. The subjects practiced their assigned regimens during the fall term of an academic year. The results of the study were: (a) flexibility of the trunk and hip increased with all methods, (b) ballistic stretch seemed to be the most effective for increasing trunk and hip flexibility, and (c) the combination method of bounce and hold was least effective.

A study by Logan and Egstrom (1961) randomly divided 12 women and 13 men from college physical education classes into two subgroups with men and women in each. The two subgroups were identified as a static stretch group and a ballistic stretch group. Each group completed 20 repetitions of hip flexion daily for ten days to improve range of motion of the hip. Results of the study showed that both groups improved flexibility significantly. The women had flexibility increases that

were significant at the .01 level of confidence for the ballistic subgroup and at the .05 level for the static stretch subgroup. The men had flexibility increases that were significant at the .01 level of confidence for both groups. Logan and Egstrom stated that the ballistic subgroup complained of immediate and residual pain and, therefore, recommended that the static stretch technique was a better method for improving hip flexibility.

A study by de Vries (1962) supported the hypothesis that improvement in hip-trunk flexion and extension may occur through training with either static or ballistic stretching methods. Fifty-seven male college students were divided into two groups, one using ballistic techniques and the other following a Hatha Yoga exercise routine that was characteristic of static stretching. The training involved seven 30-minute sessions of stretching over a three and one-half week period. Subjects were tested before and after the experimental period, utilizing Cureton's (1941) flexibility tests of hip flexion, trunk extension, and shoulder elevation. Both groups made significant gains at the .01 level of confidence in all three measures of suppleness. Results also showed that none of the differences in gains between groups was significant at the .05 level of confidence.

Fieldman (1966) studied the effect of selected ballistic-type exercises on improving flexibility of the hip joint. Thirty-three college males were tested six times over a five-week period for hip joint flexibility. Immediately prior to each test they were administered some form of ballistic stretching as a warmup. Each subject showed an increased range of motion in the hip following the final test. This increase was

significant at the .01 level of confidence.

In the light of the preceding data, there would appear to be a lack of definitive information pertaining to the optimum training technique for improving flexibility. Previous investigations have provided inconsistent results. This study, designed to compare the efficacy of static and ballistic stretching methods, will provide additional insights into the technique controversy.

Summary

Flexibility, or the range of motion about an anatomical joint or series of joints, has been shown to be an important parameter of physical well-being. Numerous studies have demonstrated that good flexibility may lessen susceptibility to low back pain and joint stiffness (Cureton, 1941; Kraus, 1961) as well as enhance general mobility of the elderly (Lesser, 1978).

The relationship of flexibility to age and aging is equivocal. The review of literature did not provide definitive norms for flexibility, making it difficult to relate differences in age to suppleness characteristics. The most recent literature has strongly implied the existence of a physiological dimorphism whereby inactivity, which frequently accompanies aging, appears to produce changes in connective tissue which may induce the onset of decreased range of joint motion (Booth, 1975; Clarke, 1975).

Finally, studies concerned with the investigation of the modifiability of flexibility were reviewed. These investigations indicated that a person's suppleness may be improved through specific training techniques

(Cureton, 1976; Frekany, 1976). Two basic types of training, ballistic and static, were identified as successful stretching techniques for improving the range of motion or flexibility about given joints of the body (Wessel, 1970).

CHAPTER III

RESEARCH METHODS

Selection of Equipment

The equipment used for the gathering of flexibility data was the Leighton Flexometer. This instrument has been shown to provide a valid, objective, and reliable measure of flexibility (Leighton, 1955).

The Leighton Flexometer consists of a weighted 360-degree dial and a weighted pointer in a case. The dial and pointer operate freely and independently; the movement of each controlled by gravity. The instrument records movement while in any position which is 20 degrees or more off the horizontal. The zero mark on the dial and the tip of the pointer move freely to a position of rest and coincide when the instrument is placed in any position off the horizontal. Interdependent locking devices are provided for the pointer and the dial, which stop all movement of either at any given position. The flexometer is first strapped at a specific point on the body segment to be measured. The initial movement is made (e.g., shoulder flexion) and the pointer is locked at this position. The second movement is made (e.g., shoulder extension) and the dial is locked. The direct reading of the pointer on the dial is the arc through which the movement has taken place.

Subjects

An initial sample of 52 female volunteers ranging in age from 55

to 75 served as subjects for this study. All subjects completed a personal health and activity questionnaire, adapted for this study from that used by Bell and Hoshizaki (1980). A copy of the questionnaire may be found in Appendix A. The data from this screening device were utilized to identify those subjects whose medical background would preclude their participation in the present study. A final sample of 44 subjects was used for this study. Eight subjects were eliminated for reasons which included sickness, domestic disruption and/or other personal problems.

Prior to data collection, each subject was made cognizant of her required involvement in the study and written approval was obtained. A copy of the two explanatory letters and consent form used for these procedures may be found in Appendices B, C, and D.

Each subject was a volunteer from one of three Greater Victoria recreation facilities: the Crystal Pool, the Oak Bay Recreation Center, and the Esquimalt Swimming Pool. The Crystal Pool and Oak Bay Recreation Center provided 14 and 16 subjects, respectively. These groups were classified as Experimental Group A and Experimental Group B. A third group of 14 subjects, the Control Group, consisted of volunteers from all three facilities; four from the Crystal Pool and five from both the Oak Bay Recreation Center and the Esquimalt Swimming Pool.

The subjects selected for Experimental Group A and Experimental Group B were women who participated in an instructor-administered water-exercise program during regularly scheduled swimming sessions at their respective aquatic center. The programs offered at both facilities were very similar. They had a solid cardiovascular and muscular strength component and included no movements which required the women to stretch

maximally.

The subjects selected for the Control Group were also women who regularly attended swimming sessions at their respective aquatic center. Although not a participant of a formal instructor-administered program, the subjects in this group regularly devoted time each session to a self-structured regimen of water-based activities. Examples of this activity would include exercises such as holding on to the side of the pool and stretching, performing water aerobics such as running in the shallow end of the pool, and swimming laps.

Class Procedures

Flexibility Training

The treatment for both Experimental Group A and Experimental Group B subjects started in January 1980. It was administered over a three-week period, during which the investigator conducted group flexibility training sessions. These sessions were designed to improve the range of motion in the subjects' shoulders, elbows, waist, hips, knees, and ankles.

There were a total of 18, 12-minute training sessions, nine sessions for each experimental group. These sessions were administered at the rate of one session per day, three times a week, for a period of three weeks. Experimental Group A subjects received a regimen of static stretching exercises, hereinafter referred to as SSR. Experimental Group B subjects received a regimen of ballistic stretching exercises, hereinafter referred to as BSR. All training sessions were designed and administered by the investigator.

The nine flexibility training sessions for both experimental groups

took place on the pool decks of their respective aquatic centers. Individual-sized rubber mats were utilized during exercise sessions to promote subject comfort. During the period of the study subjects were requested to avoid any other new activity that might affect their flexibility.

Static Stretching Regimen

A static stretching regimen (SSR) of flexibility exercises was randomly assigned to Experimental Group A. Subjects were led as a group through nine training sessions conducted by the investigator. For all nine sessions a total of three SSR lesson plans were utilized: Lesson Plan No. 1 on three successive Tuesday mornings at 9:50; SSR Lesson Plan No. 2 on three successive Wednesday mornings at 10:00; SSR Lesson Plan No. 3 on three successive Fridays at 1:00 in the afternoon.

The duration of each SSR training session was approximately 12 minutes. All sessions contained 15 exercises, each of which was allotted a specific time period for its administration. The exercises consisted of two basic types of stretching. The first type required subjects to rotate a body part about a joint through as large an arc as possible in a slow, deliberate manner. The second type of stretching required subjects to assume and hold a position of maximum stretch for five seconds. All exercises used for the SSR treatment were compatible with both static and ballistic stretch techniques. A copy of the three SSR lesson plans may be found in Appendix E.

Ballistic Stretching Regimen

A ballistic stretching regimen (BSR) of exercises was randomly

assigned to Experimental Group B. Subjects were led as a group through nine flexibility training sessions conducted by the investigator. For all nine sessions a total of three BSR lesson plans were utilized: BSR Lesson Plan No. 1 on three successive Mondays; BSR Lesson Plan No. 2 on three successive Wednesdays; BSR Lesson Plan No. 3 on three successive Fridays. All sessions were scheduled at 10:30 in the morning.

The duration of each BSR training session was approximately 12 minutes. All sessions contained 15 exercises, each of which was allotted a specific time period for its administration. The exercises consisted of two basic types of stretching. The first type required subjects to rotate a body part about a joint through as large an arc as possible in a rapid manner, with momentum of each rotation controlling the pace. The second type of ballistic stretching required subjects to perform a series of bounces or pulls, whereby the momentum of a body segment exerted force against the resistance of the opposing muscle groups being stretched. To coincide with the SSR sessions, all exercises used for the BSR treatment were compatible with both static and ballistic stretch techniques. A copy of the three BSR lesson plans may be found in Appendix F.

Control Group

Subjects in the Control Group had basically the same pool involvement as did the subjects in the experimental groups. There was, however, no specific flexibility training administered. The two test sessions were identical in all respectsfor this group to those received by subjects in Experimental Group A and Experimental Group B.

Testing Procedures

The Leighton Flexometer was used to obtain ten measures of flexibility for each subject. Nine of the test measures were administered as described in the original reference provided by Leighton (1955). One measure, trunk flexion-extension, was modified for reasons of safety; and subjects were instructed to use a table for balance and support when bending backwards during the extension phase of the movement (see Appendix G).

The flexibility measures taken were: shoulder flexion-extension, shoulder abduction-adduction, trunk lateral flexion, elbow flexion-extension, shoulder rotation, trunk rotation, trunk flexion-extension, hip flexion-extension, ankle dorsiflexion-plantarflexion, and knee flexion-extension.

Two criteria were utilized in selecting these measures:

1. Each measure was representative of a joint requiring good range of motion for functional movement. For example, the shoulder is a joint requiring flexibility to facilitate the performance of daily tasks such as reaching high shelves.
2. Each measure was representative of a joint adaptable to either static or ballistic training techniques for improving the range of motion.

All subjects attended two test sessions (see Appendix H). The first session was scheduled during the week immediately preceding the first activity class, and the second session was held during either the first or second week immediately following the final activity class. The time of day of each subject's second test session was within two hours of the

time of day of their original test session. During the first session the subject's weight was recorded.

Subjects were not provided with any warmup prior to either test session. They were instructed to wear the same loose, comfortable clothing for both sessions and were given detailed instructions explaining the procedure and purpose of each measure prior to its administration. These instructions included the requirement that all stretches were to be executed within the subject's normal range of motion and obtained without discomfort.

The ten measures of flexibility were administered in a sequence that was consistent for all subjects and both test sessions. Utilizing the non-dominant side of the body, each measure was taken three times in succession, with the criterion measure being the mean of the three readings. A copy of the protocol for each test session may be found in Appendix G.

The duration of each subject's test session was approximately 30 minutes. All tests were administered at the subject's respective recreation center, in a quietroom away from the exercise area. The testing was carried out by the investigator who acted as both evaluator and recorder-supporter. Tester reliability had been previously established as the investigator had been a member of the testing team for the University of Victoria Flexibility Study (Bell and Hoshizaki, 1980). The Victoria study, utilizing a Leighton Flexometer, attained r values ranging from .71 to .94 for test-retest reliability.

Lifestyle Awareness Program

The nine training sessions and two test sessions were initially offered to prospective participants as part of a health and fitness "package", labelled Lifestyle Awareness Program (see Appendices B and C). The sole purpose of this "package" was to serve as a motivational tool in recruiting and retaining subjects for this study. It was not involved in the collection or analysis of the data.

The Lifestyle Awareness Program included an educational component for all subjects. Immediately after conducting each of the experimental groups' training sessions, the investigator would lead a five-minute discussion on one of several health-related topics. The Control Group subjects received a modified Lifestyle Awareness Program which took place immediately following the subjects' two test sessions. The nine topics of discussion were: weight control, the importance of exercise, exercise and aging, heart rate monitoring, nutrition, stress management, the concept of lifestyle, walking for exercise, and exercise prescription.

CHAPTER IV

DATA TREATMENT AND ANALYSIS

Statistical Procedures

Mean Differences

The data collected during the two test sessions were used to calculate pretest and posttest mean scores for each subject on each of the ten flexibility test measures. In turn, these means were averaged to provide pretest and posttest mean scores for each group on the same ten flexibility test measures. Finally, the groups' ten pretest mean scores were subtracted from the corresponding ten posttest mean scores. This provided mean differences, or flexibility gain scores, which were later used to make within-group comparisons.

t-Tests

Correlated t-tests were applied to the pretest-posttest flexibility gain scores for each group on each of the ten flexibility test measures. These statistical tests determined what improvement in flexibility had taken place within the control and experimental groups (Popham and Sirotnik, 1973).

Analysis of Covariance

Analysis of covariance was used to determine the differences in flexibility change between the control and experimental groups (Popham

and Sirotnik, 1973). This statistical technique was used to analyze the adjusted posttest mean scores to test for significant differences between groups. As stated by Campbell and Stanley (1963:93),

> . . . analysis of covariance with pretest scores as the covariate are usually preferable to simple gain-score comparisons. Since the great bulk of educational experiments show no significant difference . . ., the use of this more precise analysis would seem highly desirable.

The use of analysis of covariance was also a preferred technique to statistically equate the experimental and control groups in relation to age distribution and pretest levels of flexibility within the groups. The twenty-year range in ages and varying potential for change prior to treatment of the subjects used for this study warranted such a control.

Scheffé Multiple Comparison of Means

To identify which of the experimental and control groups' means were different from each other, a Scheffé multiple comparison of means procedure was chosen (Winer, 1971). This statistical technique was used to test for significant differences between all possible pairings of the experimental groups and the control group.

Analysis of the Data

The means and standard deviations for subject age and weight within the control and experimental groups are presented in Table 4.1. Correlated t-tests were used to determine pretest and posttest differences for each measure of flexibility in each of the control and experimental groups. The results of these t-tests are presented in Tables 4.2, 4.3, and 4.4.

TABLE 4.1

Means and Standard Deviations
of Subjects' Age and Weight
for Control and Experimental Groups

Group	Age (yrs.) Mean	S.D.	Weight (lbs.) Mean	S.D.
Experimental Group A (n = 14)	66.3	5.88	140.6	31.38
Experimental Group B (n = 16)	64.6	6.10	130.7	14.32
Control Group (n = 14)	60.8	3.42	134.4	16.31

As identified in Table 4.2, Experimental Group A registered higher readings on the Flexometer during the posttest than readings taken during the pretest for all test measures, except shoulder abduction-adduction which experienced a slight decrease. The difference between the pretest and posttest means for shoulder rotation and trunk flexion-extension resulted in t ratios of 3.30 and 3.50, respectively. These t ratios all met the criterion for significance at the .01 level of confidence. A fourth measure, shoulder flexion-extension, had a mean difference of 3.4 degrees. This difference resulted in a t ratio of 2.10 which was significant at the .05 level of confidence.

As identified in Table 4.3, Experimental Group B registered improved posttest readings on the Flexometer for all ten measures of flexibility. Four of the ten measures obtained t ratios for the difference between pretest and posttest means, which were significant at the .01 level of

TABLE 4.2

Significance of the Differences between Pretest and Posttest Means of Experimental Group A (SSR) (n = 14)

Test Measure	Pretest Mean	Posttest Mean	(Difference) Mean	t*	Significance
Shoulder Flexion-Extension	199.7	203.1	3.4	2.10	.05
Shoulder Abduction-Adduction	149.0	148.6	-0.4	-0.29	-
Trunk Lateral Flexion	80.9	81.8	0.9	0.77	-
Elbow Flexion-Extension	141.2	143.5	2.3	1.77	-
Shoulder Rotation	155.8	164.5	8.7	3.30	.01
Trunk Rotation	99.9	104.6	4.7	1.66	-
Trunk Flexion-Extension	183.2	194.0	10.8	3.50	.01
Hip Flexion-Extension	117.1	120.6	3.5	1.87	-
Ankle Dorsiflexion-Plantarflexion	50.0	53.1	3.1	1.46	-
Knee Flexion-Extension	114.5	116.2	1.7	1.28	-

*Correlated t-test formula as identified in Popham and Sirotnik (1973:145).
NOTE: Means and mean differences are recorded in degrees of a circle.

confidence. The four measures were: shoulder abduction-adduction, shoulder rotation, trunk rotation, and trunk flexion-extension. Of the remaining six posttest measures, four had t ratios which were significant at the .05 level of confidence. The four measures were: shoulder flex-

TABLE 4.3

Significance of the Differences between Pretest and Posttest Means of Experimental Group B (BSR) (n = 16)

Test Measure	Pretest Mean	Posttest Mean	(Difference) Mean	t*	Significance
Shoulder Flexion-Extension	210.6	214.8	4.2	2.36	.05
Shoulder Abduction-Adduction	145.3	150.6	5.3	3.13	.01
Trunk Lateral Flexion	83.3	86.0	2.7	2.49	.05
Elbow Flexion-Extension	142.0	145.8	3.8	2.30	.05
Shoulder Rotation	154.3	163.8	9.5	3.67	.01
Trunk Rotation	109.0	118.2	9.2	5.68	.01
Trunk Flexion-Extension	188.3	199.9	11.6	5.50	.01
Hip Flexion-Extension	120.1	122.8	2.7	2.57	.05
Ankle Dorsiflexion-Plantarflexion	55.6	56.8	1.2	1.09	-
Knee Flexion-Extension	116.0	116.4	0.4	0.34	-

*Correlated t-test formula as identified in Popham and Sirotnik (1973:145).
NOTE: Means and mean differences are recorded in degrees of a circle.

ion-extension, trunk lateral flexion, elbow flexion-extension, and hip flexion-extension.

The Control Group, Table 4.4, had three measures which registered higher posttest readings on the Flexometer than those recorded during

TABLE 4.4

Significance of the Differences between Pretest and Posttest Means of the Control Group (n = 14)

Test Measure	Pretest Mean	Posttest Mean	(Difference) Mean	t*	Significance
Shoulder Flexion-Extension	195.4	197.2	1.8	1.15	-
Shoulder Abduction-Adduction	150.0	149.0	-1.0	-0.51	-
Trunk Lateral Flexion	90.0	89.3	-0.7	-0.42	-
Elbow Flexion-Extension	141.0	137.6	-3.4	-2.87	.05
Shoulder Rotation	153.3	156.0	2.7	1.41	-
Trunk Rotation	108.9	114.1	5.2	3.23	.01
Trunk Flexion-Extension	206.1	204.4	-1.7	-0.60	-
Hip Flexion-Extension	122.6	121.6	-1.0	-0.63	-
Ankle Dorsiflexion-Plantarflexion	54.6	53.1	-1.5	-1.56	-
Knee Flexion-Extension	116.2	116.2	0.0	0.00	-

*Correlated t-test formula as identified in Popham and Sirotnik (1973:145).
NOTE: Means and mean differences are recorded in degrees of a circle.

the pretest; six measures which had lower posttest scores, and one measure which recorded no apparent flexibility increase or decrease between the pretest and posttest results. The three measures indicating improvement were: shoulder flexion-extension, shoulder rotation, and trunk

rotation. Of these three measures only the t ratio for the difference between the pretest and posttest means for trunk rotation was significant at the .01 level of confidence. The six measures which experienced decreased flexibility were: shoulder abduction-adduction, trunk lateral flexion, elbow flexion-extension, trunk flexion-extension, hip flexion-extension, and ankle dorsiflexion-plantarflexion. Of these six measures, only the elbow flexion-extension posttest differences obtained a t ratio which was significant at the .05 level of confidence. Knee flexion-extension was the one measure which recorded no apparent change in flexibility between pretest and posttest sessions.

Analysis of covariance was used to perform two statistical functions. The first function was to adjust the control and experimental ten posttest flexibility mean scores. This ensured that the three groups, Experimental Group A, Experimental Group B and the Control Group, were in fact representative of the same sample population in relation to age distribution and initial levels of flexibility within the group. The results of this procedure are presented in Table 4.5.

The second function performed by analysis of covariance was to identify differences between the control and experimental groups. This was accomplished by a built-in analysis of variance which tested for significant differences between the groups' adjusted posttest means for all ten measures of flexibility. The results of the statistical procedure are presented in Table 4.6.

As identified in Table 4.6, the analysis of covariance technique revealed that, following treatment, five of the ten flexibility test measures had significant differences between the control and experimental

TABLE 4.5

Adjusted Posttest Means
for the Control and Experimental Groups

Test Measure	Experimental Group A (n = 14)		Experimental Group B (n = 16)		Control Group (n = 14)	
	Mean	Adjusted Mean	Mean	Adjusted Mean	Mean	Adjusted Mean
Shoulder Flexion-Extension	203.1	204.5	214.8	208.6	197.2	203.0
Shoulder Abduction-Adduction	148.6	148.1	150.6	152.9	149.0	146.7
Trunk Lateral Flexion	81.8	84.9	86.0	87.0	89.3	85.0
Elbow Flexion-Extension	143.5	143.6	145.8	145.3	137.6	138.0
Shoulder Rotation	164.5	164.4	163.8	164.3	156.0	155.5
Trunk Rotation	104.6	110.7	118.2	116.2	114.1	110.4
Trunk Flexion-Extension	194.0	201.6	199.9	203.4	204.4	192.9
Hip Flexion-Extension	120.6	122.5	122.8	122.5	121.6	120.0
Ankle Dorsiflexion-Plantarflexion	53.1	55.5	56.8	55.3	53.1	52.3
Knee Flexion-Extension	116.2	117.2	116.4	116.0	116.2	115.6

groups. Of the five measures, elbow flexion-extension had a difference which obtained an F-ratio of 7.48 which met the requirement to be significant at the .01 level of confidence. The F-ratios for the remaining four measures, shoulder abduction-adduction, shoulder rotation, trunk rotation

TABLE 4.6

Significance of the Differences between Adjusted Posttest Means for the Control and Experimental Groups

Test Measure	Source of Variation	Square Mean	F	Significance
Shoulder Flexion-Extension	Treatments	93.92	2.83	-
	Within Groups	33.14		
Shoulder Abduction-Adduction	Treatments	153.13	4.03	.05
	Within Groups	37.98		
Trunk Lateral Flexion	Treatments	22.39	1.01	-
	Within Groups	22.36		
Elbow Flexion-Extension	Treatments	186.62	7.48	.01
	Within Groups	24.94		
Shoulder Rotation	Treatments	314.78	4.11	.05
	Within Groups	76.46		
Trunk Rotation	Treatments	156.13	3.44	.05
	Within Groups	45.30		
Trunk Flexion-Extension	Treatments	355.01	3.69	.05
	Within Groups	96.04		
Hip Flexion-Extension	Treatments	25.48	0.93	-
	Within Groups	27.36		
Ankle Dorsiflexion-Plantarflexion	Treatments	37.69	1.64	-
	Within Groups	22.92		
Knee Flexion-Extension	Treatments	8.53	0.36	-
	Within Groups	23.11		

(F $\underline{d}$ 2,39 df)

and trunk flexion-extension, were significant at the .05 level of confidence.

A Scheffé multiple comparison of means procedures was applied to the five flexibility test measures identified as having significant differences between the control and experimental groups. The Scheffé procedure determined which groups were different from each other. The results of this technique are presented in the series of probability matrices (Table 4.7).

TABLE 4.7

Probability Matrices for Identifying which of the Control and Experimental Groups were Significantly Different from Each Other

Group 1 - Experimental Group A (SSR)
Group 2 - Experimental Group B (BSR)
Group 3 - Control Group

Shoulder Abduction-Adduction

Group	1	2
1		
2	.098	
3	.856	.028

Trunk Rotation

Group	1	2
1		
2	.095	
3	.993	.074

Elbow Flexion-Extension

Group	1	2
1		
2	.652	
3	.018	.001

Trunk Flexion-Extension

Group	1	2
1		
2	.882	
3	.079	.021

Shoulder Rotation

Group	1	2
1		
2	.999	
3	.035	.031

As identified in Table 4.7, the flexibility improvement of Experi-

mental Group B in shoulder abduction-adduction was significantly greater than that experienced by the Control Group at the .01 level of confidence. Both experimental groups experienced greater improvement than the Control Group in elbow flexion-extension, which was significant at the .01 level of confidence. In addition, both Experimental Group A and Experimental Group B had greater improvement than the Control Group in shoulder rotation, which was significant at the .05 level of confidence. For the test measure trunk flexion-extension, Experimental Group B experienced greater improvement than the Control Group, significant at the .05 level of confidence. The Scheffé procedure also indicated that, although the overall difference between groups for trunk rotation was significant, the difference was not great enough to be significant when studying adjacent group pairs.

Discussion of Findings

It was interesting to note in this study that during the course of it there were few, if any, visual or verbal signs of subjects experiencing difficulty when executing the prescribed flexibility exercises. In addition, the overall high attendance and positive feedback from subjects regarding both experimental training programs led the investigator to believe that such activity programs may be a welcome addition, both physically and mentally, to the daily life of older adults.

These non-statistical observations aside, further discussion of the findings may be best directed to the specific concerns implicit in the study, namely: (A) the ability of static stretching to improve flexibility of older women, (B) the ability of ballistic stretching to improve

flexibility of older women, and (C) the comparative effects of static and ballistic stretching for improving flexibility of older women.

(A) The results from correlated t-test comparisons of pretest and posttest means within the control and experimental groups would appear to indicate that static stretching may affect positive changes in the flexibility of the older population. Subjects in Experimental Group A, who received a three-week program of static stretch training (SSR), collectively improved their flexibility on all ten test measures. Three of these measures, shoulder flexion-extension, shoulder rotation and trunk flexion-extension, indicated marked flexibility improvement which, in turn, resulted in t ratios which were significant at both the .01 or .05 level of confidence. Such evidence suggests that, for these three test measures at least, static stretch training (SSR) was a very effective technique for improving flexibility.

(B) The results from t-test comparisons of pretest and posttest means within the control and experimental groups would appear to indicate that ballistic stretching (BSR) may improve flexibility for older women. Subjects who received a program of ballistic stretching over a three-week period collectively improved their flexibility on all test measures. The flexibility improvements for Experimental Group B subjects resulted in t ratios which were great enough for eight measures to be significant at both the .01 or .05 level of confidence. The only two flexibility measures which did not experience a significant improvement were knee flexion-extension and ankle dorsiflexion-plantarflexion. One reason for this may concern the nature of ballistic exercises. As originally stated, ballistic stretching involves creating momentum in one body

part so as to exert force on another body part which is to be stretched. Ostensibly, the rhythm of the movement creates added force, allowing the subject to overcome inertia for a more maximum stretch. In regards to knee flexion-extension and ankle dorsiflexion-plantarflexion, the investigator found it difficult to design true ballistic stretching, in that the knee and ankle joints are not adaptive to flexibility exercises where a substantial amount of momentum force can be applied. Thus, the subjects in Experimental Group B may have had to rely more on strength when performing exercises designed for the knee and ankle joints. It is conceivable that such would have been a limiting factor to flexibility improvement and a reason for knee flexion-extension and ankle dorsiflexion-plantarflexion not attaining a significant flexibility change. Conversely the significant improvement in flexibility experienced by the other eight measures may have been facilitated by the momentum quality of ballistic stretching. All eight measures attaining significance experienced substantial ballistic training which involved a high degree of momentum or rhythmical force; and, as such, subjects may have had to rely less on strength for attaining positions of maximum stretch. If this was indeed true, it would be interesting to compare strength levels with flexibility training capability.

(C) Analysis of covariance, having first controlled for the possible confounding variables of age distribution and initial levels of flexibility within groups, revealed a significant difference between experimental and control group posttest means for five of the ten flexibility measures taken. The five measures were: shoulder abduction-adduction, elbow flexion-extension, shoulder rotation, trunk rotation, and trunk

flexion-extension. The Scheffé statistical procedure delineated further the differential change in flexibility manifested by the control and experimental groups following the treatment period. For four of the five test measures shown to be significant, shoulder abduction-adduction, elbow flexion-extension, shoulder rotation and trunk flexion-extension, Experimental Group B (BSR) recorded an improved posttest mean score that was significantly greater than the posttest mean score for the Control Group. The Scheffé technique also revealed that for elbow flexion-extension and shoulder rotation Experimental Group A (SSR) had significantly greater flexibility improvement than the Control Group. Such evidence would suggest that, for certain flexibility measures, a defined program of either static or ballistic stretching, such as that received by subjects in the experimental groups, may be preferred vis-a-vis a program of self-administered activity, such as that pursued by subjects in the Control Group.

As to the salient question of which stretching technique, static or ballistic, would be the preferred method of effecting a change in flexibility, the results of this study were inconclusive. The Scheffé procedure did not reveal any change made by one experimental group as being significantly different from the other experimental group.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FUTURE RESEARCH

Summary

The purpose of this study was to compare static and ballistic stretching techniques for improving the flexibility, or range of motion, about ten selected anatomical joints of elderly females. Forty-four women, ranging in age from 55 to 75 years, who regularly attended swimming pool sessions at three Greater Victoria aquatic centers, served as subjects for this study. The subjects were classified into three groups, Experimental Group A, Experimental Group B, and Control Group. The subjects in Experimental Group A received a three-week treatment program of static stretch exercises, whereas the subjects in Experimental Group B received a three-week treatment program of ballistic stretch exercises. The Control Group received no specific flexibility training. The treatment for both experimental groups was designed to improve flexibility in the subjects' shoulders, elbows, trunk, hips, knees, and ankles. All 44 subjects were tested on ten measures of flexibility prior to and following the three-week exercise programs. The data from the subjects' two test sessions were subjected to correlated t-tests, analysis of covariance, and Scheffé multiple comparison of means.

Conclusions

The statistical analysis for this study revealed that several significant improvements in flexibility were manifested within both experimental groups following treatment. The majority of the improvements were attributed to the ballistic stretch treatment. The non-specific flexibility training experienced by the subjects in the control group resulted in virtually no flexibility improvement. Comparisons between groups disclosed that, for certain measures, the flexibility change manifested by the experimental groups was significantly greater than that manifested by the control group. Statistical analysis failed to disclose significant differences between the flexibility changes of the two experimental groups.

In most experimental designs there are uncontrolled variables, both known and known, which may exert an influence on the obtained results. The known uncontrolled variables are usually presented as limitations of the study, and it is within these limits that the results must be interpreted. In the present study, five such limitations existed: (1) the inability of the investigator to control the amount of outside flexibility-related activity of the subjects; (2) subjects were perhaps a specialized group, in that their level of daily physical activity may have been atypical of the normal activity pattern of older adults; (3) the composition of the control and experimental groups was non-random due to practical reasons; (4) the small sample size; and (5) the overall length of programmed treatment experienced by the experimental groups. Considering the limitations, the conclusions which may be drawn from this study are as follows:

1. Evidence suggests that a three-week program of planned static stretching exercises may significantly improve the range of joint motion of older adults for shoulder flexion-extension, shoulder rotation, and trunk flexion-extension.
2. Findings from this study suggest that a three-week program of planned ballistic stretching exercises may significantly improve the range of joint motion of older adults for shoulder flexion-extension, shoulder abduction-adduction, trunk lateral flexion, elbow flexion-extension, shoulder rotation, trunk rotation, trunk flexion-extension, and hip flexion-extension.
3. The results from this study would appear to indicate that while general physical activity such as swimming is capable of maintaining flexibility for the older person, in order to significantly improve joint range of motion, specific flexibility training must be applied.
4. Findings pertaining to the comparative effects of static and ballistic stretching indicate that while both training techniques may substantially improve flexibility for selected measures, neither method was shown to be superior vis-a-vis the other stretching technique.

Recommendations for Future Research

1. The question of which stretching technique is the more desirable for improving the range of motion about joints for older adults is equivocal. Continued investigation in this area is necessary to better determine the preferred technique. Future investiga-

tors would be advised to strive for a larger sample size and a longer treatment period than that which was utilized in the present study.

2. Both static and ballistic stretching techniques would appear to be capable of improving flexibility for older adults. Further study to investigate whether or not there is a specific joint-stretching technique relationship may be warranted.
3. Studies should be undertaken to investigate the relationship between strength and flexibility for older adults. Specifically, it should be determined if an individual's flexibility training capability is affected, in a positive or negative manner, by the individual's strength availability for performing the flexibility exercises.
4. Physical activity for the older person is assumed to be an effective variable for enhancing physical independence and mental health. Therefore, investigations should be initiated to quantify and qualify the level of self-sufficiency, self-concept, and general outlook on life of physically-active older adults as compared to those of their sedentary counterparts.

BIBLIOGRAPHY

"Age and joint mobility." British Medical Journal, 4:405, November, 1968.

American College of Sports Medicine. Guidelines for Graded Exercise Testing and Exercise Prescription. Philadelphia: Lea and Febiger, 1975.

Bell, R. D. and T. Blaine Hoshizaki. "Aging and joint mobility as determined by factor analysis." Unpublished paper, University of Victoria, 1980.

Booth, Frank W. and Edwin W. Gould. "Effects of training and disuse on connective tissue." Exercise and Sport Sciences Reviews, 3:83-112, 1975.

Campbell, Donald T. and Julian C. Stanley. "Experimental designs in education research" from Handbook of Research on Teaching. N. L. Gage (ed.), American Educational Research Association. Chicago: Rand McNally and Company, 1963.

Carlson, B. "Level of maximum isometric strength and relative load isometric endurance." Ergonomics, 12:429-35, 1969.

Clarke, Harrison H. "Exercise and aging." Physical Fitness Research Digest, series 7, no. 2, April 1977.

Clarke, Harrison H. (ed.). "Joint and body range of movement." Physical Fitness Research Digest, series 5, no. 4, October 1975.

Collis, Martin L. Employee Fitness. Ottawa: Queen's Printer, 1977.

Cooper, Kenneth K. The New Aerobics. New York: Bantam Books, 1970.

Corbin, Charles B. and Larry Noble. "Flexibility: a major component of physical fitness." Journal of Physical Education and Recreation, 51:23-24, 57-60, June 1980.

Corbin, C. B. and others. Concepts in Physical Education. (3rd edition). Dubuque, Iowa: Wm. C. Brown, 1978.

Cotten, Doyice J. "A comparison of selected trunk flexibility tests," American Corrective Therapy Journal, 26:24-26, January-February 1972.

Cureton, Thomas K. "Flexibility as an aspect of physical fitness." Research Quarterly, 12:381-90, May 1941.

_____. Physical Fitness and Dynamic Health. New York: Dial Press, 1973.

Cureton, Thomas K. and Maurice Jette. "Anthropometric and selected motor fitness measurement of men engaged in a long-term program of physical activity." Research Quarterly, 47:666-71, 1976.

de Vries, Herbert A. "Electromyographic observations of the effects of static stretching upon muscular distress." Research Quarterly, 32:468-79, 1961a.

_____. "Prevention of muscular distress after exercise." Research Quarterly, 32:177, 1961b.

_____. "Evaluation of static stretching procedures for improvement of flexibility." Research Quarterly, 33:222-29, May 1962.

_____. "Muscle soreness in baseball." The Athletic Journal, :48-50, February 1975.

Downie, Patricia D. "A study of the relationship between flexibility measures and chronological age of six to ten-year-old girls." Master's thesis, University of Oregon, 1965.

Fieldman, Harold. "Effects of selected extensibility exercises on the flexibility of the hip joint." Research Quarterly, 37:326-31, October 1966.

Flint, M. M. "Lumbar posture: a study of roentgenographic measurement and the influence of flexibility and strength." Research Quarterly, 34:15-21, 1963.

Frekany, George and David K. Leslie. "Effects of an exercise program on selected flexibility measurements of senior citizens." The Gerontologist, 16:182-184, May 1976.

Harris, Margaret L. "Flexibility: review of the literature." Physical Therapy, 49:591-601, 1969.

Harris, Raymond. "Fitness and the aging process," in Guide to Fitness after Fifty, Raymond H. Harris and L. J. Frankel (eds.). New York: Plenum Press, 1977.

Heikkinen, Eino and Birgit Kayhty. "Gerontological aspects of physical activity — motivation of older people in physical training," in Guide to Fitness after Fifty, Raymond H. Harris and L. J. Frankel (eds.). New York: Plenum Press, 1977.

Holland, George J. "The physiology of flexibility: a review of the literature." Kinesiology Review, 49-62, 1968.

Hubbard, Alfred W. (ed.). Research Methods in Health, Physical Education, and Recreation (3rd revised edition). Washington, D.C.: AAHPER Publications, 1973.

Hupperich, F. L. and Peter O. Sigerseth. "The specificity of flexibility in girls." Research Quarterly, 21:25-33, March 1950.

Kamenetz, Herman L. "Exercises for the elderly," in Guide to Fitness after Fifty, Raymond H. Harris and L. J. Frankel (eds.). New York: Plenum Press, 1977.

Kendall, Henry and Florence P. Kendall. "Normal flexibility according to age groups." Journal of Bone and Joint Surgery, 39:690-694, July 1948.

Knuttcken, H. G. "Aerobic capacity of adolescents." Journal of Applied Physiology, 22:655-58, 1967.

Kraus, Hans. "Preservation of physical fitness," in Guide to Fitness after Fifty, Raymond H. Harris and L. J. Frankel (eds.). New York: Plenum Press, 1977.

Kraus, Hans and others. Hypokinetic Disease. Illinois: Charles C. Thomas, 1961.

Kraus, Hans and Ruth P. Hirschland. "Minimum muscular fitness tests in school children." Research Quarterly, 25:178-188, May 1954.

Landreth, W. G. "A comparative study of two methods for improving range of movement." Master's thesis, University of California, Los Angeles, 1957.

Leighton, Jack R. "A simple, objective, and reliable measure of flexibility." Research Quarterly, 13:205-216, 1942.

_____. "An instrument and technique for the measurement of range of joint motion." Archives of Physical Medicine and Rehabilitation, 36:571-578, September 1955.

_____. "Flexibility characteristics of males ten-eighteen years of age." Archives of Physical Medicine and Rehabilitation, 37:494, August 1956.

_____. "On the significance of flexibility for physical education." Journal of Physical Health, Education and Recreation, 31:27, November 1960.

Lesser, Mercedes. "The effects of rhythmic exercise on the range of motion in older adults." American Corrective Therapy Journal, 32:118-32, July-August 1978.

Logan, Gene A. and Glen H. Egstrom. "Effects of slow and fast stretching on the sacro-femoral angle." Association for Physical and Mental Rehabilitation Journal, 15:85-89, 1961.

Low, John W. "The reliability of joint measurement." Physiotherapy, 62:227-29, July 1976.

RM695/P5

McGraw, C. and S. Burnam. "Resistive exercises in the development of muscular strength and endurance." Research Quarterly, 37:79-88, 1966.

Minister of State for Fitness and Amateur Sport. Highlights of the 1977 Fitness and Sport Survey. Ottawa: 1977.

O'Shea, John. Scientific Principles and Methods for Strength Fitness. Massachusetts: Addison-Wesley, 1969.

Popham, James W. and Kenneth A. Sirotnik. Educational Statistics: Use and Interpretation (2nd edition). New York: Harper and Row, 1973.

Reynolds, Bill. The Complete Weight Training Book. Mountain View, California: World Publications, 1976.

Robert, L. "Biogenesis, maturation, and aging of elastic tissue." Experientia (Basel), 30:211-12, February 1974.

Roberts, J. A. and W. P. Morgan. "Effect of type and frequency of participation in physical activity upon physical working capacity." American Corrective Therapy Journal, 25:99-104, 1971.

Saltin, B. "Physiological effects of physical conditioning." Medicine and Science in Sports, 1:50-56, 1969.

Shephard, R. J. Endurance Fitness. Toronto: University of Toronto Press, 1969.

Sheppard, Roy J. Physical Activity and Aging. Chicago: Year Book Medical Publishers, Inc., 1978.

Sinclair, Gary D. and Edward C. Rhodes. Fundamental Knowledges Basic to the Understanding of the Relationship of Physical Activity and Nutrition to Physiological Well-Being. Vancouver: Action B.C., 1977.

Taylor, Joe. "New methods of stretching for improved flexibility." Sport-Talk, 7:5-6, 1978.

Tuckman, Bruce W. Conducting Education Research (2nd edition). New York: Harcourt Brace Jovanovich, Inc., 1978.

Tuttle, W., C. Janney and C. Thompson. "Relation of maximum grip strength to grip strength endurance." Journal of Applied Physiology, 2:663-70, 1950.

Walls, E. W. "The anatomy of aging." Physiotherapy, 56:528-33, December 1970.

Wear, Robert E. "Conditioning exercise programs for normal older persons," in Guide to Fitness after Fifty, Raymond H. Harris and L. J. Frankel (eds.). New York: Plenum Press, 1977.

Weber, S. and Hans Kraus. "Passive and active stretching of muscles." Physical Therapy Review, 29:407-10, September 1949.

Weiskoph, Don. "Stretch to win." The Athletic Journal, :32-34, December 1974.

Wessel, Janet A. Movement Fundamentals: Figure, Form, Fun. New Jersey: Prentice-Hall, 1970.

Weichec, F. J. and F. H. Kusen. "A new method of joint measurement and a review of the literature." American Journal of Surgery, 43:659-68, March 1939.

Winer, B. J. Statistical Principles in Experimental Design (2nd edition). New York: McGraw-Hill Book Company, 1971.

Wright, V. "Stiffness: a review of its measurement and physiological importance." Physiotherapy, 59:107-111, April 1973.

APPENDIX A

HEALTH AND ACTIVITY APPRAISAL QUESTIONNAIRE

Health and Activity Appraisal Questionnaire

Name: _____ Date of Birth: _____

Occupation: _____ _____
Present Former

	In the past, have you ever had trouble with the following activities			Do you have trouble with them at present?		
	Often	Sometimes	Never	Often	Sometimes	Never
Climbing stairs						
Reaching high shelves						
Bending down						
Getting up from a chair						
Getting in and out of car						
Opening doors						
Dressing						
Combing hair						
Washing and bathing						
Preparing meals						
Feeding yourself						
Household chores						
Shopping						
Walking						

Have you ever had any of the following?

	Yes	No	Not Sure
Rheumatism/Arthritis			
Stroke			
Back Pain			
Bone Ailments			
Muscle Ailments			
General Soreness			
Specific Soreness (where)			
Heart Problems			
Other Chronic Diseases (specify)			
Injuries (specify)			

ACTIVITY:

How do you best describe your average daily activity? Check one only.

_____ I am usually sitting and do very little walking around.

_____ I stand or walk about quite a lot during my day, but seldom lift heavy loads.

_____ I usually lift or carry light loads or have to climb stairs or hills often.

_____ I do heavy work or carry heavy loads.

APPENDIX B

LETTER TO PROSPECTIVE SUBJECTS FOR EXPERIMENTAL GROUPS

School of Physical Education

TELEPHONE (604) 477-6911, TELEX 049.7222

University of Victoria
P.O. BOX 1700, VICTORIA
BRITISH COLUMBIA, CANADA
V8W 2Y2

Open Letter to Prospective Participants for Lifestyle Awareness Program

Fall 1979

Dear Participant:

The following is an explanation of what your participation in this Lifestyle Awareness Program will entail:

1. For three successive weeks, three times per week, you will receive ten minutes of light mobility training designed to improve your flexibility and general mobility.

2. Immediately following each ten-minute activity session you will receive and hopefully participate in a five-minute discussion regarding positive lifestyle practices. These will include such topics as nutrition, weight control, stress, relaxation techniques, and exercise.

3. You will receive two completely non-strenuous flexibility tests; the first test will be administered during the week prior to your first activity session and the second during the week following your final activity session. The time requirement for both tests will be approximately twenty-five minutes. During each test some ten measures of flexibility will be taken. Each measure will be within your normal range of motion and all are obtained without any personal discomfort.

Other things you should know:

1. All sessions, activity, and testing require only normal everyday clothing -- e.g. lightweight trousers, shirt, shoes.

2. During the first test session you will be asked to complete a personal activity appraisal questionnaire. This information will help us to interpret your results from the two test sessions.

. . . . . /2

3. Confidentiality for both the questionnaire and test results is assured.

4. Your participation is entirely voluntary and you may withdraw from the program at any time.

I am confident you will find the program an interesting and enjoyable experience and I look forward to meeting you personally.

Very truly yours,

Denis E. Smith

DES:ms

APPENDIX C

LETTER TO PROSPECTIVE SUBJECTS FOR CONTROL GROUP

School of Physical Education

TELEPHONE (604) 477-6911, TELEX 049.7222

University of Victoria
P.O. BOX 1700, VICTORIA
BRITISH COLUMBIA, CANADA
V8W 2Y2

Open Letter to Prospective Participants for Lifestyle Awareness Program

Fall 1979

Dear Madam:

The following is an explanation of what your participation in this program will entail:

1. In the first or second week of January you will receive a completely non-strenuous flexibility assessment. Some ten measures will be taken, all of which are within your normal range of motion, and are easily obtained without any discomfort.

2. Approximately three weeks later you will receive the SAME assessment for the second and last time. Immediately following both assessment sessions, you will receive information regarding positive lifestyle practices. These will include such topics as nutrition, weight control, stress, relaxation techniques, and exercise.

3. During the first assessment you will be asked to complete a personal activity questionnaire. This information will help us interpret your results from the two assessments.

4. For both assessments you are asked to appear in lightweight trousers and shirt. You will remain fully clothed during all testing which will require approximately twenty-five minutes for each of the two assessments.

I am confident you will find the program an interesting experience and I look forward to meeting you personally.

Very truly yours,

Denis E. Smith

DES:ms

APPENDIX D

CONSENT FORM FOR LIFESTYLE AWARENESS PROGRAM

CONSENT FORM FOR LIFESTYLE AWARENESS PROGRAM

I have read a description of, and understand the nature of the program in which I am involved, including risks and benefits. I also understand that participation is fully voluntary and that I may withdraw from the program at any time.

Participant's Name (printed)_____

Participant's Signature_____

Address_____

Telephone Number_____

APPENDIX E

LESSON PLANS FOR STATIC STRETCHING REGIMEN (SSR)

STATIC STRETCHING REGIMEN: LESSON PLAN NO. 1

1. Shoulder Shrug (Time: 30-40 seconds)

Stand erect with feet shoulder width apart. Shrug left shoulder and simultaneously tilt head to left and hold for slow count to four, then return to starting position and relax. Change to right side and repeat. Perform total exercise three times.

2. Shoulder Rotation (Time: 25-35 seconds)

Stand erect with feet shoulder width apart. Shrug both shoulders and rotate them forward to slow count to four for three rotations, then return to starting position and relax. Change to backward rotation and repeat.

3. Arm Circle (Time: 45-55 seconds)

Stand erect with feet shoulder width apart. Position right hand on right hip for balance. Keep left arm straight and rotate it forward to slow count to four for three rotations then reverse to backward rotation for three rotations, then return to starting position and relax. Change to right arm and repeat.

4. Arm Lift (Time: 20-30 seconds)

Stand erect with feet shoulder width apart. Raise both arms sideways to above head and cross them and hold for slow count to four, then return to starting position and relax. Perform three times.

5. Body Side Stretch (Time: 35-45 seconds)

Stand erect with feet shoulder width apart. Extend arms above head and clasp hands. Keeping arms straight, pull left arm to the right and hold for slow count to four, then return to starting position

and relax. Perform three times then change to right side and repeat.

6. Side Bend (Time: 35-45 seconds)

Stand erect with feet shoulder width apart. Extend left arm straight and above head so bicep rests against left ear. Lean upper torso to the right and hold for slow count to four, then return to starting position and relax. Perform three times then change to right side and repeat.

7. Shoulder Extension (Time: 20-30 seconds)

Stand erect with feet shoulder width apart. Clasp hands behind the back. Keep arms straight and extend them back and upward and hold for slow count to four, then return to starting position and relax. Perform four times.

8. Hip Circle (Time: 30-40 seconds)

Stand erect with feet approximately 12 inches apart. Position hands on hips and rotate hips left in a large circle to slow count to four. Perform three times then reverse direction and repeat.

9. Knee Lift (Time: 40-50 seconds)

Stand erect and adjacent to fixed object for balance support. Lift left knee up and across to right side of body to touch right elbow and hold for slow count to four, then return to starting position and relax. Perform three times then change to right leg and repeat.

10. Elbow Flex (Time: 35-45 seconds)

Stand erect with feet shoulder width apart. Position both arms in front of body at shoulder height with palms up. Fully extend arms and hold for slow count to four then fully flex arms for slow count to four. Perform three times.

11. Standing Quad Stretch (Time: 40-50 seconds)

Stand erect and adjacent to fixed object for balance support. Flex left leg and grasp left foot with left hand and pull heel to buttocks and hold for slow count to four, then return to starting position and relax. Perform three times then change to right leg and repeat.

12. Tuck and Reach (Time: 45-55 seconds)

Sit erect on floor with left leg straight and right foot tucked to groin. Keeping both legs flat on floor, bend upper torso forward and reach towards left foot and hold for slow count to four, then return to starting position and relax. Perform four times then change leg positions and repeat.

13. Hip Rotation (Time: 40-50 seconds)

Lie supine on floor with arms extended sideways on the floor. Lift knees up to a position of right angle to upper torso and roll legs left and hold for slow count to four, then return to starting position and relax. Perform three times then change to right side and repeat.

14. Sitting Trunk Twist (Time: 40-50 seconds)

Sit erect on floor with legs straddled and arms held sideways at shoulder height. Twist upper torso to the left and hold for slow count to four, then return to starting position and relax. Perform three times then change to right side and repeat.

15. Ankle Flex (Time: 35-45 seconds)

Sit erect on floor with legs together and flat on the floor. Extend feet and hold for slow count to four then flex feet for slow count to four, then return to starting position and relax. Perform

three times.

STATIC STRETCHING REGIMEN: LESSON PLAN NO. 2

1. Shoulder Rotation

For description of technique utilized, refer to Static Stretching Regimen (SSR) Lesson Plan no. 1, exercise 2.

2. Volleyball Split (Time: 40-50 seconds)

Stand erect with feet shoulder width apart. Extend both arms in front of body at shoulder height with palms face down. Keeping arms straight, simultaneously extend left arm up and back, and the right arm down and back, and hold for slow count to four, then return to starting position and relax. Reverse arm direction and repeat. Perform total exercise three times.

3. Arm Circle

For description of technique utilized, refer to SSR Lesson Plan no. 1, exercise 3.

4. Body Side Stretch

For description of technique utilized, refer to SSR Lesson Plan no. 1, exercise 5.

5. Shoulder Extension

For description of technique utilized, refer to SSR Lesson Plan no. 1, exercise 7.

6. Karate Punch (Time: 30-40 seconds)

Stand erect with feet one and one-half times shoulder width apart and knees slightly bent. Make two fists and position hands on hips with

palms up. Slowly thrust left arm straight out to full extension at shoulder height in line with the nose, simultaneously rotating left fist approximately full circle and hold for slow count to four, then return to starting position and relax. Change to right arm and repeat. Perform total exercise two times.

7. Hip Circle

For description of technique utilized, refer to SSR Lesson Plan no. 1, exercise 8.

8. Side Bend

For description of technique utilized, refer to SSR Lesson Plan no. 1, exercise 6.

9. Sitting Trunk Twist

For description of technique utilized, refer to SSR Lesson Plan no. 1, exercise 14.

10. Tuck and Reach

For description of technique utilized, refer to SSR Lesson Plan no. 1, exercise 12.

11. Knee Press (Time: 15-25 seconds)

Lie supine on floor with arms at side. Bend legs and clasp hands together at back of knees. Pull knees towards chest and hold for slow count to four, then return to starting position and relax. Perform three times.

12. Prone Stretch (Time: 35-45 seconds)

Lie prone on floor with arms extended above head and legs together. Simultaneously push left arm forward and left leg back and hold for slow count to four, then return to starting position and relax. Change

to right side of body and repeat. Perform total exercise three times.

13. Prone Quad Pull (Time: 40-50 seconds)

Lie prone on floor with arms extended sideways. Flex left leg and grasp heel with left hand. Pull left heel to buttocks and hold for slow count to four, then return to starting position and relax. Perform three times then change to right leg and repeat.

14. Good Morning Exercise (Time: 25-35 seconds)

Lie prone on floor with palms positioned on floor beside the shoulders. Keeping hips on floor, extend arms and push upper torso up off the floor and tilt head back and hold for slow count to four, then return to starting position and relax. Perform three times.

15. Ankle Circle (Time: 30-40 seconds)

Sit erect on floor with hands on the floor behind the back, supporting upper torso, and legs slightly apart. Rotate feet in opposite directions to slow count of four, making large circle. Perform three rotations then reverse directions and repeat.

STATIC STRETCHING REGIMEN: LESSON PLAN NO. 3

1. Shoulder Rotation

For description of technique utilized, refer to SSR Lesson Plan no. 1, exercise 2.

2. Volleyball Split

For description of technique utilized, refer to SSR Lesson Plan no. 2, exercise 2.

3. Arm Circle

For description of technique utilized, refer to SSR Lesson Plan

no. 1, exercise 3.

4. Traffic Cop (Time: 35-45 seconds)

Stand erect with feet shoulder width apart. Extend arms sideways to shoulder height, forming right angle at elbow joints. Maintaining both right angles, rotate arms backward and hold for slow count to four, then return to starting position and relax. Reverse arm direction forward and repeat. Perform total exercise three times.

5. Back Scratch (Time: 40-50 seconds)

Stand erect with feet shoulder width apart. Reach left arm behind and up the left side of the back and the right arm over the right shoulder and down the back. Try to clasp hands and hold for slow count to four then relax. Perform three times then change arm positions and repeat.

6. Trunk Twist (Time: 40-50 seconds)

Stand erect with feet shoulder width apart. With hands on hips and feet kept flat on the floor, twist upper torso, including head, to the left and hold for slow count to four, then return to starting position and relax. Repeat to the right side. Perform total exercise three times.

7. Side Bend

For description of technique utilized, refer to SSR Lesson Plan no. 1, exercise 6.

8. Charleston (Time: 25-35 seconds)

Stand erect with feet shoulder width apart. Bend forward slightly at the waist and place corresponding hands on knees. Bring knees together and cross arms so hands grasp opposite knees. Spread knees

apart and hold for slow count to four, then return to starting position and relax. Perform four times.

9. Toe Bounce (Time: 30-40 seconds)

Stand erect with feet together and adjacent to fixed object for balance support. Extend up on toes and hold for slow count to four, then return to starting position and relax. Perform five times.

10. Walking Stance (Time: 40-50 seconds)

Stand erect with left leg far forward and partially bent at the knee, and right leg extended far back and held straight. Keeping both feet flat on the floor and facing straight ahead, increase bend of left leg and hold for slow count to four, then return to starting position and relax. Perform three times then change leg positions and repeat.

11. Toe Touch (Time: 30-40 seconds)

Sit erect on floor with legs together and flat on the floor. Bend forward, attempting to touch forehead to knees and hold for slow count to four, then return to starting position and relax. Perform four times.

12. Single Knee Press (Time: 40-50 seconds)

Lie supine on the floor with arms at side. Clasp hands together at back of left knee and pull left knee to chest and hold for slow count to four, then return to starting position and relax. Perform three times then change legs and repeat.

13. Hip Stretch (Time: 60-70 seconds)

Lie on floor sideways with right side of body on the floor. Support head with right hand. Keeping left leg straight, flex it forward and hold for slow count to four, then extend it backward and hold for slow count to four, then return to starting position and relax. Perform

two times then change to opposite side of body and repeat.

14. Prone Quad Pull

For description of technique utilized, refer to SSR Lesson Plan no. 2, exercise 13.

15. Ankle Flex

For description of technique utilized, refer to SSR Lesson Plan no. 1, exercise 15.

APPENDIX F

LESSON PLANS FOR BALLISTIC STRETCHING REGIMEN (BSR)

BALLISTIC STRETCHING REGIMEN: LESSON PLAN NO. 1

1. Shoulder Shrug (Time: 30-40 seconds)

Stand erect with feet shoulder width apart. Shrug left shoulder and simultaneously tilt head to the left and bounce stretch six times, attempting to touch shoulder to ear, then return to starting position and relax. Change to right side and repeat. Perform total exercise two times.

2. Shoulder Rotation (Time: 25-35 seconds)

Stand erect with feet shoulder width apart. Shrug both shoulders and lively rotate them forward six times, then return to starting position and relax. Change to backward rotation and repeat. Perform total exercise two times.

3. Arm Circle (Time: 45-55 seconds)

Stand erect with feet shoulder width apart. Position right hand on right hip for balance. Keep left arm straight and lively rotate it forward six times, then change to backward rotation for six rotations, then return to starting position and relax. Change to right arm and repeat. Perform total exercise two times.

4. Arm Lift (Time: 20-30 seconds)

Stand erect with feet shoulder width apart. Keeping both arms straight, raise them sideways to above head and cross them and bounce stretch six times, then return to starting position and relax. Perform total exercise three times.

5. Body Side Stretch (Time: 35-45 seconds)

Stand erect with feet shoulder width apart. Extend arms above head and clasp hands. Keeping arms straight, pull left arm to the

right and bounce stretch four times, then return to starting position and relax. Perform three times then change to right side and repeat.

6. Side Bend (Time: 35-45 seconds)

Stand erect with feet shoulder width apart. Extend left arm straight and above head so bicep rests against left ear. Lean upper torso to the right and bounce stretch four times, then return to starting position and relax. Perform three times then change to right side and repeat.

7. Shoulder Extension (Time: 20-30 seconds)

Stand erect with feet shoulder width apart. Clasp hands behind the back. Keep arms straight and extend them back and upward and bounce stretch six times, then return to starting position and relax. Perform three times.

8. Hip Circle (Time: 30-40 seconds)

Stand erect with feet approximately 12 inches apart. Position hands on hips and lively rotate hips left in a circle six times then relax. Change direction and repeat. Perform total exercise two times.

9. Knee Lift (Time: 40-50 seconds)

Stand erect and adjacent to a fixed object for balance support. Lift left knee up and across to right side of body to touch right elbow and bounce stretch six times, then return to starting position and relax. Perform three times then change to right leg and repeat.

10. Elbow Flex (Time: 35-45 seconds)

Stand erect with feet shoulder width apart. Position both arms in front of body at shoulder height with palms up. Fully extend arms and bounce stretch six times, then fully flex arms and bounce stretch

six times then relax. Perform total exercise three times.

11. Standing Quad Stretch (Time: 40-50 seconds)

Stand erect and adjacent to fixed object for balance support. Flex left leg and grasp left foot with left hand and pull heel to buttocks and bounce stretch six times, then return to starting position and relax. Perform three times then change to right leg and repeat.

12. Tuck and Reach (Time: 45-55 seconds)

Sit erect on floor with left leg straight and right foot tucked to groin. Keeping both legs flat on floor, bend upper torso forward and reach towards left foot and bounce stretch six times, then return to starting position and relax. Perform three times then change leg positions and repeat.

13. Hip Rotation (Time: 40-50 seconds)

Lie supine on floor with arms extended sideways on the floor. Lift knees up to a position of right angle to upper torso and roll legs left and bounce stretch six times, then return to starting position and relax. Perform two times then change to right side and repeat.

14. Sitting Trunk Twist (Time: 40-50 seconds)

Sit erect on floor with legs straddled and arms held sideways at shoulder height. Twist upper torso left and bounce stretch six times, then return to starting position and relax. Perform three times then change to right side and repeat.

15. Ankle Flex (Time: 35-45 seconds)

Sit erect on floor with hands on the floor behind the back supporting upper torso and legs together and flat on the floor. Extend feet and bounce stretch six times, then flex feet and bounce stretch six

times then relax. Perform total exercise three times.

BALLISTIC STRETCHING REGIMEN: LESSON PLAN NO. 2

1. Shoulder Rotation

For description of technique utilized, refer to Ballistic Stretching Regimen (BSR) Lesson Plan no. 1, exercise 2.

2. Volleyball Split (Time: 40-50 seconds)

Stand erect with feet shoulder width apart. Extend both arms in front of body at shoulder height with palms face down. Keeping arms straight, simultaneously extend left arm up and back and the right arm down and back and bounce stretch six times, then return to starting position and relax. Reverse arm direction and repeat. Perform total exercise three times.

3. Arm Circle

For description of technique utilized, refer to BSR Lesson Plan no. 1, exercise 3.

4. Body Side Stretch

For description of technique utilized, refer to BSR Lesson Plan no. 1, exercise 5.

5. Shoulder Extension

For description of technique utilized, refer to BSR Lesson Plan no. 1, exercise 7.

6. Karate Punch (Time: 30-40 seconds)

Stand erect with feet one and one-half times shoulder width apart and knees slightly bent. Make two fists and position hands on hips

with palms up. Thrust left arm out to full extension at shoulder height in line with the nose, simultaneously rotating left fist approximately full circle and bounce stretch four times, then return to starting position and relax. Change to right arm and repeat. Perform total exercise three times.

7. Hip Circle

For description of technique utilized, refer to BSR Lesson Plan no. 1, exercise 8.

8. Side Bend

For description of technique utilized, refer to BSR Lesson Plan no. 1, exercise 6.

9. Sitting Trunk Twist

For description of technique utilized, refer to BSR Lesson Plan no. 1, exercise 14.

10. Tuck and Reach

For description of technique utilized, refer to BSR Lesson Plan no. 1, exercise 12.

11. Knee Press (Time: 15-25 seconds)

Lie supine on floor with arms at side. Bend legs and clasp hands together at back of knees. Pull knees towards chest and bounce stretch four times, then return to starting position and relax. Perform three times.

12. Prone Stretch (Time: 35-45 seconds)

Lie prone on floor with arms extended above head and legs together. Simultaneously push left arm forward and left leg back and bounce stretch six times, then return to starting position and relax. Change

to right side of body and repeat. Perform total exercise three times.

13. Prone Quad Pull (Time: 40-50 seconds)

Lie prone on floor with arms extended sideways. Flex left leg and grasp heel with left hand. Pull left heel to buttocks and bounce stretch six times, then return to starting position and relax. Perform three times then change to right leg and repeat.

14. Good Morning Exercise (Time: 25-35 seconds)

Lie prone on floor with palms positioned on floor beside the shoulders. Keeping hips on floor, extend arms and push upper torso up off the floor and tilt head back and bounce stretch six times, then return to starting position and relax. Perform three times.

15. Ankle Circle (Time: 30-40 seconds)

Sit erect on floor with hands on the floor behind the back, supporting upper torso, and legs slightly apart. Lively rotate feet in opposite directions, making large circles. Perform six rotations then reverse directions. Perform total exercise three times.

BALLISTIC STRETCHING REGIMEN: LESSON PLAN NO. 3

1. Shoulder Rotation

For description of technique utilized, refer to BSR Lesson Plan no. 1, exercise 2.

2. Volleyball Split

For description of technique utilized, refer to BSR Lesson Plan no. 2, exercise 2.

3. Arm Circle

For description of technique utilized, refer to BSR Lesson Plan

no. 1, exercise 3.

4. Traffic Cop (Time: 35-45 seconds)

Stand erect with feet shoulder width apart. Extend arms sideways to shoulder height, forming right angles at elbow joints. Maintaining both right angles, rotate arms backward and bounce stretch six times, then return to starting position and relax. Reverse arm direction forward and repeat. Perform total exercise three times.

5. Back Scratch (Time: 40-50 seconds)

Stand erect with feet shoulder width apart. Position left hand behind and up the left side of the back and the right arm over the right shoulder and down the back. Try to clasp hands and bounce stretch six times then relax. Perform three times then change arm positions and repeat.

6. Trunk Twist (Time: 40-50 seconds)

Stand erect with feet shoulder width apart. With hands on hips and feet kept flat on floor, twist upper torso, including head, to the left and bounce stretch six times, then return to starting position and relax. Repeat to the right side. Perform total exercise three times.

7. Side Bend

For description of technique utilized, refer to BSR Lesson Plan no. 1, exercise 6.

8. Charleston (Time: 25-35 seconds)

Stand erect with feet shoulder width apart. Bend forward slightly at the waist and place corresponding hands on knees. Bring knees together and cross arms so hands grasp opposite knees. Spread knees apart and bounce stretch six times, then return to starting position

and relax. Perform three times.

9. Toe Bounce (Time: 30-40 seconds)

Stand erect with feet together and adjacent to fixed object for balance support. Extend up on toes and bounce stretch six times, then return to starting position and relax. Perform four times.

10. Walking Stance (Time: 40-50 seconds)

Stand erect with left leg far forward and partially bent at the knee, and right leg extended far back and held straight. Keeping both feet flat on the floor and toes facing straight ahead, increase bend of left leg and bounce stretch six times, then return to starting position and relax. Perform three times then change leg positions and repeat.

11. Toe Touch (Time: 30-40 seconds)

Sit erect on floor with legs together and flat on the floor. Bend forward, attempting to touch forehead to knees and bounce stretch six times, then return to starting position and relax. Perform four times.

12. Single Knee Press (Time: 40-50 seconds)

Lie supine on floor with arms at side. Clasp hands together at back of left knee and pull left knee to chest and bounce stretch six times, then return to starting position and relax. Perform three times then change legs and repeat.

13. Hip Stretch (Time: 60-70 seconds)

Lie on floor sideways with right side of body on floor. Support head with right hand. Keeping left leg straight, flex it forward and bounce stretch six times then extend it backward and bounce stretch six times, then return to starting position and relax. Perform two times then change to opposite side of body and repeat.

14. Prone Quad Pull

For description of technique utilized, refer to BSR Lesson Plan no. 2, exercise 13.

15. Ankle Flex

For description of technique utilized, refer to BSR Lesson Plan no. 1, exercise 15.

APPENDIX G

DESCRIPTION OF FLEXIBILITY MEASUREMENTS

DESCRIPTION OF FLEXIBILITY MEASUREMENTS

The measurements are listed in their sequence of administration.

1. Shoulder Flexion-Extension

The subject assumed a standing position at the projecting corner of a wall. The back was to the wall with shoulder blades, buttocks, and heels touching the wall. The arm to be measured was extended just beyond the projecting corner of the wall. The flexometer was attached to the lateral side of the upper arm, midway between the shoulder and the elbow. The arm was locked straight, extended up and as far back as possible. The pointer was then locked. The arm was then moved forward and upward in an arc as far as possible. The dial was locked and the reading taken. This measurement required that the heels, buttocks, and shoulders touch the wall at all times during the movement.

2. Shoulder Adduction-Abduction

The subject assumed a standing position with arms at sides, and side of body towards wall, the shoulder touching the wall. The fist of the non-dominant arm was doubled with the knuckles forward. The thumb side of the fist was touching the hip and the opposite side of the fist was touching the wall. The feet were together, the knees and elbows held straight. The instrument was fastened to the back of the arm which was farthest from the wall, midway between the shoulder and the elbow. The palm of the arm to be measured was pressed against the side of the leg. The pointer was locked. The arm was then moved sideward, outward, and upward in an arc as far as possible. The dial was then locked and the reading taken. This measurement required that the fist be in contact

with the wall and the hip at all times. The knees, body, and elbows must be kept straight. The heels of the feet may not be raised off the floor. The arm must be raised directly sideward, not forwards or backwards.

3. Trunk Lateral Flexion

The subject assumed a standing position with feet together, knees straight, and the arms held straight at the sides. The flexometer was attached to the middle of the upper back at armpit height. The subject leaned sideways to the right as far as possible and the pointer was locked. The subject then leaned sidewards to the left as far as possible. The dial was locked and the reading taken. This measurement required that the feet remain flat on the floor at all times. The knees must be kept straight throughout the movement. The subject may lean sidewards and backwards but not forward.

4. Elbow Flexion-Extension

The subject assumed a supine position on a table. The arm was extended sideward so the elbow joint was positioned just past the edge of the table. The flexometer was attached to the side of the forearm, midway between the wrist and the elbow. The arm was fully extended and the pointer was locked. The hand was then moved upward and backward in an arc to a position as near the shoulder as possible. The dial was locked and the reading taken. This measurement required that the upper arm was not moved during the movement.

5. Shoulder Rotation

The subject assumed a supine position on a table. The arm to be measured was extended perpendicular to the side of the table so as to

form a right angle at the elbow. The flexometer was attached to the side of the forearm, midway between the wrist and the elbow. The arm was extended downward and backward in an arc as far as possible. The pointer was locked. The forearm was then moved forward, upward, and downward in an arc as far as possible. The dial was locked and the reading taken. This measurement required that the elbow joint maintain a right angle throughout the full movement.

6. Trunk Rotation

The subject assumed a supine position on a table. The legs were held together, with knees raised slightly above the hips and the lower legs held parallel to the table and the upper body. The flexometer was fastened to the middle of the upper legs, midway between the knees and hips, the strap going around both legs. The knees were lowered to the left as far as possible and the pointer was locked. The knees were then rolled to the right side of the body as far as possible. The dial was locked and the reading taken. This measurement required that the shoulders remain flat on the table and the knees were held above the hips throughout the full movement.

7. Trunk Flexion-Extension

This measurement was the sum of two separate movements. For trunk flexion the subject assumed a supine position on a table. The flexometer was attached to either side of the upper body, just below the armpit. The pointer was locked. Keeping the legs flat on the table, the subject sat up and bended forward towards the knees as far as possible. The dial was locked and the reading taken. For trunk extension the attachment of the instrument remained the same. The subject assumed

a standing position with feet shoulder width apart, the back adjacent to the edge of the table and body perpendicular to the floor. The pointer was locked, The hands were placed behind the back to rest on the surface of the table. The investigator placed his hand on the middle of the subject's upper back for added support as the subject leaned backwards as far as possible. The dial was locked, the reading taken. The reading was then added to the reading for trunk flexion to provide one score for the two measurements. The latter measurement, trunk extension, required that the feet remain flat on the floor and the knees were kept straight. The subject also needed to have confidence in the investigator so as to fully extend the trunk without fear of falling back.

8. Hip Flexion-Extension

The subject assumed a supine position on a table so the belt line was on the edge of the table. The leg to be measured hung freely over the edge while the foot of the opposite leg was placed on a chair. The flexometer was attached to the side of the upper thigh, midway between the knee and the hip. The leg to be measured was fully extended and the pointer was locked. The knee of the measured leg was moved upward and backward in an arc to a position as close to the chest as possible. The dial was locked and the reading taken. This measurement required that the foot of the opposite leg remain flat on the chair throughout the movement.

9. Ankle Dorsiflexion-Plantarflexion

The subject assumed a sitting position on a table so the knees were straight, and the legs rested on and feet projected over the end of the table. The instrument was attached to the inside of the foot. The foot

to be measured was turned upward and towards the knee as far as possible and the pointer was locked (dorsiflexion). The foot was then turned downward as far as possible (plantarflexion). The dial was locked and the reading taken. The measurement required that the knee of the leg being measured remain straight throughout the movement, and no sideward turning of the foot was allowed.

10. Knee Flexion-Extension

The subject assumed a prone position on a table so the knees extended just beyond the edge of the table. The flexometer was attached to the side of the lower leg, midway between the knee and the ankle. The leg to be measured was fully extended and the pointer was locked. The foot was moved upward and backward in an arc to a position as near the buttocks as possible. The dial was locked and the reading taken. This measurement required that the upper leg remain flat on the table.

APPENDIX H

FLEXIBILITY TESTING DATA SHEET

FLEXIBILITY TESTING DATA SHEET

Name: _____ Subject No: _____

Age: _____ Weight: _____

Date Test Session A: _____ Time of Test: _____

Date Test Session B: _____ Time of Test: _____

MEASUREMENT	SESSION A				SESSION B			
	1	2	3	mean	1	2	3	mean
1. shoulder flexion-extension								
2. shoulder abduction-adduction								
3. trunk lateral flexion								
4. elbow flexion-extension								
5. shoulder rotation								
6. trunk rotation								
7. trunk flexion-extension								
8. hip flexion-extension								
9. ankle dorsiflexion-plantarflexion								
10. knee flexion-extension								

APPENDIX I

RAW DATA

Raw Data for Experimental Group A (SSR)

Subject No.	Age	Weight (lbs.)	Test Measures 1 Pre	1 Post	2 Pre	2 Post	3 Pre	3 Post	4 Pre	4 Post	5 Pre	5 Post
01	69	120.0	192	202	146	145	81	84	145	148	155	176
02	55	112.0	203	206	152	163	90	87	135	134	169	172
03	70	120.0	213	210	151	148	89	92	152	152	163	174
04	75	115.0	195	210	159	153	73	77	140	143	168	176
05	67	124.0	193	195	150	152	61	71	161	166	132	127
06	70	163.0	197	204	155	152	65	69	135	137	182	183
07	61	210.0	191	191	155	146	88	88	149	146	161	173
08	65	165.0	208	211	151	151	89	85	131	129	154	154
09	71	138.0	214	212	154	145	100	96	144	144	162	161
10	67	167.0	188	203	135	129	84	88	120	123	150	145
11	68	119.0	203	200	131	142	77	80	132	138	126	148
12	56	184.0	188	187	146	147	72	68	142	149	160	176
13	62	120.0	207	209	142	149	77	80	152	147	149	169
14	72	112.0	204	204	160	158	87	81	139	153	151	169

Raw Data for Experimental Group A (SSR), continued

Subject No.	Test Measures									
	6		7		8		9		10	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
01	74	97	186	179	141	140	64	59	123	118
02	125	131	203	205	121	124	53	55	118	118
03	138	132	187	194	134	135	41	57	121	124
04	42	52	176	202	127	121	43	48	124	122
05	116	113	163	187	119	123	51	49	125	134
06	84	83	152	162	111	113	48	62	112	115
07	63	74	201	214	100	110	65	59	114	109
08	121	126	177	185	107	126	40	41	109	106
09	120	133	188	212	112	119	58	54	99	111
10	92	94	191	187	117	127	57	57	119	119
11	110	95	195	218	112	116	23	41	109	110
12	74	96	202	209	108	104	50	51	105	112
13	129	132	183	179	125	118	50	51	111	114
14	111	106	161	184	105	112	58	59	114	115

Raw Data for Experimental Group B (BSR)

Subject No.	Age	Weight (lbs.)	Test Measures 1 Pre	1 Post	2 Pre	2 Post	3 Pre	3 Post	4 Pre	4 Post	5 Pre	5 Post
15	67	137.0	207	201	135	140	81	87	143	139	156	146
16	65	127.0	221	224	140	151	79	82	123	135	136	158
17	73	130.0	213	222	139	145	80	88	150	149	150	152
18	74	123.0	206	215	153	153	77	78	145	146	163	173
19	59	129.0	210	213	156	177	80	90	133	134	165	188
20	72	114.0	197	216	144	146	79	82	153	151	174	169
21	60	145.0	221	228	168	166	77	79	151	153	163	174
22	57	135.0	219	220	145	151	82	77	141	153	135	160
23	62	120.0	194	204	166	162	91	95	140	141	179	178
24	60	110.0	217	217	136	134	82	88	154	153	173	180
25	58	115.0	203	207	147	160	84	91	155	149	167	174
26	59	129.0	189	201	108	114	78	78	137	140	116	130
27	69	119.0	204	221	151	150	70	73	143	148	135	141
28	73	120.0	212	208	143	150	91	89	143	152	155	183
29	67	160.0	224	228	147	150	111	107	131	143	146	150
30	59	155.0	222	212	147	148	91	91	132	137	144	165

Raw Data for Experimental Group B (BSR), continued

Subject No.	Test Measure 6 Pre	6 Post	7 Pre	7 Post	8 Pre	8 Post	9 Pre	9 Post	10 Pre	10 Post
15	108	112	169	168	116	116	50	50	111	106
16	114	118	201	206	121	127	50	50	111	111
17	94	112	167	178	99	110	45	45	110	112
18	120	131	183	206	142	142	73	74	118	125
19	126	141	174	186	118	119	42	54	116	114
20	83	90	187	216	120	122	49	51	121	119
21	101	111	191	198	125	127	78	71	115	114
22	126	128	141	145	140	134	61	60	116	121
23	130	129	197	218	122	124	69	70	119	125
24	89	110	199	214	111	120	48	44	111	121
25	135	139	209	218	141	149	64	71	140	137
26	84	98	194	196	86	88	41	45	102	98
27	91	109	156	179	112	114	40	39	112	111
28	107	111	201	208	116	120	50	55	106	105
29	109	116	248	258	130	131	68	69	128	126
30	127	136	196	205	122	121	61	60	120	117

Raw Data for Experimental Control Group

Subject No.	Age	Weight (lbs.)	Test Measures 1 Pre	1 Post	2 Pre	2 Post	3 Pre	3 Post	4 Pre	4 Post	5 Pre	5 Post
31	57	160.0	185	192	138	140	89	90	143	135	149	167
32	61	140.0	183	174	135	136	70	67	137	132	138	150
33	64	130.0	201	195	140	141	83	87	143	142	165	161
34	65	147.0	223	221	179	175	94	95	133	135	144	153
35	60	117.0	192	191	146	150	100	94	145	150	142	146
36	64	142.0	206	206	191	189	99	96	139	130	156	154
37	68	130.0	191	191	157	154	99	104	143	133	130	127
38	60	137.0	189	191	143	139	73	66	133	127	136	130
39	58	138.0	198	196	151	138	95	88	147	142	168	172
40	60	102.0	205	211	132	145	92	91	140	139	187	181
41	62	125.0	194	203	143	141	81	78	146	141	145	151
42	57	160.0	209	214	167	157	86	81	130	130	175	174
43	57	150.0	161	173	135	137	88	102	142	143	141	142
44	58	121.0	199	203	139	142	110	111	153	147	170	174

Raw Data for Experimental Control Group, continued

Subject No.	Test Measures									
	6		7		8		9		10	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
31	103	115	187	198	120	116	55	61	110	121
32	124	125	184	196	110	106	46	46	112	110
33	62	62	189	167	126	131	47	47	109	107
34	129	124	207	215	133	139	59	52	125	123
35	108	116	229	228	118	117	50	49	120	119
36	124	124	219	216	117	123	57	57	115	118
37	99	102	194	196	124	120	49	51	107	107
38	114	124	187	178	95	103	60	54	100	95
39	89	100	222	200	140	137	52	54	119	129
40	116	115	194	189	125	112	41	34	122	121
41	119	129	216	216	124	125	61	57	122	123
42	107	115	213	219	144	136	61	58	126	120
43	105	120	218	216	109	110	66	62	115	112
44	126	127	226	232	132	128	61	61	125	122

VITA

Surname: SMITH Given Names: DENIS ELLWOOD

Place of Birth: NANAIMO, B.C. Date of Birth: September 1, 1950

Educational Institutions Attended, with Dates of Entering and Leaving:

UNIVERSITY OF VICTORIA 1973 to 1977

____ to ____

Degrees, Diplomas, Etc., Awarded, with Dates and Names of Institutions:

B.Ed. 1977 University of Victoria, B.C.

Honors and Awards:

None

Publications:

None

PARTIAL COPYRIGHT LICENSE

I hereby grant the right to lend my thesis (the title of which is shown below) to users of the University of Victoria Library, and to make single copies only for such users or in response to a request from the library of any other university, or similar institution, on its behalf or for one of its users. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by me or a member of the University designated by me. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Title of Thesis

A COMPARISON OF STATIC AND BALLISTIC STRETCHING TECHNIQUES FOR IMPROVING THE RANGE OF MOTION ABOUT SELECTED ANATOMICAL JOINTS OF 55 TO 75 YEAR OLD FEMALES

Author [redacted]
Signature

DENIS ELLWOOD SMITH

DECEMBER, 1980
Date