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The Effects of a 7-week Dance Exercise Class upon the Flexibility of Athletes

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CERTIFICATE OF APPROVAL

MASTER OF SCIENCE THESIS

This is to certify that the Master of Science Thesis of

Heidi Skolnik

submitted in partial fulfillment of the requirements for the degree of Master of Science in the School of Health, Physical Education, and Recreation at Ithaca College has been approved.

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THE EFFECTS OF A 7-WEEK DANCE EXERCISE CLASS UPON THE FLEXIBILITY OF ATHLETES

by

Heidi Skolnik

An Abstract

of a thesis submitted in partial fulfillment

of the requirements for the degree of

Master of Science in the School of

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Thesis Advisor: Dr. Patricia A. Frye

ABSTRACT

The effects of a dance exercise program on the flexibility of male collegiate lacrosse players were examined. The dance exercise program included stretching and strengthening exercises derived from various dance techniques. Emphasis was placed on teaching correct body alignment for the various exercises. The 45-minute exercise class was taught twice a week for 7 weeks. The subjects of the study were 22 available members of the Ithaca College men's lacrosse team. Ages ranged from 18 to 25 years. A pretest, posttest design was employed. Six practical flexibility tests and two tests of muscular endurance were administered to all subjects. In addition to the practical tests, 15 subjects were also tested using a Leighton flexometer. All pretests were completed during a 3-day time period in a laboratory setting; posttests were completed under the same conditions 7 weeks later. All subjects were required to warm up for 3 minutes and were given an option for an additional 3 to 5 minutes to warm-up. All subjects read the explanations and were shown demonstrations of the test procedures. Two trials of each flexibility test were performed and the better score was recorded. One trial was allowed for each endurance test. The data were analyzed in three sections: practical tests, endurance tests, and flexometer tests. A check for multicollinearity was run on each set of variables, resulting in the elimination of the trunk extension forward, trunk extension backward, and hip flexion and extension tests. The means for all variables except dynamic flexibility and shoulder flexion and extension improved. The observed decrease in shoulder flexion and extension may have been due to the large amount of shoulder movement demanded by lacrosse participation. MANOVA was then run on each of the three data sets to determine if any significant ($p < .05$) change from pretest to posttest

occurred. This analysis resulted in the rejection of the null hypothesis for the combined variables for the practical tests of flexibility and for the endurance tests. The MANOVA results for the flexometer tests did not indicate significant change, but ANOVA tests found significant changes occurred over time for three out of six individual flexometer variables. This may be due to improved body positioning during the posttest or the conflicting demands season training has on flexibility.

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A Thesis Presented to the Faculty of the
School of Health, Physical
Education, and Recreation
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In Partial Fulfillment of the
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Chapter 1

INTRODUCTION

Perhaps because physical educators have not been properly taught stretching, that is body placement and alignment, progression of exercise, timing, and the values of increased flexibility, they have not seen great results from stretching endeavors. Therefore, coaches and teachers may be reluctant to devote to stretching the proper amount of time that is needed in any conditioning program. Many teams devote some time to stretching in a warm-up, but this time is often ill spent and of limited value due to the lack of knowledge of how, when, and why to stretch. Coaches do not emphasize stretching during cool-down contrary to research that cool-down is the best time to increase muscle elongation and range of movement (ROM) (Sapega, Quedenfeld, Moyer, & Butler, 1981). Proper stretching, which leads to increased flexibility, can decrease injuries, tears, pulls, and strains of the muscles, tendons, and ligaments, as well as decrease muscle soreness and contribute to improved athletic performance (Beaulieu, 1981; Prentice, 1983; Surburg, 1983). Stretching may help promote a keener kinesthetic awareness and awareness of space, time, force, and balance (Dimondstein, 1983).

Dancers, who are quite strong, are also required to maintain flexibility to perform their art efficiently and with apparent ease. By combining the physiology of sport science and the practicality of years of dance training, dance exercise is an optimal medium for increasing flexibility while maintaining strength and muscular endurance.

Scope of Problem

There were 22 members of the Ithaca College men's lacrosse team, ranging in age from 18 to 25, who served as subjects to test the effects of a dance exercise program on flexibility of athletes. The men were working toward individual improvement of flexibility. The 7-week program, designed specifically to teach proper stretching techniques to increase flexibility and muscular endurance and described in detail in Appendix A, met twice a week for 45 minutes each session. There was a 1-week break following the 6th week due to school intersession. All men were pretested at the beginning of the program and posttested at the end of the 7 weeks. The posttest coincided with the 2nd week of the athletes' season. The testing consisted of a total of 14 tests: six practical flexibility tests, two muscular endurance tests, and six objective measures of flexibility using a Leighton flexometer.

Problem Statement

The effects of a 7-week dance exercise class upon the flexibility of athletes were investigated.

Hypothesis

Due to participation in a 7-week dance exercise program designed to increase flexibility of muscles and range of movement (ROM) around joints through stretching, strengthening, and muscular endurance exercises, a significant increase in flexibility and muscular endurance of the lacrosse players will occur.

The subhypotheses were as follows:

1. There will be a significant increase in flexibility as represented by the results of practical (field) testing.

2. There will be a significant increase in muscular endurance as represented by the results of endurance tests.

3. There will be a significant increase in flexibility as represented by the results of flexometer testing.

Assumptions

The following were assumed in this study:

1. The tests of flexibility used yielded valid measures.

2. A period of 7 weeks is an adequate time allowance for flexibility to increase significantly.

3. The subjects concentrated and participated to their fullest capacities during class time.

4. The subjects were able to participate to their potential during both the pretest and posttest procedures.

5. The areas of flexibility selected to be measured were important and relevant to participation in the game of lacrosse.

Definition of Terms

The following terms were operationally defined for the purpose of this study:

1. Dance Exercise Program: A 45-minute class incorporating exercises for increasing flexibility, muscular endurance, balance, coordination, and relaxation. The exercises are taken from various dance technique classes, including jazz, modern, and ballet, and from yoga. Emphasis is directed toward teaching proper stretching techniques, placement of the body parts, progression of exercise, breathing techniques, and mind/body integration. The exercises are outlined in Appendix A.

2. Flexibility: The range of movement around a joint as determined by the musculotendinous tissues which produce movement of that joint. Flexibility is not a general ability but specific to each body part (i.e., an individual may be more flexible around the shoulder than the hip) (deVries, 1980; Johnson & Nelson, 1974; Mathews, 1973; Prentice, 1983).

3. Muscular Endurance: "The ability to persist in physical activity, to resist muscular fatigue" (deVries, 1980, p. 410).

4. Placement: Correct positioning of the body and its parts while executing a movement.

Delimitations

The delimitations of this study were as follows:

1. Only male college lacrosse players were tested.

2. Only the program outlined in Appendix A was used (i.e., different exercises, in a different combination, may alter the effect).

3. Only 7 weeks of class were taught, with classes meeting for 45-minute sessions twice a week.

4. Only six practical (or field) tests were employed, only one of which tested dynamic flexibility.

5. Only six objective flexibility measures were utilized.

6. Only two muscular endurance tests were used.

Limitations

The limitations of the study were as follows:

1. For all three data sets--practical flexibility, endurance, and flexometer--a specific testing procedure was employed. It is possible that a different test other than the one used may be a better indicator of that variable. For example, a timed sit-up was used to measure trunk endurance, but a leg-lift test might have been a better indicator (Fleishman, 1964).

2. Not all areas of the body that the dance exercise program worked on were tested. Therefore some changes that may have occurred are not evident.

3. A 1-week interval during which no class was given elapsed between the 6th and 7th weeks of conditioning due to school intersession. The possible effect of this interruption on the results is unknown.

Chapter 2

REVIEW OF RELATED LITERATURE

Introduction

A basic understanding of how and why stretching works to increase flexibility is necessary to form an optimal stretching program. The forthcoming chapter reviews physiological stretch reflexes, limiting and facilitating factors of flexibility, various stretching techniques, and methods of flexibility testing.

Physiological Stretch Reflex

In deciding which stretching technique is best, how much time to devote to stretching, and, in fact, when to stretch, a basic understanding of some of the physiology involved when stretching is needed. Two myotatic reflexes, the stretch reflex and the inverse stretch reflex, are important. When intrafusal and extrafusal muscle fibers lengthen due to being stretched, the stretch reflex sends a message to contract the muscle in an effort to protect it from overstretching. If a muscle is stretched quickly and forcefully, the stretch reflex will respond accordingly and contract the muscle quickly (Beaulieu, 1981; Sapega, Quedenfeld, Moyer, & Butler, 1981).

The inverse stretch reflex responds to both stretch and contraction (i.e., tension) as opposed to the stretch reflex which is sensitive only to stretch. When tension is perceived, be it from stretching or contracting, the inverse stretch response causes the muscle to relax. It cannot however completely relax a muscle that is tense due to a forceful contraction, as when a stretch reflex response is employed due to a forceful stretch. The inverse stretch reflex has a greater tolerance to stretch than the stretch reflex (Beaulieu, 1981).

A third relevant physiological phenomenon is termed reciprocal inhibition. This phenomenon involves the contraction and relaxation of agonist and antagonist muscle groups in selective patterns to inhibit and relax those muscles in an attempt to facilitate a greater stretch. The role of these reflex reactions in facilitating or limiting stretching will be explained in a later section.

Limiting Factors

Limiting factors in increasing flexibility include length of bones, bulk of muscles, joint structure, age, sex, and inelasticity of connective tissue (Myers, 1983a). Connective tissue refers to ligamentous joint capsules, tendons, and muscle sheaths, all of which have potential to increase in flexibility. Scars, adhesions, and fibrotic contractures, which are pathological connective tissue, possess little potential to increase in flexibility, but improvement may occur if the connective tissue is stretched through therapeutic means (Sapega et al., 1981). Muscle can stretch to one and a half times its resting length or contract (shorten) to half its resting length. Tendons, which connect muscle to bone, possess the property of elasticity, but their potential for stretch is not as great as the potential of muscle. Ligaments, which connect bone to bone, have limited flexibility and once stretched will not return to their original lengths (Myers, 1983a).

Temperature is another factor which may affect flexibility. As tissue temperature increases, permanent elongation (also termed plastic) is more probable, especially when temperature rises above 103°F (Sapega et al., 1981; Sharkey, 1979; Shellock, 1983). An increase in muscle temperature increases the blood flow and saturation, which also facilitates muscle elasticity (Myers, 1983b; Shellock, 1983).

Stretching Techniques

Ballistic stretching is the first of five stretching techniques reviewed by this investigator. Ballistic stretching involves bouncing movements. The force of the bounce stretches the muscle quickly and forcefully. This forced stretch invokes a strong stretch reflex causing the muscle to contract forcefully. This contraction is the opposite of the desired result (i.e., elongation) (Beaulieu, 1981; Sapega et al., 1981). Using the ballistic method increases chance of injury to muscles and tendons and promotes tightness and soreness (Anderson, 1980; Beaulieu, 1981; Myers, 1983a). Ballistic stretching is to be avoided. Another stretching technique should be chosen.

The second method, static stretching, entails assuming a stretch position and holding it. Gravity may be used as a facilitating force with proper breathing a contributing factor (exhale to promote relaxation) (Beaulieu, 1981; Myers, 1983a; Wilmore, 1983). Sharkey (1979) advises holding the stretch position for 10 seconds, Beaulieu (1981) suggests 30-60 seconds, while Roy and Irvin (1983) suggest beginning with 10 seconds but increasing to 60 seconds. Static stretching is thought to induce the least amount of tension, producing not reflexive muscular resistance but a passive elongated stretch (Sapega et al., 1981). Since the stretch is gradual, enough tension is built up over time to signal the inverse stretch reflex to relax the muscle. This in turn allows further stretch, since a relaxed muscle will stretch further. Static stretching is viewed as the safest way to increase flexibility. Static stretching may also relieve soreness (Beaulieu, 1981; Cornelius, 1983; deVries, 1980; Myers, 1983a; Sharkey, 1979). The advantages to the static stretch technique are that it is safe, it can be performed anywhere, and it does not require assistance.

The passive stretch technique involves the aid of a partner to guide an individual through a stretch. The disadvantages of this technique are that a partner is needed and, although effective in inducing greater flexibility, injury may occur due to improper stretching if the guiding person does not pay attention or know how to how to guide properly. This technique seems to be more appropriate for the more knowledgeable individual or in a therapeutic setting (Beaulieu, 1981; Myers, 1983a).

A fourth approach is the contract-relax technique in which an isometric (fixed resistance, no movement takes place) contraction of the muscle is held for 10-15 seconds prior to stretching (Roy & Irvin, 1983). It is thought that the contraction will trigger the inverse stretch reflex to relax the muscle, allowing the muscle to stretch further. However, it is unclear if more tension is produced in the muscle due to the contraction than would occur if a pure static stretch were employed. A static stretch would allow a similar elongation without the tension (Beaulieu, 1981; Myers, 1983a; Sapega et al., 1981).

The fifth technique is a combination of active and passive techniques known as proprioceptive neuromuscular facilitation (PNF), which is based on reciprocal inhibition (Prentice, 1983; Surburg, 1983). The PNF technique seeks a further stretch than the other techniques by contracting and relaxing agonist and antagonist muscles selectively. Prentice (1983) points out that the term proprioceptive neuromuscular facilitation may be misleading in that relaxation of the muscle occurs due to inhibitory rather than facilitory mechanisms (i.e., the inverse stretch reflex inhibits the stretch reflex from causing a contraction, so the relaxation of the muscle occurs).

In an attempt to find which technique was best Prentice (1983) compared static stretch to PNF in a 10-week program (3 days per week). There were 46 subjects, both male and female students, aged 18-34 years. The left leg (hamstring) served as the control leg; only the right hamstring group was stretched using the static or PNF techniques. Both pre- and posttests were administered using a goniometer to measure the right and left hip joints. The results of a 2 x 2 factorial analysis indicated that both methods were effective (Prentice, 1983). However, PNF was found to be more effective. (The group mean gain scores in degrees of change were 8.86 static, 12.04 PNF). The static stretch technique that was used in the study lasted for 10-second intervals (repeated three times). To allow the golgi tendon organ (where the inverse stretch response initiates) to override the stretch-reflex, tension must remain for at least 30 seconds (Beaulieu, 1981; Myers, 1983a). Therefore, the comparison of PNF to static stretch may be invalid in this study because the static stretch was not held long enough. In another study college males were used to compare PNF and static stretching using integrated electromyographic (IEMG) measure during hip flexion. No reduced muscular activity was found for either PNF or static stretching (Cornelius, 1983). This implies that neither method is more effective in increasing flexibility than the other based on the premise that a more extensive stretch will occur when the muscle bundle and surrounding tissues are relaxed which would result in less sensory activity (Cornelius, 1983; Sapega et al., 1981). PNF may have greater impact when used in a therapeutic setting or with individuals with a greater knowledge of correct body placement and a need for extensive flexibility (e.g., gymnasts, dancers). The average individual will probably find static stretching adequate to maintain or increase flexibility.

PNF has been reported to cause a bilateral transfer effect on hamstring flexibility, attributing a basic motor-learning-integration aspect to flexibility (Surburg, 1983). Whether this applies to other methods was not mentioned.

All of the five techniques can utilize psychological facilitation techniques. Examples of psychological facilitation techniques that may enhance stretching are facets of relaxation training, visualization, biofeedback training, and focus of attention (Dimondstein, 1983; Myers, 1983b; Surburg, 1983).

Stretching as Part of Warm-up and Cool-down

Warming up prior to an event is important in preparing an individual to perform. An ideal warm-up would incorporate stretching. During a warm-up (e.g., a brisk walk, slow jog, or cycling) increases in heart rate, body temperature, and blood flow to muscles are evident, all of which facilitate stretching (Beaulieu, 1981; Myers, 1983a; Sapega et al., 1981; Shellock, 1983; Surburg, 1983). A $1^{\circ}C$ to $2^{\circ}C$ increase in rectal temperature is a good indication that the body is warmed up. However, the breaking of a sweat will suffice as an indicator. Body temperature will return to its normal level given 45 minutes of rest, so warm-up should be done as close to the main event as possible (Shellock, 1983). External heating (e.g., saunas or hot showers) is only superficial and does not reach the deep muscles. Therefore, this kind of warm-up will not really benefit an individual. Ultrasound may be used, but is not suggested except for therapeutic use (Sapega et al., 1981). The length of warm-up is specific to the demands of the event; weather and temperature; the individual's level of conditioning, age, past and/or present injuries; and the amount and type of activity participated in throughout the day (Myers, 1983b; Roy & Irvin, 1983; Shellock, 1983). Myers (1983b) points out the "psyching" aspect of a warm-up with stretching: the individual may rid the mind of the past day's events, and focus on the self and the upcoming event. In order to stretch properly individuals need to focus on their bodies, take note of tension levels, tight spots, and at what point relaxation occurs, then breath and stretch further.

A recent study (Wiktorsson-Möller, Oberg, Ekstrand, & Gillquist, 1983) compared the effects of a general warm-up to massage, general warm-up plus massage, and general warm-up plus stretching on the range of motion (ROM) of six muscle groups of the lower extremity. A significant increase in ROM for all six muscle groups was found with the stretch plus general warm-up group, while the other procedures significantly influenced only ankle dorsiflexion. The results imply a benefit to incorporating stretching into the warm-up.

During a warm-up that includes stretching, muscles should be worked in pairs. An imbalance can predispose an individual to injury due to an uneven tension or pull on the postural muscles disturbing alignment and placement (Beaulieu, 1981; Myers, 1983b). Stretching for individual games or events without including stretching as a regular practice will be of limited value. To achieve the maximum benefit, a stretching program should begin 6 to 8 weeks prior to the event and should be conducted at least three times a week (Beaulieu, 1981; deVries, 1980). Once a muscle is adequately stretched, it will remain stretched up to 3 hours, thereby meeting the demands of the event (Beaulieu, 1981; Myers, 1983a). However, due to the nature of the muscle after the work out (i.e., temperature up, blood flowing, and so on) a cool-down offers an opportune time to increase flexibility (Sapega et al., 1981). The advantages to stretching after a workout include increased potential of muscle extensibility, more permanent (plastic) stretch, and a reduction of soreness (Beaulieu, 1981; Myers, 1983a; Sapega et al., 1981). A post-stretching sequence, if only one stretching sequence is to be performed, is the better choice unless a high-intensity, short duration activity (e.g., weight lifting or sprinting) is required. Activity such as running can shorten the muscles, thereby counteracting the effects of the warm-up stretch (Sharkey, 1979). To stop an activity without stretching is to leave the muscle in this shortened state. A good guideline for a workout schedule would consist of a mild warm-up, stretching, the main exercise, and then a cool-down stretch session (Beaulieu, 1981; Myers, 1983a; Sapega et al., 1981; Surburg, 1983).

Stretch and Strength

To achieve the maximum benefit of increased flexibility while in action (dynamic flexibility) stretching must be accompanied by strengthening exercises (deVries, 1980). Without strength there is little control. Therefore, although the ROM may be increased, without strength to carry through the wider range there is little value (Iashvili, 1983; Myers, 1983a). If strengthening exercises are included, the gap between passive and active (dynamic) flexibility will be narrowed (Iashvili, 1983). A correlational analysis of 400 subjects, using top-ranked athletes from four different sports, showed a higher relationship of the level of sports achievement with active flexibility (r = .81) than with passive mobility (r = .69) (Iashvili, 1983). This study failed to operationalize many terms, and neither the review of literature nor a list of references was available.

Another important factor in combining strength and stretch is maintenance of proper alignment. Without the control to stretch properly, the designated muscle may be pulled incorrectly, which could lead to injuries (Myers, 1983b; Surburg, 1983). Muscles should be worked in pairs; for example, if the quadriceps are stretched or strengthened, then the hamstrings should also be stretched or strengthened (Myers, 1983b). The treatment for muscle imbalance consists of strengthening the weaker muscle and stretching the stronger one (Mirkin & Hoffman, 1978). Hage (1983) reported a study in which three of four soccer players who had asymmetrical hamstring flexibility suffered time-loss injuries on the corresponding side of the body. (The article did not specify, but implied the leg of lesser flexibility suffered the injury.) However, no mention was made of how many injuries were suffered by the other 21 players, who all had symmetrical hamstring flexibility.

Increased flexibility can facilitate speed. A relaxed, stretched muscle is capable of a more forceful contraction and, therefore, more strength. Greater strength facilitates greater speed (Olinekova, 1982).

Stretching also relieves soreness. There are two types of soreness, immediate and delayed (24-48 hours after work-out). Why people become sore is not really known. Soreness might be due to fatigue and build-up of metabolites (e.g., lactic acid) or perhaps due to tissue or structural damage. The muscle spasm theory suggests soreness is due to slight uncontrolled contractions or spasms occurring in the muscle fibers (deVries, 1980; Sharkey, 1979). Static stretching elongates the muscle, counteracting the tension and shortening effect from tissue damage or contractions and perhaps thereby reducing soreness (deVries, 1980; Sharkey, 1979).

Loss of strength due to increased flexibility and over-flexibility arising from a stretching program is sometimes a concern voiced by athletes. As long as strenghthening exercises are included in the training program, flexibility will not decrease strength, but will actually increase strength by allowing a greater contraction (Olinekova, 1982). Wiktorsson-Möller et al. (1983) found no decrease in strength during a warm-up stretch program. Over-flexibility is not really a problem in the average athlete with the exception of gymnasts and dancers. As with any activity the proper technique and method of stretching must be employed for an individual to achieve the safest, most effective increase or maintenance of flexibility according to his/her own goals.

Flexibility Testing

In searching for the most accurate measure of flexibility, much information is to be found in the physical therapy literature. However, most of this work is geared toward the abnormal patient rather than the active athlete. In addition, in physical therapy, flexibility assessment is often left to the trained physical therapist's eye, a skill that most physical educators have not developed. Flexibility testing was developed during World War I and World War II as a means for evaluating veterans' functional ability (Meyers, 1974). Since then, flexibility has been recognized as a basic component of fitness and included in basic fitness testing.

One main problem with all flexibility testing is the difficulty, if not impossibility, of determining the optimum flexibility for an individual. It is imperative to make the decision of how much flexibility is "good" based on the body part involved, the task demand, and the ease and safety necessary to execute the task (Johnson & Nelson, 1974). A second problem associated with testing flexibility is that variations might occur due to differences in anthropometric lengths. Such variation in anthropometric measures reduces the validity of comparing individuals and establishing norms. It is also quite important to specify correct body alignment and maintain this alignment while executing the flexibility tests (Leighton, 1942; Meyers, 1974).

It is important to note that there is not much variety among available flexibility tests and most existing tests measure gross flexibility. Few flexibility tests exist to measure the specific muscles and/or joints or the subtle improvements that a good stretching class may produce.

There are two distinct categories of flexibility measures: direct and indirect (deVries, 1980). Goniometry is an example of direct measurement of the angle of a joint. The goniometer is a protractor-like device made from plastic or metal. One arm is stationary, the other movable. The center of the instrument is aligned with the axis of the joint. The goniometer reads 0^{o} when the joint is in anatomical position. The measurement increases toward 180^{o} or 360^{o} as the joint moves through its range of motion.

There are problems associated with the use of the goniometer. The investigator must make a subjective determination of the joint axis, instrument placement, and body segment stabilization (deVries, 1980; Lusin, Gajdosik, & Miller, 1979; Meyers, 1974). An electronic goniometer records the angular changes during motion, however it has not been used extensively (Meyers, 1974; Lusin et al., 1979).

The Leighton flexometer is widely reviewed as the most accurate standardized, objective instrument to measure flexibility (Johnson & Nelson, 1974; Leighton, 1942; Lusin et al., 1974; Mathews, 1973; Meyers, 1974). Gravity is used as the origin (as opposed to joint axis) as the device is strapped around the body segment being measured. This alleviates the problem of subjective determination of joint axis and the possible subsequent manipulative effects on results. Mounted in a 4.5-inch diameter case is a weighted 360° dial and a weighted pointer. Separate locking devices exist. The dial is locked in the starting position as the pointer remains free during the movement. The reading taken from the dial at the end of movement records the arc or range of movement in degrees of deviation from the starting position (Leighton, 1942; Meyers, 1974). It is important to control excessive movement of the body segments not being measured (Leighton, 1942; Lusin et al., 1979). Meyers (1974) reported the reliability estimates originally to be between .889 to .997, with subsequent studies reporting reliability estimates falling within these same numbers. Mathews (1973) reported test-retest reliability estimates between .913 and .996 (on a study involving 128 boys).

Indirect testing of passive flexibility of joint angles measures the distance between one body part to another or to a specified reference point (deVries, 1980). Indirect measurements, or practical tests, were devised and are used in physical fitness tests because of their ease of administration and the fact that sophisticated instrumentation is not needed (Johnson & Nelson, 1974). Many of the tests are simply variations or modifications of some of the more traditional tests. Wells and Dillon (1952) devised a sit-and-reach test to measure trunk, hip, and leg flexibility. The validity and reliability coefficients were reported at .98 and .90, respectively. This form of the test, where the subject is in a sitting position, is recommended over the Scott-French standing bend-reach test, due to a reduction in anxiety about falling (Mathews, 1973; Meyers, 1974; Wells & Dillon, 1952).

Cureton's series of practical tests is also widely mentioned and reviewed in the literature (deVries, 1962; Johnson & Nelson, 1974; Meyers, 1974). Gross flexibility measures such as back extension, trunk flexion, shoulder elevation, and ankle flexion and extension have been examined. In Cureton's tests, a sliding caliper is used to measure the direct difference between two reference points, resulting in a linear system of measurement. Leighton (1942) criticized the lack of consideration of differences in body segment lengths and sizes of subject that occurs with a linear system of measurement. This criticism has been directed toward other practical tests as well (Leighton, 1942; Meyers, 1974). McCloy (as described in Meyers, 1974) offered a modified Cureton test in which an attempt is made to correct for these individual differences by adjusting the scores. (For Leighton flexometer tests this problem is avoided by employing an angular measurement system that records the arc formed throughout a ROM).

Summary

It appears that to enhance athletic performance, stretching must be an integral part of one's conditioning. Stretching, which may lead to increased flexibility, may decrease chance of injury, increase ROM, decrease muscle soreness, improve athletic performance, and increase kinesthetic awareness. Static stretching appears to be the safest, most effective technique for the average athlete. The PNF technique may be best in therapeutic settings and for those in need of "extra flexibility" (e.g., dancers, gymnasts, and swimmers). A warmed muscle possesses the greatest potential of elasticity, so a warm-up should precede stretching and stretching should become a major part of a cool-down regime. All stretching programs should include strengthening exercises as well in order to maximize control through the wider ROM. Over-flexibility and injury due to stretching incorrectly can be avoided in most cases by becoming familiar with the principles of why, how, and when to stretch.

Chapter 3

METHODS AND PROCEDURES

The methods and procedures employed for this study are explained in this chapter. The topics include (a) selection of subjects, (b) the dance exercise class, (c) testing design, (d) testing procedures, (e) methods of data collection and scoring of data, (f) treatment of data, and (g) summary.

Selection of Subjects

The Ithaca College men's lacrosse team participated in a dance exercise class for 7 weeks. The class met twice a week for 45-minute sessions. All members of the team who could attend class (N = 22) served as subjects.

The Dance Exercise Class

The dance exercise class was designed to increase flexibility, muscular endurance, and muscular strength through exercises derived from various dance techniques, such as ballet, modern, and jazz, and from yoga. A few of the objectives of the class were to teach proper body alignment and proper body positioning while stretching, increase kinesthetic awareness, and promote mind/body integration, all of which facilitate stretching (see Appendix A for further detail). For the purpose of this study, the effects of the dance exercise class on the flexibility of the athletes were determined by the results of tests administered in a pretest, posttest design. Due to a time conflict seven of the subjects completed only the two practical sections of the testing. All sections of the testing were completed by 15 subjects.

Testing Design

A pretest, posttest design was utilized for this study. The pretesting was completed within a 3-day period. The posttesting was also completed within a 3-day period. The same four persons administered specified tests; two persons administered the practical flexibility and endurance tests, and two persons administered the flexometer tests. Two or three subjects were tested during any designated testing session.

All subjects were required to read a statement explaining the purpose and format of the testing. This was followed by a written explanation of the warm-up procedure. The subjects being tested in the selected time slot warmed-up together for 3 minutes (an easy stationary jog with shoulder rotations) and on their own for 3 to 5 minutes. After the warm-up, one or two subjects started the practical tests, while one began the flexometer measurements. After finishing one testing situation, the subjects rotated testing stations. The order of administrations of the practical tests was as follows: (a) the Wells and Dillon sit and reach, (b) Cureton's trunk flexion forward, (c) Cureton's trunk extension backward, (d) Cureton's shoulder elevation, (e) timed sit-up, (f) timed push-up, (g) Fleishman's extent flexibility test, and (h) Fleishman's dynamic flexibility test. The order of the flexometer testing was as follows: (a) shoulder flexion and extension, (b) trunk and hip flexion and extension, (c) sideward trunk and hip flexion and extension, (d) hip flexion and extension, (e) leg abduction, and (f) leg flexion, both right and left legs.

Testing Procedures

Wells and Dillon Sit and Reach Test

This test was devised to measure the flexibility of the back and leg, more specifically the hamstring muscle, without the anxiety reported by subjects taking the "standing, bobbing test" by Scott and French (Wells & Dillon, 1952). The modification of the Wells and Dillon sit and reach test as described in Lifetime Health Related Physical Fitness Test Manual (American Alliance, 1980, p. 19) was used for this study. The reliability estimate was reported as above .70.

Cureton's Practical Tests

Trunk Flexion Forward. The subject sits on a mat with legs straight in front, 18 inches apart, back vertical, arms clasped behind neck. The subject then bends the forehead downward and forward as far as possible, keeping the knees straight. The vertical distance from the forehead to the mat is the score taken.

Trunk Extension Backward. The subject lies in a prone position. The arms are clasped behind the neck. The subject lifts the head and chest upward and backward as far as possible, while the legs remain straight and flat and the hips remain on the mat. The vertical distance from the chin to the mat is the score.

Shoulder Elevation. The subject assumes a prone position. Arms are extended forward on the mat. The subject holds one end of a meter stick in each hand, keeping both the arms and the stick parallel to the floor. The stick is then raised as high as possible while wrists and elbows remain straight. The score is the distance from the stick to the mat.

A sliding caliper is used to measure and record the Cureton test scores to the nearest eighth of an inch. Reliability estimates have been reported between .70 and .95 (Cureton, 1941; Meyers, 1974). The criticism of Cureton's tests arising from the lack of consideration for the variation in body segment lengths and size of subjects (Leighton, 1942; Meyers, 1974) was not considered a factor here. In this study, subjects were not compared to each other but rather compared to themselves because of the pretest to posttest design. Any individual differences in body segments that may affect the score therefore should affect both pretest and posttest scores in the same manner.

Sit-ups

Lying on back, the subject flexes knees over a yardstick while sliding heels as close to buttocks as possible. Keeping the yardstick under the knees, the subject slowly slides the feet forward. At the point where the yardstick drops to the mat, the heel line and seat line are indicated as the position to remain in during the execution of the sit-up. Keeping the hands grasped behind the neck, the subject rolls the torso towards the knees and rolls back to the floor, touching the back of his hands to the mat each time. The number of repetitions completed in 1 minute is recorded.

Push-ups

The subject takes a traditional push-up position--arms shoulder width apart, palms flat on floor, arms extended to hold the shoulders off the floor, body extended, weight on hands and toes. The subject bends at the elbow lowering the body toward the floor until the chest slightly touches the floor. At this time the subject pushes away from the floor to the original position, elbows extended. It is important that the subject maintain a straight body positioning. The number of repetitions completed in 1 minute is the score.

Fleishman's Extent Flexibility Test

The subject stands arm width away from a wall, with one side to the wall. Keeping the arm that is furthest way from the wall at shoulder height, palm facing the floor, the subject twists around behind himself and touches the wall. The furthest point touched on a scale drawn on the wall serves as the score. The procedure for this test, also known as twist and touch, followed specifically Fleishman's (1964, p. 78) directions. The reliability estimate of this extent flexibility test was reported at .90 (Fleishman, 1964).

Fleishman's Dynamic Flexibility Test

The subject stands with back to the wall a few inches away from the wall. The subject then touches the floor between his feet, straightens up and twists to touch the wall at shoulder height behind his back. This represents one cycle. Each cycle alternates twisting to the right and then left. The subject's score is the number of cycles completed in 20 seconds. The procedure for this test, also known as bend, twist, and touch, followed specifically Fleishman's (1964, p. 79) directions. The reported reliability estimate of this test was .92 (Fleishman, 1964).

Leighton Flexometer Testing

For each of the seven measures, the flexometer is strapped to a specific body part. The subject is instructed to execute a flexion and extension of that body part. The measurements are taken in the following order: shoulder flexion and extension, trunk and hip flexion and extension, sideward trunk and hip flexion and extension, hip flexion and extension, leg abduction, and leg flexion. The recorded score is in degrees, representing the angle between the device attached to the limb being measured and a perpendicular established by gravity (deVries, 1980;

Leighton, 1942; Mathews, 1973). Because the angle of movement is measured as opposed to a linear measurement (as in Cureton's tests) the problem of variation of limb length is claimed to be solved (Leighton, 1942). The exact body placement and procedure for this segment of testing followed the guidelines described by Leighton (1942) in his original article. The reliability estimates of tests using the Leighton flexometer have been reported as between .913 and .996 (Leighton, 1942; Mathews, 1973).

Methods of Data Collection and Scoring of Data

The scores for the sit and reach were determined to the furthest centimeter marking touched by both hands on the horizontal scale. A sliding caliper was used to determine the distance, to the nearest eighth of an inch, from the selected focal point to the mat in Cureton's trunk flexion forward, trunk extension backward, and shoulder elevation tests. The sit-ups and push-ups were recorded as number of successful repetitions per minute. Fleishman's extent flexibility score was determined to the nearest half inch on a scale drawn on the wall. The number of cycles completed in 20 seconds determined the score for Fleishman's dynamic flexibility test. The flexometer tests were recorded in degrees. All subjects were given two trials at each test except for the sit-ups and push-ups, for which a single trial was given. The better of the two trial scores was used for analysis.

Treatment of Data

A check for multicollinearity was run for each of the three sets of data--the practical tests, the endurance tests (sit-ups and push-ups), and the flexometer tests--to assess which variables were highly associated so that any variables that were significantly ($p < .05$) correlated with any others could be eliminated. This check is to ensure that the basic assumption of independence of the multivariate analysis of variance (MANOVA) has been met.

For each of the three data sets, MANOVA was run for all the variables of the set to determine the differences, if any existed, between the pretest and posttest scores. Univariate ANOVA tests were run to determine which variables, when considered independently, changed signficantly over the 7 weeks. Discriminant function analysis identified which of the individual variables had the greatest influence in the significant multivariate change for each section.

Summary

The subjects for this study were 22 Ithaca College male lacrosse players. All subjects were required to participate twice a week, 45-minutes per session, for 7 weeks in a dance exercise class. This dance exercise class focused on proper stretching techniques to increase flexibility and on exercises to increase muscular endurance.

A pretest, posttest design was employed. The test consisted of six practical tests of flexibility and two tests of muscular endurance. Using a Leighton flexometer, 15 of the 22 subjects were further tested for flexibility.

A test for multicollinearity was run to determine if any variables were highly correlated ($p < .05$) so that the data sets would meet the independence assumption for multivariate analysis. To determine whether any differences existed over time between the pretest and posttest, MANOVA was used.

Chapter 4

ANALYSIS OF DATA

The statistical analysis of data from this study is presented in this chapter. The data were divided into three data sets: (a) practical tests, (b) endurance tests, and (c) flexometer tests. A test for multicollinearity was run, as well as MANOVA and two post hoc tests for MANOVA, univariate ANOVA and discriminant function analysis. The .05 level of significance was chosen for all statistical tests.

Multicollinearity

The Pearson product-moment technique was used to provide correlations on all variables within each of the three data sets. Intercorrelation matrices for each data set were derived from the SPSS program, PEARSON CORR (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975). A check for multicollinearity allowed the investigator to eliminate any test if it significantly correlated with any other test in order to select variables that meet the assumptions of the MANOVA. Trunk flexion forward (TFFWD) and sit and reach (see Table 1) had a significant correlation of $r = -.66$. TFFWD scores were disregarded and the sit and reach scores retained, because sit and reach scores had a lower relationship to other variables that were being retained. Trunk extension backward (TEXB) and shoulder elevation correlated at $r = .66$ (see Table 1). The shoulder elevation test was retained due to its apparent greater relevance to the game of lacrosse. Sit-ups and push-ups had a correlation of only $r = .20$ ($p > .05$), so both variables were retained. Hip flexion and extension (HIPFLEX) and leg abduction (ABDUCT) in the flexometer set had a correlation of $r = .67$, $p < .05$ (see Table 2). Because abduction had lower correlations with other variables and hip flexion and extension had already been measured to some

Table 1

Intercorrelations of Practical Flexibility Tests

Test	2	3	4	5	6
1. Sit and reach (SITREACH)	-.66*	.08	.17	.34	.33
2. Trunk flexion forward (TFFWD)		-.21	-.21	-.39	-.01
3. Trunk extension backward (TEXB)			.67*	.19	.27
4. Shoulder elevation (SHOULDER)				.26	.26
5. Extent flexibility (EXTFLEX)					.22
6. Dynamic flexibility (DYNFLEX)					

*$p < .05$.

Table 2

Intercorrelations of Flexometer Tests

Test	2	3	4	5	6	7
1. Shoulder flexion and extension (SHROM)	-.11	-.04	-.07	.03	-.05	-.18
2. Trunk and hip flexion and extension (TRHIPROM)		.05	.29	.24	.34	-.29
3. Sideward flexion and extension (SIDEROM)			.39	.34	-.20	.27
4. Hip flexion and extension (HIPFLEX)				.67*	.05	.09
5. Leg abduction (ABDUCT)					.13	-.09
6. Right flexion of the leg (RIGHT)						.42
7. Left flexion of the leg (LEFT)						

*$p < .05$

extent in trunk and hip flexion and extension and sit and reach, HIPFLEX was eliminated. All other variables remained to be further analyzed.

Mean Scores

The means and standard deviations of the variables at both pretest and posttest were also calculated by the SPSS program, PEARSON CORR. The means increased for three of the four practical tests of flexibility: sit and reach, shoulder elevation, and extent flexibility (see Table 3). The mean for dynamic flexibility decreased. The mean scores for sit-ups and push-ups increased. The mean scores for all of the flexometer tests increased, with the exception of the shoulder range of motion.

MANOVA

MANOVA was performed for each of the three data sets. For the practical flexibility tests, MANOVA resulted in $F(4,18) = 16.39$, $p < .05$. Therefore, a significant change over time did occur. Because the means increased, this significant change leads to the rejection of the null hypothesis for the practical tests. The combined effects of the endurance tests resulted in a significant change across time, $F(2,20) = 4.81$, $p < .05$. The combined flexometer results did not show a significant multivariate difference, $F(6,9) = 3.07$, $p > .05$, however, further analysis showed significant changes occurred for some individual variables from pretest to posttest within the flexometer data set.

ANOVA

ANOVA was used to determine the significance of change in each variable independently from pretest to posttest. Table 3 indicates those that differed significantly. Shoulder elevation and extent flexibility increased significantly. Dynamic flexibility changed significantly, however the mean decreased from 13.68 to 12.32 cycles instead of

Table 3

Means and Standard Deviations of Variables by Data Set

Variable	N	Pretest M	Pretest SD	Posttest M	Posttest SD
Practical flexibility[a]					
SITREACH	22	31.1	8.5	32.5	6.9
SHOULDER	22	11.6	4.3	13.3*	4.8
EXTFLEX	22	3.0	12.5	10.8*	8.1
DYNFLEX	22	13.7	1.7	12.3*	1.3
Endurance					
SIT-UPS	22	46.7	7.0	47.5	7.4
PUSH-UPS	22	44.4	9.6	48.6*	9.2
Flexometer[b]					
SHROM	15	225.4	42.6	216.1	49.3
TRHIPROM	15	188.0	18.6	202.0	30.6
SIDEROM	15	106.6	13.0	108.3	11.5
ABDUCT	15	107.3	20.7	123.3*	19.9
RIGHT	15	120.2	13.7	131.1*	12.7
LEFT	15	115.3	14.1	126.1*	10.9

[a] Sit and reach scores were recorded in centimeters; all other practical flexibility tests were recorded in inches.

[b] All flexometer scores were recorded in degrees.

*Significant (p < .05) change over 7 weeks.

increasing. As can be seen from the table, in the endurance data set, the only test for which a significant increase was seen was the push-ups test. The sit and reach did not change significantly over time, although the mean did increase.

Although the combined scores of the flexometer data did not produce a significant change, three of the six individual variables did show a significant change. Leg abduction and right and left flexion of the leg changed significantly in the expected direction. Trunk-hip flexion and extension (TRHIPROM) and side trunk and hip flexion and extension (SIDEROM) did not change significantly, although their means increased slightly. The mean shoulder range of motion decreased, but not a significant amount.

Discriminant Function Analysis

The discriminant function analysis identified the order of importance of each variable within each of the three MANOVAs and the percentage of the multivariate difference accounted for by that variable. For the practical tests, dynamic flexibility contributed the highest percentage toward the signficant change, followed by extent flexibility, and shoulder elevation (see Table 4). The multivariate change in endurance across time was mainly due to push-ups (99.61% of the variance accounted for) rather than sit-ups. For the flexometer tests, abduction of the legs contributed the highest percentage to the F statistic. Left leg flexion contributed the next highest percentage followed by trunk-hip flexion and extension, then side trunk and hip flexion and extension. The remaining tests combined contributed less than 5% to the multivariate difference (see Table 5).

Summary

A check for multicollinearity resulted in dropping two tests of practical flexibility, the trunk flexion forward due to its high

Table 4

Discriminant Function Analysis for Practical Flexibility Tests

Variable	Standardized Discriminant Weight	Squared Discriminant Weight	Percent of Contribution to the Discriminant Function
SITREACH	-.0549	.0030	.30
SHOULDER	-.1489	.0222	2.22
EXTFLEX	-.1693	.0287	2.87
DYNFLEX	.9727	.9461	94.61

Table 5

Discriminant Function Analysis for Flexometer Tests

Variable	Standardized Discriminant Weight	Squared Discriminant Weight	Percent of Contribution to the Discriminant Function
SHROM	-.0873	.0076	.76
TRHIPROM	-.1135	.1288	12.88
SIDEROM	-.2841	.0807	8.07
ABDUCT	.8408	.7069	70.69
RIGHT	.2024	.0410	4.10
LEFT	.3885	.1509	15.09

correlation with the sit and reach test, and the trunk extension backward due to its high correlation with shoulder elevation. The hip flexion and extension test was dropped from the flexometer variables due to its significant correlation with abduction of the legs. MANOVA was run on each set of variables (practical flexibility, endurance, and flexometer). Significant ($p < .05$) multivariate changes over time from the pretest to posttest were found for the practical flexibility and endurance tests. No significant change occurred for the combined flexometer variables. ANOVA tests were run to determine if significant changes of the individual variables occurred over time. Significant changes occurred for all variables except sit and reach, sit-ups, shoulder flexion and extension, trunk and hip flexion and extension, and side hip and trunk flexion and extension. Although not all variables increased significantly, all means increased except shoulder elevation and dynamic flexibility. Dynamic flexibility changed significantly but in the opposite direction from what was expected. Discriminant function analysis clarified the influence each variable had on the multivariate F statistic.

Chapter 5

DISCUSSION OF RESULTS

In this chapter, the results of this investigation, which measured the flexibility of male collegiate lacrosse players before and after a 7-week dance exercise class, will be reviewed. The possible effects of some of the limitations of this study will be discussed. Discussion of additional benefits resulting from the program that did not manifest themselves in the statistical data will follow as well.

Interpretation of Results

The statistically significant results of this investigation imply an inconsistent pattern concerning the effects that participation in the dance exercise program had on flexibility of lacrosse players. It is not surprising that some of the variables showed statistically significant changes (i.e., shoulder elevation, extent flexibility, push-ups, leg abduction, and right and left leg flexion and extension) while some results did not (i.e., sit and reach, sit-ups, shoulder flexion and extension, trunk and hip flexion and extension, and sideward flexion and extension). Flexibility is specific to the joint and the individual movements of the joint and is not a general trait (deVries, 1980; Dickinson, 1960; Harris, 1977; Meyers, 1974). Therefore, the program logically may have improved the flexibility of certain muscles and joints and their ROM more than other muscles and joints. However, the means for all variables except shoulder elevation and dynamic flexibility increased, which means flexibility may have improved a meaningful amount even if not a statistically significant amount.

This meaningful increase in flexibility may enhance athletic performance by contributing to a greater impulse. Impulse is the product of force and time. A wider ROM allows force to be exerted over a greater length of time, thus resulting in a greater impulse.

Unfortunately, no control group was used to investigate what might have happened to flexibility as a result of participating only in the regular preseason workouts. It is possible that without the program, the men's flexibility might not have increased at all or perhaps would have decreased. This speculation would be supported by the review of literature. The running involved during preseason and the 1st week of the regular season, if not supplemented with stretching, would tend to decrease, not increase, flexibility of the lower extremities (Mirkin & Hoffman, 1978; Sharkey, 1979; Wilmore, 1983).

Any movement that is repeatedly executed only through a portion of its full ROM will tend to shorten the muscle (Johnson & Nelson, 1974). This might explain the decrease in the mean for shoulder elevation, as throwing in lacrosse is a frequent task demand and is often executed without employing a full ROM.

The instructor of the class observed that the subjects developed an increased awareness of proper alignment and placement of the body for stretching and moving. This increased awareness may be a second explanation of why some of the variables did not show statistically significant increases. Though the test instructions and administrators did specify placement, it is very difficult to enforce exact placement. For example, for the shoulder flexion and extension test subjects were to keep buttocks and shoulders against the wall, trying to isolate the shoulder by not arching the back. However, regardless of instructions and corrections by the test administrator, subjects were still able to arch the back slightly and have this arch go undetected. This could have led to spuriously high scores on the preprogram tests. Even if this was not a great amount of arch, perhaps it was a sufficient amount to affect test performance. When the subjects were more aware and able to control and isolate movements more easily, as they might be able to due to the dance exercise program, resulting (or subsequent) movement might not be as great, but it would be correct. The importance of maintaining correct alignment is evident when it is realized that a stretch done improperly can do more harm than good (Myers, 1983a).

A third factor contributing to the results may rest in the fact that 10 of the subjects were posttested on the day after Saint Patrick's Day, which fell on a Saturday, the only day the men were allowed to visit the bars. This may have negatively influenced their performance on the posttest.

Although twice a week for 7 weeks should be enough time for a stretching program to affect flexibility (Beaulieu, 1981; Wilmore, 1983) the circumstances surrounding this group may have been such that a longer time was necessary for some areas to be affected. The men seemed skeptical about the class and the word "dance." The movements and exercises were very new to them. The 1st week was dedicated to simply breaking down, demonstrating, and explaining each exercise. It took 2 weeks for the majority of the men to really begin to feel comfortable with the class. Even as the men began to feel more comfortable with the movements they were often distracted by the female gymnasts who entered the room to begin warming up for their practice, which began immediately after the men's class. If not for time limitations, 3 days per week, as opposed to 2 days per week, would have been preferred. Another time problem was that the week off between the 6th and 7th weeks broke the continuity of the class. The effect this week off had on the subjects and therefore on the results of the flexibility tests is unknown.

The full effects of the class were probably not evident by the end of 7 weeks due to many of the aforementioned reasons. As with most tasks when they are first attempted, much energy and concentration is focused on the gross task without an appreciation of the subtleties that make up the task. For example, when an individual begins a jogging program and is not yet conditioned, effort and concentration is often on completing the first milestone, perhaps a mile. Because the individual is not conditioned, shortness of breath, soreness, and possibly boredom may all seem overwhelming. It is not until the individual is able to jog at a comfortable stride, breathe a bit more easily, perhaps experience the "runner's high," or see some results like weight loss or higher energy level that he/she can understand all the praise for jogging. It is often these results that motivate an individual to keep jogging, thereby developing or maintaining a conditioned state. This analogy may have a parallel in the stretching program. The men, at first unsure and a bit awkward, needed time to adjust and experience stretching and some of its benefits. Now that most of the subjects have experienced some of these benefits, perhaps they will see the importance of stretching and incorporate it in their daily workouts. This is indeed what appeared to occur and will be discussed further on in this chapter.

At the completion of the posttest the subjects were asked to evaluate their own effort in class according to a 2-point scale: (a) ready to work or (b) just went through the motions. Although five subjects said they did not come to class "ready to work" but rather "went through the motions," all subjects, on an open-ended response evaluation, said they felt they benefited from the class. Many repeated comments concerned the athletes feeling stretched in areas they never before experienced stretching; feeling better in practice; having reduced injuries, less tension, and better overall performance; learning new stretches; and having a desire to participate in such a program again.

Additional Benefits of Dance Exercise

The number of musculotendinous injuries sustained by members of the lacrosse team decreased this year from past years, as reported by the team trainers, the coaches, and the players themselves. There were no players who were unable to participate in the spring trip training due to musculotendinous injuries. A reduction in the number of musculotendinous injuries while participating in the dance exercise program is not surprising. In fact, this result supports much of the current literature (Beaulieu, 1981; Surburg, 1983; Wiktorsson-Möller et al., 1983). The number of injuries throughout the entire season was also smaller than in previous seasons.

The teacher of the dance exercise class observed that when the class began the majority, if not all, of the subjects did not know the proper alignment to maintain in various stretching positions. For example, if subjects were requested to "touch your toes," their heads would be cocked instead of relaxed and hanging. This puts unnecessary pressure on the vertebrae in the neck and works against the desired outcome. By cocking the head energy is diverted outward rather than downward to allow gravity to facilitate a further stretch. The increased awareness and knowledge of placement allowed the subjects to execute the 7-minute team stretching at the beginning of practice more efficiently, as observed by both the investigator and the team coaches.

Another example of how the subjects applied the knowledge gained through the program was apparent during the testing. The subjects were required to participate in a 3-minute warm-up with an optional 3-5 minute continuation before the pretest and the posttest. It was apparent that the players used more time stretching during the warm-up for testing at the conclusion of the program than they did before the program began. If the subjects continue to spend more time stretching properly, greater increases in flexibility will probably occur.

Summary

Although the means for all of the variables except dynamic flexibility and shoulder flexion and extension increased, the statistically significant results of this investigation imply an inconsistent pattern concerning the effects that participation in the dance exercise program had on flexibility of the lacrosse players. This inconsistency may be due to the task demands that participation in lacrosse has on the muscles and joints tested. Another explanation for the inconsistent results may be due to better body positioning during the posttest. The incorrect body positioning on the pretest may have contributed to spuriously high scores, thereby reducing the amount of significant change over time. Additional benefits that were observed by the investigator, coaches, and trainers that appear to be due to the dance exercise class are a reduction of musculotendinous injuries, increased efficiency in stretching efforts, a greater amount of time taken to stretch prior to games, an increased awareness of proper body alignment and positioning while stretching, and a knowledge of a greater variety of stretches to choose from.

Chapter 6

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER STUDY

Summary

The effects of a dance exercise program on the flexibility of male collegiate lacrosse players were examined. The dance exercise program included stretching and strengthening exercises derived from various dance techniques. Emphasis was placed on teaching correct body alignment for the various exercises. The 45-minute exercise class was taught twice a week for 7 weeks. The class was held in the dance studio of the Hill Physical Education Center, Ithaca College, on Tuesdays and Thursdays. The subjects of the study were 22 available members of the Ithaca College men's lacrosse team. Ages ranged from 18 to 25 years. A pretest, posttest design was employed. Six practical flexibility tests and two tests of muscular strength were administered to all subjects. In addition to the practical tests, Leighton flexometer tests were also administered to 15 subjects.

All pretesting was completed during a 3-day time period in a laboratory setting. All posttesting was completed during a 3-day period in the same room. All subjects warmed up for 3 minutes and were allowed an additional 3 to 5 minutes to continue to warm-up on their own. All subjects read the explanations and were shown demonstrations of the test procedures. For endurance tests a single test was performed. Two trials of each of the other tests were performed, and the better score was recorded.

The data were analyzed in three sections: practical flexibility tests, endurance tests, and flexometer tests. A check for multicollinearity was run on each set of variables, resulting in the elimination of the trunk extension forward, trunk extension backward and flexion and extension tests. MANOVA was then run on each of the three data sets to determine if any significant ($p < .05$) change from pretest to posttest occurred. Univariate ANOVA was used to identify which items, when taken individually, showed significant changes. Discriminant function analysis identified which of the variables had the greatest influence on the multivariate difference.

The means for all variables except dynamic flexibility and shoulder flexion and extension improved. The observed decrease in shoulder flexion and extension may have been due to the excessive use of the shoulder as demanded by lacrosse participation. The MANOVA analysis resulted in the rejection of the null hypothesis for the combined variables for the practical tests of flexibility and for the endurance tests. The MANOVA results for the flexometer tests did not indicate a significant change, but ANOVA tests found significant changes occurred over time for three out of six of the individual flexometer variables. This may be due to improved body positioning during the posttest or the conflicting demands season training has on flexibility.

Conclusions

On the basis of the findings and within the limitations of this study the following conclusions were supported:

1. The dance exercise program, when participated in for 45-minute sessions twice a week for 7 weeks, was effective in increasing male lacrosse players' flexibility as represented by a series of practical flexibility tests.

2. The dance exercise program, when participated in for 45-minute sessions twice a week for 7 weeks, was effective in increasing male

lacrosse players' muscular endurance as represented by a set of practical endurance tests.

3. The flexibility of male lacrosse players as measured by a series of tests using a Leighton flexometer did not increase significantly while participating in a 7-week dance exercise program.

Recommendations for Further Study

The following recommendations are offered for further investigation:

1. The same program and investigation could be employed using a control group.

2. The effect of the same or a similar program on injury rate could be investigated.

3. The effect of a post-practice stretching program on flexibility could be investigated.

4. The effects of a shorter program given more frequently than twice a week could be investigated.

5. The effects of increased flexibility on speed could be investigated.

6. The development of a wider variety of more specific flexibility tests could be attempted.

7. The use of a stretching program to facilitate relaxation and reduce stress could be investigated.

8. The use of team stretching as a "psyching" period before practice and/or games could be investigated.

9. The effects of stretching on muscle soreness could be investigated.

10. The athletes' perceptions of the effects stretching and increased flexibility have on performance could be investigated.

Appendix A

DANCE EXERCISE PROGRAM

The dance exercise program used for this thesis was initially developed by Michelle Cole, instructor of dance at Ithaca College. Developed in 1979, the class derives its content from various dance techniques, including ballet, modern, and jazz, and from yoga. By combining the physiological knowledge revealed by the review of literature and an appreciation and knowledge of dance theory this investigator adapted the program specifically to meet the needs of the lacrosse players.

This appendix describes most of the exercise class which met twice a week for 7 weeks. Repetitions varied according to need, as perceived by the instructor. These variations were contingent on the perceived ability and level of fitness of the subjects, a desire for variety, and a need to vary emphasis.

One of the distinguishing features of this dance exercise program that is usually not included in physical education instruction is the emphasis on certain concepts derived from dance technique that give attention to the subtleties, specifics, and quality of movement that go beyond simple execution. The simple execution of the exercises does not guarantee that the maximum benefits (which include flexibility) have been achieved. Prior to any movement occurring in class these basic concepts that are necessary to correctly execute the exercises effectively and efficiently were explained. The following concepts and terms are intrinsic to the dance exercise program in general and to various specific exercises in particular. This basic information should be assimilated and applied to the exercises that will be explained in this appendix.

General Instructions and Concepts

Some of the concepts and instructions may seem limiting and quite disciplined, however understanding and following these guidelines will lead to freer movement, help maintain muscle balance, and prevent injury due to improper body positioning.

Position Knee Over Toe: It is particularly important to maintain this alignment during bending motions (plié, lunge) in order to prevent torquing of the knee.

Head Release: When the body hangs forward the neck muscles must be in a relaxed state in order to allow the head to hang freely. The head release utilizes the effect of gravity and allows for correct alignment.

Weight Forward: This is particularly important when the torso is in flat back position or hanging forward. Weight should be on balls of the feet, not on the heels; this facilitates greater stretch and aids balance.

Hips Squared: Both hips should be on an even plane in order to maximize efficiency of movement.

Small of Back Pressed to Floor: During many of the floor exercises it is necessary to press the small of the back toward the floor in order to prevent strain on the lower back and to strenghthen the stomach muscles.

Unlocked Knees: Legs should be straightened only to a point where they are not locked or hyperextended.

<u>No Bouncing</u>: All stretching movements should be steady and gradual to insure safe execution and to derive kinesthetic awareness from the movement.

<u>Breathing</u>: It is important not to hold the breath, for in many of the exercises a simple rhythmic breathing pattern should be maintained. On certain exercises a deliberate pattern of when to inhale and exhale is specified for greater efficiency. Proper breathing from the abdomen will promote relaxation of tense areas.

<u>Remain Relaxed</u>: During stretching movements effort must be made not to tense the muscles being stretched.

<u>Support Lower Back With Hands</u>: On many of the floor movements it may be necessary for some individuals to support the lower back with the hands.

<u>Working Entire Body</u>: Although an exercise is being executed for a specific target area, it is important to maintain alignment and energy level throughout the entire body.

<u>Momentum</u>: This is particularly pertinent to release and swing type movements. This action allows the body to experience fluidity of movement, momentum, and the effects of gravity.

<u>Visual Imagery</u>: This refers to the use of specific words or images to evoke a desired action or movement. For example, when rolling up from a hanging position a visualization of the spine as a snake facilitates a fluid motion upward.

Use of Space: When executing a movement it is necessary to be aware of the relationship of the body in and through space. By realizing the resistance of air against the body spatial awareness is increased.

Alignment: This refers to maintaining the general principles of correct body positioning and posture throughout any movement.

Kinesthetic Awareness: This refers to an awareness of the degree of muscle tension in the body during the execution of movement.

Definitions

The following are definitions of terms frequently used in the description of a dance exercise.

First Position Parallel: Feet together, toes pointing forward.

First Position Turned Out: Heels together, toes pointing (usually) on a diagonal. The degree of turnout is initiated and determined by the degree of outward rotation from the hip socket.

Second Position Parallel: Feet shoulder width apart (sometimes wider), toes pointed forward.

Second Position Turned Out: Feet shoulder width apart (sometimes wider), toes pointing (usually) on a diagonal. See detail under first position turned out.

Arms, Second Position: Arms extended outward from the shoulder, slightly forward and slightly below shoulder level.

Plié: Bend knees without raising heels. Knees must be aligned directly over toes. Posture and alignment of torso must be maintained.

Roll Down: Head drops forward, the weight of which initiates a movement beginning at the top of the spine and gradually continues down the back through the base of the spine, pulling the torso forward toward the floor. Arms and shoulders hang in a relaxed position; weight is forward over balls of feet. Head remains released and hanging.

Roll Up: Reverse above process.

Relevé: Body is lifted to balls of the feet.

Flat Back: Body bends forward from the hip joints, keeping back straight. Head remains in line with spine.

EXERCISES

The following exercises constitute the majority of those performed during the 45-minute class sessions. Variations of many of the exercises exist. Repetitions of each exercise increase as the weeks progress and the ability of the students to execute the exercises improves.

I. Standing

A. Warm-up and general body exercises

1. Jog Warm-Up: An easy jog around the room is performed, moving forward and backward. Students are directed to jog at increased and decreased tempos, to change direction, and to vary intensity. While jogging arm circles are sometimes added. Skipping, sliding, galloping, and various other additions are sometimes initiated.

2. <u>Reach Up</u>: Standing, feet parallel, hips squared front, reach up with the right arm and then the left. Keep alternating. The reach should initiate from the side of the body (the waist). Shoulders should remain pressed down. As the right arm is straight and reaching, the left elbow may relax and vice versa.
3. <u>Reach Up With Plié</u>: The above is repeated but as the right arm (and right side of body) reaches up the right knee bends slightly. Alternate.
4. <u>4-Part Plié With Breath</u>: Taking a second position turned out, inhale as both arms reach up. Then exhale and plié as arms slowly lower. At the lowest point of plié allow back, neck, and head to hang over between legs, and hands lower toward the floor. Keeping the body low, allow legs to straighten and inhale. Exhale and roll up at the same time.
5. <u>Twist</u>: Legs and arms in second position, rotate upper torso to the right and allow the left heel to come off the floor (head follows same direction as movement). Reverse and continue to repeat the movement in a continuous, fluid manner.
6. <u>Side Stretch:</u> Begin in second position. Body remaining parallel to the front of the room, reach the left arm over head toward the right wall, being sure to lengthen from the waist through the finger tips. At the same time right arm also reaches toward the right wall. Return to center

and reverse, reaching the right arm over toward the left wall. Alternate.

7. <u>Side Stretch/Release Around</u>: The same beginning position as above, reach left arm over head toward right wall. At the same time right arm also reaches. From the furthest point of the side stretch, continue lengthening as the body turns to face the floor over the right leg. At the same time, release weight and allow momentum to sweep body from right to left and up bringing right arm overhead and finishing in second position. Reverse to the other side. Knees may bend during the release. Exhale during the release.

8. <u>Twist to Flat Back, Release</u>: Arms and legs are in second position. Turn upper torso to the right side, bend to a flat back, drop arms, and release (chest to right knee). Return to flat back as arms extend forward. Lift upper body, and return arms to second position. Reverse to left side.

9. <u>Lunge Variation</u>: From second position lunge to the right (knee remains over toe). Keeping weight over right leg, turn body to the left, and relax torso over left leg. Recover and reverse.

10. <u>Lunges</u>: From second position, keeping hips centered, lunge right. In a fluid, continuous motion, lunge left. Repeat side to side.

-As lunges continue, turn upper torso to right on right lunge, at the same time both arms swing to right reaching high in front of body. Arms then swing down and up to the left as lunge reverses to left. Repeat from side to side.

-Assume a flat back position, with arms in second position. Continue lunges.

-Continue to lunge. Reach right elbow to left knee on left lunge. Reverse.

-Continue to lunge. Place palms or fingertips on floor.

-To complete lunge series, center weight, straighten legs, allow body to hang forward. Roll up.

11. Hang Over: Standing, feet in second position, roll down, keeping head released and just hanging. Hold this position. Return to starting position. Repeat same action facing to the left, and then to the right leg.

12. Leg Swings: Start with feet in first position, arms in second. Point the right foot to the right diagonal, keeping weight on the left. Swing right leg across front of body with knee lifted up, release, and allow leg to swing to right diagonal with knee lifted up. Repeat across and up to side. To reverse, drop working leg in second position, plié, transfer weight to right leg, and begin left.

13. Parallel Relevés: In first position parallel, relevé and then slowly lower heels to the floor. Repeat.

14. <u>Forward Stretch</u>: Right leg is forward, knee is bent (similar to lunge position except weight is centered), back leg is extended straight with heel reaching toward floor. Hold. Shift weight toward back leg as front leg straightens and back foot goes flat to the floor. Lift toes off the floor (front foot), relax, and release chest toward front knee. On last repetition allow toes to release to floor and maintain chest to knee position. Reverse.

15. <u>Inner Thigh Stretch</u>: Second position turned out, plié, flat back position, place elbows just above inner knees and gently press outward. Shift weight from side to side.

B. Arms (As arm exercises are executed, jog slowly in place, touching heel to floor on each step.)

1. <u>Arm Circles</u>: Arms are in second position with palms up. Circle arms forward from shoulder. Circle arms backward from shoulder. Repeat with palms facing the floor.

2. <u>Wrist Circles</u>: Arms are in second position. Circle wrists forward and backward.

3. <u>Finger Extension</u>: Arms are in second position. Extend fingers out. Pull fingers in to fist. Repeat.

4. <u>Isometric Press</u>: Arms are in second position. Form a 45° angle at elbow with palms facing head. Press toward head as if pressing against a fixed wall. Face palms outward and again press against an imagined resistance.

5. Front Scissors: Arms are in second position. Form a fist, palms down. Cross extended arms in front of body in a scissor fashion, returning each time to starting position.

6. Overhead Scissors: Arms are in second position. Form a fist, palms up. Extend arms over head in scissor fashion, returning to starting position each time.

7. Shoulder, Overhead: Arms are in second position. Form a fist, palms up. Bending at elbow, touch fist to shoulder. Return to starting position, press to overhead position, return to start, and repeat.

8. Diagonal Press: Arms in extended position slightly away from front of body, hands in fists touching left to right, palms down. Arms press open in diagonal fashion extending right arm up and out to right, left arm out and down to left simultaneously. Return to starting position and reverse.

9. Elbow Extension: Arms in second position. Allow palms to face the back of the room. Make a fist. Release head forward and lean slightly forward. Press fists toward armpit and extend to starting postion, then repeat.

10. Arm Stretch: Extend right elbow toward ceiling as fingertips reach down the spine. Grab elbow with left hand and gently press elbow so fingertips reach further down the spine. Repeat with other arm.

11. Arm Stretch #2: Clasp hands behind back, invert wrists and gently pull upward as body rolls down (bend knees).

Continue to pull palms upward toward head. Release arms (let them drop to floor). Roll up.

12. Scissors at Small of Back: Arms are extended in back of body, palms face away from body. Begin with right arm crossed over left. Extend arms away from each other to side, and return to starting position, with left palm on top. Repeat in scissor motion.

13. Elbows Back: Lift arms to shoulder level, elbows pointed toward side, fingertips meet in front of chest. Bring elbows back to open chest, return to starting position. Extend arms forward and open arms past second position to back; return to original position and repeat.

II. On Floor

A. Supine

1. Spinal Twist: On back, knees into chest, arms second position on floor, allow knees to roll to the right as head turns to the left. Keep left shoulder pressed to floor. Reverse.

2. Shin Press and Ankle Circles: On back, knees into chest, press shins up until legs are extended and toes pointed toward ceiling. Rotate ankles to the right and the reverse to the left. Flex feet and press heels down to original position. Repeat pressing up and down (ankle rotations only on first repetition).

3. V-Stretch and Scissors: On back, legs extended and perpendicular to the floor, allow legs to fall out to the

side (V position). Grasp inner thigh, knee, or ankle and gently press legs toward floor. Maintain V position and then, leading with inner legs, bring straight legs together (at 90° angle to floor) and apart in scissor fashion. Repeat with flexed feet.

4. Leg In, Swing Up: Lift upper back off the floor. Support weight on elbows. Feet flat on floor, knees bent. Bring right knee in to chest and then, keeping foot pointed, extend leg out along floor. When leg is fully extended, flex foot and swing up toward the ceiling, return to extended position, point foot, and draw it along the floor and into chest to repeat. After completing repetitions with right, reverse using left leg.

5. Leg Circles: Starting in the same position as above, extend both legs forward. Lift right leg slightly off the floor and circle the entire leg, from hip joint, clockwise. Circles start small and become progressively larger. Repeat with same leg, circling counterclockwise. Use left leg to repeat entire sequence.

6. Developé: Starting in the same position as above. Point feet and with the right foot draw a line on the left leg to the left knee (right knee should end pointed diagonally right). Extend lower leg so entire leg is straightened toward right diagonal. Flex right foot and resume original position by following a semi-circle through the

air. Repeat with left leg. Repeat using both legs simultaneously.

7. <u>3-Part Sit Up</u>: Lie with back flat on floor, arms at sides. Roll head and shoulders off the floor and return to original position. Roll head, shoulders, and upper back off floor and return to original position. Roll head, shoulders, upper back through lower back off floor to sitting position. Back is straight, as knees draw in to chest, and toes, pointed, rest on floor. Release and slowly roll to floor. Repeat.

8. <u>Alternating Sit Ups</u>: Lie on back, knees bent, ankles crossed. Clasp fingers behind head and roll up reaching elbow to opposite knee. Alternate. (Can be executed to center without alternating.)

9. <u>Alternating Leg Lifts</u>: Lie on back, bring right knee in to chest, lift left leg slightly off floor. Keeping left leg straight, extend left leg to ceiling as right leg extends straight out, a few inches off the floor. Return to original position by lowering left leg as right knee returns to chest. Repeat. Change legs to reverse.

10. <u>Bridge</u>: Lie on back, knees bent, feet flat on floor. Begin at base of spine, press into floor as pelvis slowly rises off floor. Continue to roll up through spine and reverse, rolling down to lower to original position. Repeat.

11. <u>Plough</u>: Lie on back, roll legs backward over head until feet reach toward or touch the floor. Hold. Allow knees to bend to floor toward ears, straighten, and slowly return to starting position.

B. Sitting

1. <u>Frog Sit</u>: Sit up, back straight, soles of feet together, and knees pointed out. Form an arc over legs with upper body and relax to floor.

2. <u>Forward Reach</u>: Sit up, back straight, legs extended straight forward. Form arc over legs with upper body and relax to floor.

3. <u>V-Sit</u>: Sit up, back straight, legs extended outward right to right, left to left.

   -With right leg, flex evenly foot and knee, then lengthen and extend through toes as leg straightens. Repeat with left leg. Repeat, using both legs simultaneously.

   -Face right leg, form an arc over leg with upper body. Return to center. Reverse to left. Repeat to center.

   -Flex feet, keep chest parallel to front wall, reach right arm overhead, and stretch to left. Reverse to right. With feet flexed, relax forward to center.

C. On Side:

Lie on left side of body, maintaining a straight position. Do not allow hips to release back. After completing with one leg, reverse the exercises using the other leg.

1. Turned Out Leg Lift: Turn leg out from hip (knee toward ceiling). Keeping leg extended, lift leg toward ceiling and lower. Repeat.
2. Turned In Leg Lift: Keeping foot flexed and knee facing forward, lift leg up and lower. Repeat.
3. Lower Leg Lift: Lift the top leg up, knee facing forward, and hold in stationary position while lower leg lifts up to meet the top leg and lowers. Repeat.
4. Forward Leg Lift: Top leg extends forward, perpendicular to body, with foot flexed. Raise and lower from this position. The bottom leg may bend to form a support.

D. Prone

1. Prone Single Leg Lift: Forehead to floor (or resting on back of hands), legs straight out in back, keeping both hips on floor, lift right leg up off floor and release. Repeat. Reverse using left leg.
2. Prone Double Leg Lift: Lift both legs at same time and hold. Lower to floor and repeat.
3. Upper Body Suspension: Keep lower body stationary, arms in second position. Lift upper body off floor. Exhale as body lifts; inhale as body lowers. Repeat.
4. Body Suspension: Repeat above lifting upper body and lower body off floor at same time.
5. Bent Knee Body Suspension: Bend knees, feet to buttocks, grasp ankles and pull upper body and lower body off floor. Exhale as body lifts; inhale as body lowers.

E. On All Fours

1. Leg Extension: Bring knee in to chest and then extend leg out toward back of room. Repeat. Reverse using other leg.

2. Angle Raise: Lift knee up at side at 90^{o} angle. Lower and raise in this position. Repeat. Reverse using other leg.

3. Angle Raise and Extension: Lift knee up at side at 90^{o} angle. Extend leg to side, straighten, bend, lower, and repeat. Reverse using other leg.

4. Relax: Relax, lowering buttocks to heels, palms to floor, reaching forward, forehead to floor. Hold position.

III. Cool-down

A. Floor to standing

1. Triangle: Lean forward on hands, lift buttocks toward ceiling, straighten legs, and press heels to floor. Allow right knee to bend and straighten. Reverse. Walk feet in to second position, bend knees, take left arm backward, and reach toward right wall, opening sternum to ceiling. Allow head to follow. Reverse.

2. Squat and Up: Keep feet hip width apart, squat to floor, palms on floor, and gently pulse. Then straighten legs, dropping head and chest toward knees. Repeat. Roll up on last repetition.

3. Head Rolls: Drop head forward and circle head to right. Reverse.

4. <u>Shoulder Rolls</u>: Lift shoulders up, press back, down, forward. Continue pattern with smooth transitions through positions.

5. <u>Shake Out</u>: Lift right arm above head and shake vigorously. Lift left leg and shake vigorously. Do the same with left arm and right leg. Shake arms simultaneously as body rolls down and up.

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