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Effects of Strengthening the Stabilizing Muscles of the Hip Joint on Strength Gain of the Hamstring Group

Tina M. Wilson
Western Michigan University

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EFFECTS OF STRENGTHENING THE STABILIZING MUSCLES OF THE HIP JOINT ON STRENGTH GAIN OF THE HAMSTRING GROUP

by

Tina M. Wilson

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the requirements for the
Degree of Master of Arts
Department of Health, Physical Education and Recreation

Western Michigan University
Kalamazoo, Michigan
June 1992
The problem under investigation was to determine if strengthening the abductor and adductor muscle groups of the hip would increase hamstring flexion strength. Forty females from aerobic classes were put into two groups, control and treatment, after being pretested on the Cybex II Dynamometer. The control group participated only in aerobics, while the treatment group participated in the aerobics and treatment program. The treatment consisted of four exercises working abduction and adduction of the thigh with SPRI's Xercise Band.

After six weeks all subjects were posttested on the Cybex II Dynamometer. Both groups had significant increases in hamstring strength. These results reflect that the treatment performed did not significantly contribute to an increase in hamstring strength. Various thigh movements performed in aerobics were probably responsible for the observed strength gains.
ACKNOWLEDGMENTS

There are some important people I would like to thank for helping me get where I am today. First, I would like to thank my mother and father, Gwen and Doug Wilson. My father’s persistent push to better myself and my mother’s ever supporting encouragement enabled me to go to graduate school. Teri, Mike, Tami, and Roy, my siblings, showed continuous support; thank you.

I extend my sincere appreciation for the guidance and support from my committee members, Dr. Mary Dawson, Dr. Roger Zabik, and Dr. Robert Moss, Jr. Dr. Robert Moss, Jr. was an outstanding advisor who understands the ups and downs of research and was willing to help with anything at anytime. Thank you, Dr. Moss.

Last, but certainly not least, I would like to thank the one person who helped me most. His expertise with computers and patience with me is very commendable from the rough draft to the final copy. His name is Craig Schlonsky and I am indebted to him forever. I love you, Craig.

One last time, thanks to all. Without all of you, this would not be possible. God Bless.

Tina M. Wilson
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Effects of strengthening the stabilizing muscles of the hip joint on strength gain of the hamstring group

Wilson, Tina Marie, M.A.
Western Michigan University, 1992
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CHAPTER I

INTRODUCTION

The hamstring muscle group is involved in almost every sport, as well as everyday activities. Logically thinking, increasing hamstring strength would benefit all those involved in sports and any other activity involving flexion of the knee. The hamstring group functions primarily to flex the knee and extend the hip, but also assists in stabilizing the hip joint. The abductor and adductor muscle groups of the thigh also function as hip joint stabilizers. It has been hypothesized that one way to increase functional capacity for hamstring knee flexion would be to strengthen the abductors and adductors of the thigh in order to relieve the hamstrings from some of their stabilizing function. This would then allow the hamstrings to work more efficiently in their knee flexion and hip extension functions, resulting in increased capacity in these movements.

A simple, inexpensive device that can be used to condition the hip stabilizing abductor and adductor muscle groups is rubber surgical tubing. Rubber tubing is commonplace in physical therapy environments where strength and conditioning are the objective. The effects of using rubber tubing to increase strength have yet to be
objectively determined, especially for stabilizing muscles such as the abductors and adductors of the thigh. However, according to Mostardi and Chapman (1990) the use of resistive bands resulted in strength increases ranging from 7 to 24%, depending on limb and specific movement.

Statement of the Problem

The problem under investigation was to determine if strengthening the abductor and adductor muscle groups of the thigh will have an effect on making the hamstring muscle group more efficient during knee flexion.

Purpose of the Study

The purpose of this study was to provide information concerning the effect of using rubber surgical tubing in a conditioning program for strengthening the abductor and adductor muscle groups of the thigh and to determine any effects of increasing the strength of the hamstring group. Research has been performed regarding ratios of agonist/antagonist muscle group strength to body mass. Studies have also detailed the importance of muscles acting as prime movers and stabilizers. The research on the hamstring muscle group has been primarily devoted to strength ratios as the muscle group works as a prime mover. Its importance as a hip stabilizer has been neglected. It is thought that the findings of this study
will educate those in the allied health fields regarding an often neglected role of the hamstring as a hip stabilizer and that by strengthening other hip stabilizers, the hip abductors and adductors, the hamstring group may work more effectively as a prime mover and display more strength in this mode.

Delimitations

The study was delimited to the following:
1. Participants were college age females.
2. Participants were from Western Michigan University's aerobic exercise classes.

Limitations

A limitation to this study was the investigator’s lack of control of the subjects’ activity outside of the treatment program.

Basic Assumptions

The following statements shall be assumed in this study:
1. The subjects performed the exercises correctly and with an all out effort.
2. The subjects performed the conditioning program at each designated time.
3. The subjects did not have any current injury to the muscles being tested.

Hypothesis

The anticipated result was that by strengthening the stabilizing muscles of the thigh, the abductor and adductor muscle groups, the hamstring muscle group will function in its knee flexion mode with greater strength since it would be relieved of some of its stabilizing responsibilities.

Definition of Terms

The terms that were specific to this study included:

1. Abduction: is movement away from the midsagittal plane of the body (Kendall & McCreary, 1983).

2. Adduction: is movement toward the midsagittal plane of the body (Kendall & McCreary, 1983).

3. Hip Extension: movement in posterior direction, bringing the thigh posteriorly as in leg-raising backwards (Kendall & McCreary, 1983).

4. Hip Flexion: movement in anterior direction, bringing the thigh toward the fixed pelvis as in supine alternate leg raising (Kendall & McCreary, 1983).

5. Knee Extension: movement in an anterior direction to a position of straight alignment of the thigh and leg (Kendall & McCreary, 1983).

7. Midsagittal Plane: a division of the body into right and left halves (Kendall & McCreary, 1983).

8. Stabilizing Muscles: in the thigh are the abductor muscles, the gluteus minimus and gluteus medius (Kendall & McCreary, 1983), and the adductor muscles, the adductor longus, adductor brevis, adductor magnus, pectineus, gracilis, and iliopsoas (Kendall & McCreary, 1983).

9. Strain: stretch, tear, or rip in the muscle or adjacent tissue (Arnheim, 1989).
CHAPTER II

REVIEW OF LITERATURE

The review of literature pertinent to this study is divided into five main areas: (1) movement and muscle function, (2) mechanism of hamstring strains, (3) conditioning programs, (4) strength increases, and (5) Cybex II Dynamometer.

Movement and Muscle Function

The main movements of concern in this study were abduction and adduction of the thigh and flexion of the knee. Extension of the knee and flexion of the hip were also important for explanation in the review of literature. Abduction is moving a limb laterally away from the midline of the body, and therefore away from the other limb. Hollinshead and Jenkins (1981) claimed the chief function of the abductors is to keep the pelvis approximately horizontal when all weight is put on one leg; normally, they contract enough to raise the unsupported side of the pelvis slightly above the horizontal. The main muscles involved in abduction are the gluteus minimus and gluteus medius in trained individuals (Wilson, Cappen, & Stubbs, 1978). Other abductors of the thigh include the tensor fasciae latae and sartorius, and to an even less
extent the piriformis, obturator internus, and the lower fibers of the gluteus maximus. Adduction is bringing the limb toward the midline of the body in the frontal plane (Hollinshead & Jenkins, 1981). An example of this movement would be the return phase of the arms and legs in jumping jacks. The adductors of the thigh include the adductor longus, adductor brevis, adductor magnus, pectineus, and gracilis with some help from the iliopsoas.

Knee flexion is movement of the leg in a posterior direction, approximating the posterior surfaces of the leg and thigh (Kendall & McCreary, 1983). The muscles involved in this movement, according to Hollinshead and Jenkins (1981), are the semimembranosus, semitendinosus, biceps femoris, gracilis and sartorius. Members of the hamstring group are the semimembranosus, semitendinosus, and biceps femoris. The hamstring group assists the gluteus maximus in hip extension with the help of the gemelli, obturator internus and adductor magnus.

The muscles involved in knee extension are the rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius; making up the quadricep muscles. Hip flexion movements are the responsibility of the iliopsoas, tensor fasciae latae, rectus femoris, sartorius, and adductors.

Prime Movers and Stabilizers

A prime mover is a muscle in which the primary
function is the production of a desired movement (Crouch, 1978). Kendall and McCreary (1983) defined stabilization as holding steady or holding down. Prime movers and stabilizers are very significant to this study. The abductor muscle group of the hip can be related to the rotator cuff of the shoulder as an example of how the prime movers and stabilizers work. The shoulder can be unstable due to the free movement, shallowness of the glenoid cavity and the laxity of the joint's articular capsule. The strength of the shoulder joint results mainly from the muscles which surround it. The rotator cuff muscles comprise those muscles and consist of supraspinatus, infraspinatus, teres minor, and subscapularis. The rotator cuff is responsible for stabilizing the shoulder while the prime mover raises arm (Soderberg, 1986). The prime mover in this instance is the deltoid muscle which abducts the arm. The abductors of the hip are responsible for stabilizing the pelvis during the swing phase of walking. This stabilization allows the hamstrings to flex during the pre and mid swing and the quadriceps to extend during terminal swing. Without the abductors stabilizing the pelvis when walking the pelvis would drop on the swing leg side which would interfere with the normal mechanics of the swing (Soderberg, 1986).
Mechanism of Hamstring Strains

Muscular strength imbalances of agonistic and antagonistic muscles and inflexibility are precipitating factors of hamstring strains according Arnheim (1989). The ratio of flexors to extensors should be 2:3 or .67%. Most muscle strains in soccer occur in the thigh muscles, particularly the biceps femoris and the quadricep muscles (Schneider et al., 1985). If these muscles are not properly conditioned or strong enough they may be prime targets for muscle strains.

Nielsen and Yde (1989) considered strains to be acute, overuse injuries. Acute and overuse pertains to continuous, excessive stretching of an area which produces an injury. The study by Nielsen and Yde (1989) on soccer injuries found that muscle tightness was the main cause for strains and that poor flexibility explained the high incident of reinjury among players with strains. Poor flexibility as a causative factor in hamstring strains was substantiated by Laird’s study (1981).

Conditioning Programs

According to Arnheim (1989), conditioning or training is defined as a systematic process of repetitive, progressive exercise or work involving the learning process and acclimatization. Three areas of importance in a conditioning program include flexibility, strength, and
endurance. Arnheim (1989) defines the three as follows:

Flexibility is the range of movement of a joint influenced by associated bones and bony structures and the physiological characteristics of the muscles, tendons, ligaments, and other tissues surrounding the joint (p. 71),

Strength is the capacity to exert force or the ability to do work against resistance (p. 77), and

Endurance is the ability of the body to perform prolonged activity (p. 90).

Athletes who are properly conditioned in these three areas have less of a chance for injury.

Warm-up is important to a conditioning program for it warms and prepares the body for the workout or conditioning. Warm-up usually consists of walking, jogging, or riding bike long enough to produce a slight sweat, usually three to five minutes. It also enhances flexibility by allowing the collagen in the muscle to be stretched more easily. Stretching helps to increase flexibility. Wikstorsson-Moller, Oberg, Ekstrand, and Gillquist (1983) studied warm-up, massage, and stretching; stretching was found to be superior to the other methods for increasing flexibility in the lower extremities. Therefore, if people stretched more they would improve their flexibility and decrease the probability of a hamstring strain.

Strengthening through conditioning the muscles will also help decrease the possibility of a hamstring strain. It is important to strengthen the muscle groups used in a
specific sport to help prevent injury to that area. Strength can be defined as the capacity to overcome a defined resistance or to counteract it by muscular tension (Krejci & Koch, 1979). Sports Performance Rehabilitation Institute (SPRI) in Wheeling Illinois, Xercise Bands can provide this resistance that the muscles must overcome. The Bands are a safe alternative to weights, because of the property of rubber, and provide a total conditioning program that accomplishes three main objectives: (1) injury prevention, (2) strength training, and (3) performance enhancement (Norman, 1990). They can be used for all movements, but were used for abduction and adduction exercises of the thigh in Norman’s study. SPRI has used this program for four and a half years and has seen success in rehabilitation and conditioning with strength gain displaying the most improvement (Norman, 1990). Strength gain allows injured athletes to return to competition quicker.

Strength Increases

This study took place over a six week period. It is important that there is enough time in the treatment program to actually increase strength. A study on eccentric and concentric training over a six week period found a strength increase in the eccentric training mode (Duncan, Chandler, Cavanaugh, Johnson, & Buehler, 1989).
Another study on concentric versus eccentric isokinetic strengthening over a six week period had significant strength gains in both the concentric as well as the eccentric modes (Ellenbecker, Davies, & Rowinski, 1988). These two studies provide evidence that a six week period was enough time to increase strength through a treatment program.

Cybex II Dynamometer

Cybex II Isokinetic Dynamometer measurements are useful in determining muscle strength (Burnett, Betts, & King, 1990). The reliability for peak torque on the Cybex II Dynamometer ranges from .84 and .93, while the total work reliability ranges from .90 and .95 (Perrin, 1986). Isokinetic devices, such as the Cybex II Dynamometer, have less error in testing when assessing muscles that cross relatively simple joints, like the knee (Rothstein, Lamb, & Mayhew, 1987). Perrin (1986) found a higher reliability with the knee extension/flexion test procedure than for the shoulder tests on the Cybex II Dynamometer.
CHAPTER III

EXPERIMENTAL PROCEDURES

The problem of the study was to determine if strengthening the abductor and adductor muscles of the thigh would have an effect of relieving the hamstring muscle group of some of its stabilizing function thereby allowing it to be more effective in its knee flexion mode and, resultantly, stronger. In order to achieve the objective of this study the following procedures were followed: (a) selection of subjects, (b) pilot study, (c) instrumentation, (d) treatment procedure, (e) data collection, and (f) data analysis.

Selection of Subjects

Subjects were forty females (age 18 to 20) from Western Michigan University’s aerobic exercise classes. The subjects volunteered from four different classes. Volunteers were informed about the study and signed a human consent form. See Appendix B for a copy of the consent form. Aerobics classes were run seven weeks out of the semester, so there were two seven week sessions of aerobic classes. Twenty females volunteered from two classes of the first session and twenty more volunteered from two classes of the second session. Subjects were
pretested for hamstring strength on the Cybex II Dynamometer and then paired according to hamstring strength. Each pair was randomly split, assigning one person to Group A and the other to Group B. Group A was the control group in which the subjects participated only in the aerobic class. Group B was the treatment group in which the subjects participated in the aerobic class and the treatment program. Group A was then compared to Group B using the results of the posttest hamstring strength scores at the end of the treatment time.

Pilot Study

The purpose of this pilot study was to determine placement of the SPRI Xercise Band and the exercise methodology. A study similar to the present investigation was conducted. Male and female soccer players from Mattawan (Michigan) High School were used. All subjects were pretested on the Cybex II Dynamometer. Following the pretest, subjects in Group B used the SPRI Xercise Band three times a week for eight weeks in exercises involving abduction and adduction of the thigh. Experimentation on placement of the band was done on the first day. The subjects placed it according to suggested methods of the company at first and then tried other ways to determine how to get the most appropriate resistance on the abductor and adductor muscle group of the thigh. Once placement
was determined, the subjects same slow, steady, sustained abduction with a "static" hold at the end of movement. The adduction return was the same slow, steady, sustained effort. These movements were repeated ten times for both abduction and adduction exercises on both thighs. At the end of the eight weeks the subjects were posttested on the Cybex II Dynamometer.

Placement of the band and exercise methodology was determined by the pilot study. Placement of the band was around the ankle, 1/8 inch above the malleolus. This placement gave the most resistance, helping to strengthen the area. The exercise methodology was not intense enough. It did not bring the muscles to a fatigued state; therefore, no strength gain was recorded. The exercise methodology must be more intense and involve more than one exercise for both the abductor and adductor muscle groups to be worked and strengthened. The exact muscles used in the current investigation are described in the treatment procedure of this chapter.

Instrumentation

The following testing instrument and treatment instrument were deemed most appropriate for the study, Cybex II Dynamometer and SPRI Xercise Band.
Cybex II Dynamometer

The Cybex II Dynamometer, Cybex Division of Lumex Inc., Ronkonkoma, New York, was used to obtain hamstring strength scores. The machine was calibrated every three months. It was used to measure hamstring strength before and after the treatment program. Both the control and treatment group were tested. The groups performed two peak torque tests with four repetitions at 60 degrees per second, and one work test with five repetitions at 240 degrees per second. Peak torque represented strength in this study. According to Perrin (1986), the reliability for peak torque on the Cybex II Dynamometer ranged from .84 and .93 and the total work reliability ranges between .90 and .95.

SPRI Xercise Band

SPRI's Xercise Band was used in the treatment program. The company's suggested band size for the lower body was used. It was the 5/8 inch Band. The bands are specifically designed to provide resistance throughout a full range of motion. In this study they were used on the abductors and adductors of the thigh. The bands were used in a "controlled" manner as described in the pilot study, throughout the four types of exercises. The normal longevity of the bands depends on the strength of the subject and how often it is used. For this study the estimated
longevity was 3 to 6 months, but if defects or tears were discovered the band was replaced.

Treatment Procedure

The subjects participating in the treatment program used SPRI Xercise Bands to strengthen the abductor and adductor muscle groups of the thigh in addition to participating in their aerobic class. The control group participated only in their aerobic class. Treatment lasted six weeks and the subjects performed four different exercises for both abduction and adduction on both the right and left thigh three times a week. The exercises were selected after the results of the pilot study and a discussion with Jeff Willson (May, 1991). It was decided that the exercises should work the muscle almost to fatigue in order to gain any benefits from the exercises.

The subjects' starting position was standing with the body in standard anatomical position. For the abduction exercise the band was placed around both of the subject's ankles and then keeping the knee straight, the subject slowly abducted her leg. For the adduction exercise the band was placed around the ankle, with the other end held by a partner or stationary object. The subject sat with both legs straight out and apart. The subject slowly adducted her leg toward center of body.

There were four specific exercises performed in both
abduction and adduction. All four of the exercises had fifteen repetitions. The exercises were as follows:

1. The first exercise movement was slow and steady to the end range with the return to the starting position also slow and steady.

2. The second exercise movement was quick to the end range and then slow and steady back to the starting position.

3. The third exercise movement was slow and steady to the end range and held for five seconds before returning slowly to the starting position.

4. The fourth exercise movement was slow and steady to the end range with five short kicks at the end range before returning slowly back to the starting position.

The subjects stretched and then performed these exercises before aerobics class. The investigator was always present during treatment time to encourage and regulate movement. All the subjects participated in the entire six weeks.

Data Collection

Data collection occurred before and after the six weeks of treatment. Subjects were given a consent form (see Appendix B) to read and sign when they first entered the clinic. The testing procedure was read to them as a group and then again when they were being tested.
Subjects were given seven minutes to warm-up before being tested. The test consisted of two peak torque tests with four repetitions at 60 degrees per second, and one work test with five repetitions at 240 degrees per second. The first and last repetitions of the work test were compared to determine if the muscle was as strong at the end of the test as it was at the beginning. Both the control group and the treatment group were tested.

At the end of the treatment phase all the subjects, both control group and treatment group, were posttested. The procedure used for the pretest was also used for the posttest, except for signing the consent form.

Data Analysis

The design of this study contained two paired groups, one control group and one treatment group. Subjects were of Western Michigan University's aerobic classes. Both groups were pretested and posttested. The treatment group went through a six week strengthening program using SPRI Xercise Bands and the control group did not. The posttest was used to determine if there was any improvement in hamstring torque/strength in the treatment group compared to the control group. A Split Plot Factoral Analysis of Variance (ANOVA) was used to test the research hypothesis.
CHAPTER IV

RESULTS AND DISCUSSION

This chapter summarizes and discusses the results obtained in the present study. All forty female participants were pre- and posttested for hamstring flexion strength on both right and left legs. The subjects' age ranged from 18 to 26 with the average age being 19. Appendix C shows the raw data of the control group and treatment group. All the participants were in aerobic exercise classes taught by the same instructor at Western Michigan University. A Split Plot Factorial ANOVA with fixed effects was utilized. There were two independent variables: time and treatment.

Results

Descriptive Data

Table 1 shows the means and standard deviations of hamstring strength scores in ft-lb. The mean pretest strength scores for the control group were 50.75 and 51.20 ft-lb for the left and right leg, respectively. The mean posttest scores were 54.35 and 55.05 ft-lb for the left and right leg, respectively. Standard deviations for the control group's pre- and posttest of the left and right leg were consistent at 7.11 ft-lb +/- 0.79.
The mean pretest strength scores for the control group were 50.05 and 49.80 ft-lb for the left and right leg, respectively. Standard deviations for the treatment group's pre- and posttest of the left and right leg were consistent at 8.72 ft-lb +/- 0.70.

It should be noted that the treatment group displayed more variability than the control group. This is reflected by a larger mean standard deviation of 8.72 ft-lb for the treatment group compared to 7.11 ft-lb for the control group.

Table 1
Means and Standard Deviations of Hamstring Strength Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left Mean (SD)</td>
<td>Right Mean (SD)</td>
</tr>
<tr>
<td>Control</td>
<td>50.75 (6.81)</td>
<td>51.20 (7.04)</td>
</tr>
<tr>
<td>n=20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>50.05 (9.25)</td>
<td>49.80 (9.13)</td>
</tr>
<tr>
<td>n=20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: units of measure in ft-lb

ANOVA

An ANOVA (see Table 2) was calculated to determine differences in the mean hamstring strength values. The following results were identified from the ANOVA:

1. The marginal mean hamstring strength score for
the control group was 53.84 ft-lb and the marginal mean score for the treatment group was 51.82 ft-lb. The analysis of variance, $F = 0.20$, did not indicate a significant difference, $F(1,38)=4.17, \ p<.05$.

2. The marginal mean hamstring strength pretest score was 50.45 ft-lb and the marginal mean posttest was 54.21 ft-lb. The analysis of variance, $F = 19.17$, indicated a significant increase over time, $F(1,38)=4.17, \ p<.05$.

3. No significant difference in hamstring strength gain, $F=0.0$, was found for the interaction of time x group, $F(1,38)=4.17, \ p<.05$.

4. The marginal mean hamstring strength score for the left leg was 52.06 ft-lb and the mean marginal score for the right leg was 52.60 ft-lb. The analysis of variance, $F = 0.29$, did not indicate a significant difference, $F(1,38)=4.17, \ p<.05$.

5. No significant difference in hamstring strength gain, $F=0.84$, was found for the interaction of time x leg, $F(1,38)=4.17, \ p<.05$.

6. No significant difference in hamstring strength gain, $F = 0.43$, was found for the interaction of time x leg x group $F(1,38)=4.17, \ p<.05$. 

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Table 2
ANOVA Summary Table for Hamstring Flexion Strength Across Groups

<table>
<thead>
<tr>
<th>Source</th>
<th>S.S.</th>
<th>df</th>
<th>M.S.</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between Subjects</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Group (A)</td>
<td>41.01</td>
<td>1</td>
<td>41.01</td>
<td>.20</td>
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<tr>
<td>Error</td>
<td>7640.19</td>
<td>38</td>
<td>201.06</td>
<td></td>
</tr>
<tr>
<td><strong>Within Subjects</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time (T)</td>
<td>566.26</td>
<td>1</td>
<td>566.26</td>
<td>19.17*</td>
</tr>
<tr>
<td>T x A</td>
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<td>0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>Error</td>
<td>1122.44</td>
<td>38</td>
<td>29.54</td>
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<tr>
<td>Leg (L)</td>
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<tr>
<td>T x L</td>
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*p<.05

Discussion

The assumption was that a strengthening program for the abductor and adductor muscle group would relieve the hamstring group of its hip stabilizing responsibilities and allow the hamstring group to function in its knee flexion mode with greater strength. There is currently no research in the available literature regarding this
topic. Others have emphasized the importance of strengthening the shoulder stabilizers, the rotator cuff musculature, in order to allow the prime mover of the shoulder, the deltoid, perform more effectively (Dvir, 1978; Saha, 1971; Soderberg, 1986). The research performed in this study assumed that a similar relationship exists at the hip. That is, strengthening the hip stabilizers will allow the hip prime movers to perform more effectively.

Marginal mean scores from Table 1 indicated that the hamstring strength scores increased significantly by an average of 3.76 ft-lb. This was expected. However, there was not a significant difference in strength gain between the control and treatment groups, 3.73 and 3.80 ft-lb, respectively. This result could be due to the types of exercises performed in the aerobics classes. Many exercises emphasize hip abduction and adduction. A few of these are named fire hydrants, cross-overs, side kicks, and leg lifts. The strength gained from these exercises may have masked the strength gain from the treatment. Also, other exercises may have directly strengthened the hamstring group. Another factor that influenced the results was the larger standard deviation of hamstring strength scores observed in the treatment group. This would decrease the chances of finding significant differences in the hamstring strength data.
CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study was undertaken to determine if the hamstring muscle group would function in its knee flexion mode with greater strength if the stabilizing muscles of the thigh, abductor and adductor muscle groups, were strengthened. The assumption was that the abductor and adductor muscles would relieve the hamstring of its stabilizing responsibilities.

Forty college age females volunteered from three of Western Michigan University's aerobic classes. Initially, 49 subjects participated in the study; however, nine subjects had to withdraw due to class change or too many missed classes. The subjects were paired according to right and left hamstring strength. The pairs were then randomly split, assigning one subject to Group A, the control group, and one subject to Group B, the treatment group. Each group had 20 subjects.

The control group participated in only the aerobics, while the treatment group participated in aerobics and a treatment program. The treatment program included abduction and adduction exercises using SFRI's Xercise Band on
both the right and left leg. There were four specific exercises performed as described in Chapter III.

Pretesting of hamstring flexion strength on the Cybex II Dynamometer took place the week prior to the beginning of the training phase. Testing took place for five consecutive days at the subject's convenience. Results were used to pair the individuals and then divide them into treatment and control groups.

Posttesting took place the week immediately following the training period. Posttesting used the same procedures as in the pretesting.

An Analysis of Variance, Split Plot Factorial statistical design was used. The independent variables for this design included time and treatment.

Findings

An alpha level of .05 was used to determine significance in this study. The ANOVA indicated the following:

1. There was a significant increase in hamstring flexion strength across both groups after six weeks.

2. The treatment did not have a significant effect on hamstring flexion strength.

Conclusions

It was the belief of this researcher that the type of treatment applied in this study was of sufficient
intensity and duration to create an increase in hamstring flexion strength. This belief was not substantiated since there was no significant difference of hamstring flexion strength in the treatment group compared to the control group. There was a significant strength gain across both groups which shows that the activities performed in the aerobics class probably led to the increased hamstring flexion strength. This could be due to all the hip movements being performed in the frontal plane in aerobics. These movements could help strengthen the abductor and adductor muscle groups. As previously discussed, strengthening the abductor and adductor muscle groups may alleviate the hamstring group from its stabilizing function and allow an increase in the flexion function. Also, the aerobic class may have incorporated exercises which directly affected hamstring strength in a positive manner, resulting in strength gains in both groups.

Initially, the majority of the subjects were hesitant about performing the activities. After trying them once they were excited. Subjects indicated they could actually feel the exercises working their muscles.

Recommendations

Several things were learned from this study. It appears that certain activities performed in this
particular Michigan university's aerobic class had a significant effect on increasing hamstring flexion strength, masking any effects from the treatment. The control and treatment groups both showed a significant increase in hamstring flexion strength over the six week period.

Future studies in this area need to address some of the following:

1. Determine what movements are involved in aerobic classes and how they could relate to strengthening the stabilizing muscles of the hip.

2. Determine the actual strength gain of the abductor and adductor muscle groups.

3. Delimit the study to a group that does not use the abductor and adductor muscle groups in its workout or sport or activity, and then apply the treatment program.

4. Add two groups of females and have one do treatment alone without any other type of exercise and one do no exercise at all.

5. Employ more subjects for each group to determine a more accurate analysis of the independent variables.
Appendix A

Human Subjects Institutional Review Board Acceptance Form
Date: October 24, 1991
To: Tina Wilson
From: Mary Anne Bunda, Chair
Re: HSIRB Project Number: 91-09-07

This letter will serve as confirmation that your research protocol, "Determining effects of strengthening stabilizing muscles of thigh on increasing hamstring strength" has been approved under the exempt category of review by the HSIRB. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the approval application.

You must seek reapproval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date.

The Board wishes you success in the pursuit of your research goals.

xc: Moss

Approval Termination: October 24, 1992
Date: September 26, 1990
To: Tina M. Wilson
From: Mary Anne Bunda, Chair
Re: HSIRB Project Number: 90-09-07

We have received the changes to your protocol as requested in our September 12 letter. This letter will serve as confirmation that your research protocol, "Determining Effects of Strengthening Stabilizing Muscles of Thigh on Increasing Hamstring Strength," has been approved under the exempt category of review by the HSIRB. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the approval application.

You must seek reapproval for any changes in this design. You must also seek reapproval if the project extends beyond the termination date.

The Board wishes you success in the pursuit of your research goals.

xc: Robert Moss, HPER

Approval Termination: September 26, 1991
Appendix B

Consent Form
CONSENT FORM

You are being invited to participate in a research study. Participation is entirely voluntary and withdrawal from the study may occur at any time without penalty. It may hurt the results of the study if treatment or class is missed, but you are not required to participate in the research if you do not want to participate. Additionally, participation or lack of participation in the research will in no way affect our course grade.

The purpose of this study is to determine if strengthening the stabilizing muscles of the thigh will also strengthen the hamstring group. The study will last six weeks and requires both the treatment and control groups have their hamstring strength pre and posttested on the Cybex II Dynamometer at the Sindecuse Health Center Sports Medicine Clinic. Transportation to and from the clinic must be provided on your own. There will be health professionals available in the rare case of an emergency.

Depending on which group you are randomly placed into determines your treatment procedure. If you are in Group A, or the control group, all that is required is participation in the class. If you are in Group B, or the treatment group, you will participate in the class and in a treatment program. The treatment program consists of a ten minute exercise regimen with the use of Spri's Exercise Bands. The Bands are similar to large rubber bands. The exercises will be of four different types working on abduction and adduction of the thigh. Abduction is the movement of taking the thigh away from the midline of the body; whereas, adduction is to add or bring to the midline of the body. The exercises will be performed in abduction and adduction and consists of (a.) moving the thigh to end range slowly and return to starting position slowly, (b.) quickly take thigh to end range and return slowly, (c.) move thigh slowly to end range, hold for ten seconds and return slowly, and (d.) slowly move thigh to end range, short kick ten times and slowly return.

The subjects will maintain their confidentiality by being assigned a number and then to a group. After the data collection is completed, you may receive results of the study. You may also receive you individual scores off the Cybex determining you hamstring strength. Again, participation is voluntary. If any questions should arise, do not hesitate to call me, Tina Wilson, at 372-7819. I am there in the evenings or leave a message and I will get back to you as soon as possible.
Thank you for volunteering to participate in my research study.

Signature of Subject ___________________________ Date __________

Signature of Researcher ___________________________ Date __________
Appendix C

Raw Data for Control and Treatment Groups
## Control Group Data on Hamstring Strength

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