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# An Electromyographic Study of Trunk Muscle Activity during Exercise on the Fitness Plus Low Back Unit

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# AN ELECTROMYOGRAPHIC STUDY OF TRUNK MUSCLE ACTIVITY DURING EXERCISE ON THE FITNESS PLUS LOW BACK UNIT

by

Joel Anderson
Bachelor of Science in Physical Therapy
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An Independent Study

Submitted to the Graduate Faculty of the

Department of Physical Therapy

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for the degree of

Master of Physical Therapy

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This Independent Study, submitted by Joel W. Anderson in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Faculty Preceptor)

(Graduate School Advisor)

(Chairperson, Physical Therapy)

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| | |
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| Department | Physical Therapy |
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Signature Joel Anderson

Date 12/11/96

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Matthew 11:28-30 NIV

Dedicated to my wife, Stacy,
my inspiration and friend,
whose example and many sacrifices
allowed me to finish the race.

## ABSTRACT

**Purpose:** Fitness Plus, Inc. has developed a series of exercise machines for strengthening of the trunk musculature. Their Low Back Unit is claimed to target the rectus abdominus (RA), gluteus maximus (GM), biceps femoris (BF), and erector spinae (ES) muscles, but there is no research to solidify these claims. The purpose of this study was to describe the electromyographic (EMG) activity during the use of the Fitness Plus, Inc. Low Back Unit. **Methods:** Fifteen healthy, males (ages 20-30) volunteered to participate in this study. Surface EMG was used to assess the muscle activity in four trunk and hip muscles. The four muscles assessed were the RA, ES, BF, and GM. An electrogoniometer was used to monitor the trunk motion during the exercise. The EMG data for each muscle was analyzed using Norquest software and compared to each subject's maximal voluntary contraction (MVC) for that muscle. Descriptive statistics were used to describe the EMG activity and average percent of MVC for each muscle and under various loads. **Results:** The results showed that the GM, BF, and ES all increased activity with an increase in weight, while the RA showed no consistent pattern of activity. **Conclusions:** Although this researcher would not recommend the Fitness Plus, Inc. Low Back Unit for a patient with a prolapsed disc, it could be an effective tool for recreational GM, BF, and ES strength training or for patients where strength training is indicated.

# INTRODUCTION

## Chapter 1

Low back pain (LBP) is thought to occur in almost 80% of adults at some point in their lives. [1] The high incidence of LBP makes it one of the leading reasons to visit a physician and is considered the most common and costly musculoskeletal problem affecting the working population. There is also an increased risk of subsequent injury once an individual has experienced an episode of back pain or impairment.

To prevent or minimize the effects of LBP, several treatment programs exist, including back schools, pre-work screening, braces, and exercise programs. The role of the physical therapist in the rehabilitation of persons with LBP include the use of various modalities and exercise techniques. Traditional treatment has included traction, bed rest, TENS, drug therapy,[1] and heat modalities, [2] along with spinal manipulation and orthosis.[3] These treatments, however, have not been shown to be effective in the treatment or prevention of LBP when scientifically tested [2]. More recently, exercise programs have been shown to be effective against both chronic and acute LBP. [2,4,5] These programs mainly utilize trunk musculature strengthening to promote optimal strength ratios in the trunk, thus stabilizing the spine.

Many sources agree that developing trunk strength is important in the prevention and treatment of low back pain. [4-10] Cresswell et al, [6] state that "increased intra-

abdominal pressure (IAP) has been discussed since the mid 1950s as a mechanism for reducing forces on the spine and thereby minimizing injury". The IAP increases as a direct result of muscular strength in the abdominals, especially in the obliques. [6,7] However, if a strength program concentrates only on an agonist group without regard to the antagonist group, muscle imbalances will occur which will counteract the purpose of the program. A program termed Spinal Stabilization has been developed to enhance lumbar spine stability during active movements. [8,9] This program utilizes the abdominal musculature co-contracting with the erector spinae, latissimus dorsi, and the deep back musculature to enhance spine stability. [8]

Paul C. William's [4] stressed the importance of maintaining a proper lumbosacral angle when in a static posture. He stated, "the erector spinae and hip flexors are the most important extensors, while the anterior abdominals and the glutei maximi are the most important flexors of the lumbosacral spine." Therefore, treatment emphasis is directed at reducing lumbosacral extension, thus shifting the center of gravity forward and reducing the posterior stress on the lumbar intervertebral discs. An exercise program with this focus in mind would attempt to strengthen the glutei maximi and abdominals, thus passively stretching the erector spinae and hip flexors. [4]

Robin McKenzie [10] developed an exercise program based on the relief of symptoms in patients with low back pain. His program focuses on positions and repetitive movements that "centralize" the pain if it is radicular, or lessening pain if it is not. The treatment goal is to develop an individualized treatment regimen comprised of those movements that alleviate pain. Through this progressive strengthening and stretching process, the patient's pain will eventually be eliminated. [2]

Hans Kraus [5] developed an assessment and treatment technique based on the relative strength or flexibility of muscle groups. He stated that "if (LBP) patients are subjected to a series of tests in which muscles are examined for weakness and tightness. . .much additional information may be gained." He felt that one important role of a practitioner was to recognize muscle imbalances early and correct them before further damage is done. Through preventative trunk muscle strengthening, Kraus believed many low back injuries could be avoided.

Because trunk muscle strengthening has been shown to be an important factor in reducing LBP, it is important for physical therapists to fully understand trunk muscle anatomy. (Table 1) The biomechanics of the trunk muscles has been extensively studied. I will review only those functions which are relevant to the present study. A summary of the actions of the following trunk musculature is listed in Table 2.

**Role of the Abdominals**

The abdominal musculature (rectus abdominus, internal oblique, external oblique) has been a focus of many exercise protocols. To effectively strengthen these muscles, many different exercises have been used. Some of these include the standard sit-up, head raise, leg raise, and the use of many fitness machines designed for this purpose. With head raising, only the rectus abdominus is thought to be recruited.[11] However, during a bilateral straight leg raise, the entire abdominal musculature is maximally activated to steady the pelvis. Another study found that the curl-up, or crunch, elicited the greatest amount of rectus abdominus activity while eliciting the least

**Table 1. Origins and Insertions of Selected Muscles***

| MUSCLE | ORIGIN | INSERTION | INNERVATION |
|---|---|---|---|
| Rectus Abdominis | Pubic Symphysis, Pubic Crest | Xiphoid Process, Ribs 5-7 | Primary Rami of Lower 6 Intercostal, Ilio-hypogastric, Ilio-inguinal |
| External Oblique | External Surfaces of Ribs 4-12 | Anterior Half of Iliac Crest, Abdominal Aponeurosis | Primary Rami of T6-12, L1-2 |
| Internal Oblique | Lumbar Fascia, Anterior 2/3 of Iliac Crest, Inguinal Ligament | Ribs 9-12, Linea Alba | Primary Rami of T6-12, L1-2, Ilio-hypogastric, Ilio-inguinal |
| Erector Spinae | Sacrum, Crest of Ilium, Spines of T11-L5 | All Ribs, Transverse Process C4-6, Spinous Process C2-T8, Occiput | Posterior Rami of Respective Spinal Level |
| Gluteus Maximus | Iliac Crest, Dorsal Sacrum & Coccyx, Sacrotuberous Ligament | Lateral Tibial Condyle, Gluteal Tuberosity | Inferior Gluteal Nerve |
| Biceps Femoris | Ischial Tuberosity, Linea Aspera, Lateral Supracondylar Line | Lateral Head of Fibula | Long Head: Tibial Division of Sciatic Nerve. Short Head: Common Peroneal Division of Sciatic Nerve |

*Information taken from Moore [12].

**Table 2. Actions of Selected Muscles***

| MUSCLE | ACTION |
|---|---|
| Rectus Abdominus (RA) | Flexes trunk, compresses abdominal viscera |
| External Oblique (EO) | Compresses/supports abdominal viscera; flexes and rotates trunk to opposite side |
| Internal Oblique (IO) | Compresses/supports abdominal viscera; flexes and rotates trunk to same side |
| Erector Spinae (ES) | Bilaterally extends head and trunk, Unilaterally assists in lateral flexion of head and trunk |
| Gluteus Maximus (GM) | Extends and laterally rotates femur |
| Biceps Femoris (BF) | Flexes and laterally rotates knee, extends femur |

* Information taken from Moore[12]

amount of rectus femoris activity when compared to eleven other abdominal exercises including a traditional hook-lying position sit-up.[13]

The prime movers of trunk flexion are the rectus abdominus and the lateral fibers of the external oblique. The major stabilizers of the lumbar spine are the internal oblique and transversus abdominus.[12] During forced trunk rotation exercises, the internal obliques of the ipsilateral side are very active while external obliques are slightly active and the rectus abdominus is inactive.[11] The abdominal musculature has also been shown to be an antagonist to the extensors of the spine during both rotation and extension of the spine. [11-13]

**Role of the Erector Spinae**

The lumbar erector spinae (longissimus, iliocostalis) can be divided into four functional groups affecting the entire spine, however I will focus only on the lumbar musculature. The vector force produced by the lumbar longissimus is directed vertically, resulting in extension and compression forces on the spine. The lumbar iliocostalis have a similar role in trunk extension, however they also act as a neutralizer of forward flexion as the abdominals rotate the trunk.[12] Neither of these muscle groups appear to posteriorly translate the vertebrae.

Various studies have been conducted to show the effectiveness of different exercises on recruiting the erector spinae. Once the spine is fully flexed, the hip extensors become the prime movers for spinal extension. [7,10] This is due to lumbar spine kyphosis causing the posterior lumbar ligaments to be taut, therefore decreasing the need for erector spinae use.[7,10] With the lumbar spine in lordosis, the erector spinae are more active and decreased stress is placed on the posterior elements of the lumbar spine when

moving into extension.[7] With lateral rotation of the trunk, the action of the erector spinae is more unilateral, causing increased activity to the ipsilateral side.[7,8]

**Role of the Gluteus Maximus**

The gluteus maximus is a primary extensor of the hip, but only when heavily or moderately resisted. It is more easily recruited during trunk extension with the spine terminally flexed.[7,9] When straightening up from the toe-touch position, the gluteus maximus shows significant activity throughout the motion. [9]

**Role of the Hamstrings**

The hamstring musculature (Biceps Femoris, Semitendinosis, Semimenbranosis) act on both the hip and knee joint. However, I will focus on the actions at the hip joint. During gait, the hamstrings are recruited for hip extension and knee flexion. However, when standing with the trunk flexed and both knees extended, these muscles act to stabilize the pelvis and move the trunk into extension.[11,12]

Through my review of the literature, it is well established that the abdominals, trunk extensors, gluteals, and hamstrings are important in maintaining trunk stability. It is this stability that helps prevent LBP by maintaining trunk control during functional activities. One role of the physical therapist is to help the patient with LBP develop the proper muscle balance and strength. In order to accomplish this, an effective exercise regimen must be developed. Because of the increasing emphasis on trunk muscle exercise to treat LBP, there are numerous types of exercise equipment on the market to train trunk musculature, each claiming superior training capabilities. A small company in North Dakota, Fitness Plus, Inc., has started to market a series of exercise machines aimed at the rehabilitation of trunk musculature in patients with LBP. These machines have some

unique characteristics, which the company feels makes them applicable for clinical use. Each of the company's prototype machines were designed to target specific trunk musculature, however there is no research that solidifies these claims. Therefore, the purpose of this study is to measure and describe the muscle activity elicited during the use of the Fitness Plus Low Back Unit.

# METHODS

## Chapter 2

### Subjects

Fifteen healthy, male, subjects volunteered to participate in this study. All of the subjects were between the ages of 20 and 30 (Table 3). All subjects reported no history of back pathology that would interfere with the study, or put the subject at risk for injury. Participants were informed of the testing procedures and their rights as a participant in accordance with Institutional Review board procedures at both the University of North Dakota and Grand Forks Medical Park. Each subject signed an informed consent form prior to voluntary participation in the study (Appendix).

**Table 3. Subject Demographic Data**

| | AVERAGE | RANGE | STANDARD DEVIATION |
|---|---|---|---|
| Age (years) | 24 | 20-30 | 4.25 |
| Height (inches) | 69 | 65-76 | 2.57 |
| Weight (pounds) | 170 | 115-220 | 18.75 |

**Instrumentation**

A prototype Fitness Plus, Inc. (P.O. Box 905, Valley City, North Dakota , 58072) low back unit, model FP101, was used in the study. (Figure 1) The unit has fifteen 5 pound plates that provide resistance during the back extension motion. It is relatively light and compact, weighing only 220 pounds (including the weights) and measuring 39 inches wide by 46 inches long.

A Noraxon Telemyo8 telemetry unit ( Noraxon USA, 13430 North Scottsdale Rd., Scottsdale, AZ, 85254) was used to collect the electromyographic data. A Penny and Giles M180 electrogoniometer (Penny & Giles Inc., 2716 Ocean Park Blvd., Santa Monica, CA, 90405) was used to measure the range of motion (ROM). The Noraxon Telomyo8 receiver collected the telemetried information from the EMG electrodes and the electrogoniometer. This information was then digitized by a DT2801-Analog to digital interface board installed in a NET 486DX computer. The Myosoft and Norquest data collection software that accompanies the Telemyo8 EMG system was used to analyze the digitized EMG signals in a variety of forms. Because contraction velocity alters EMG activity,[14] an electronic metronome was used to standardize the speed of the repetitions.

**Procedure**

Electromyographic activity was monitored in four selected muscle groups unilaterally on the right: Rectus Abdominus (RA), Gluteus Maximus (GM), Biceps

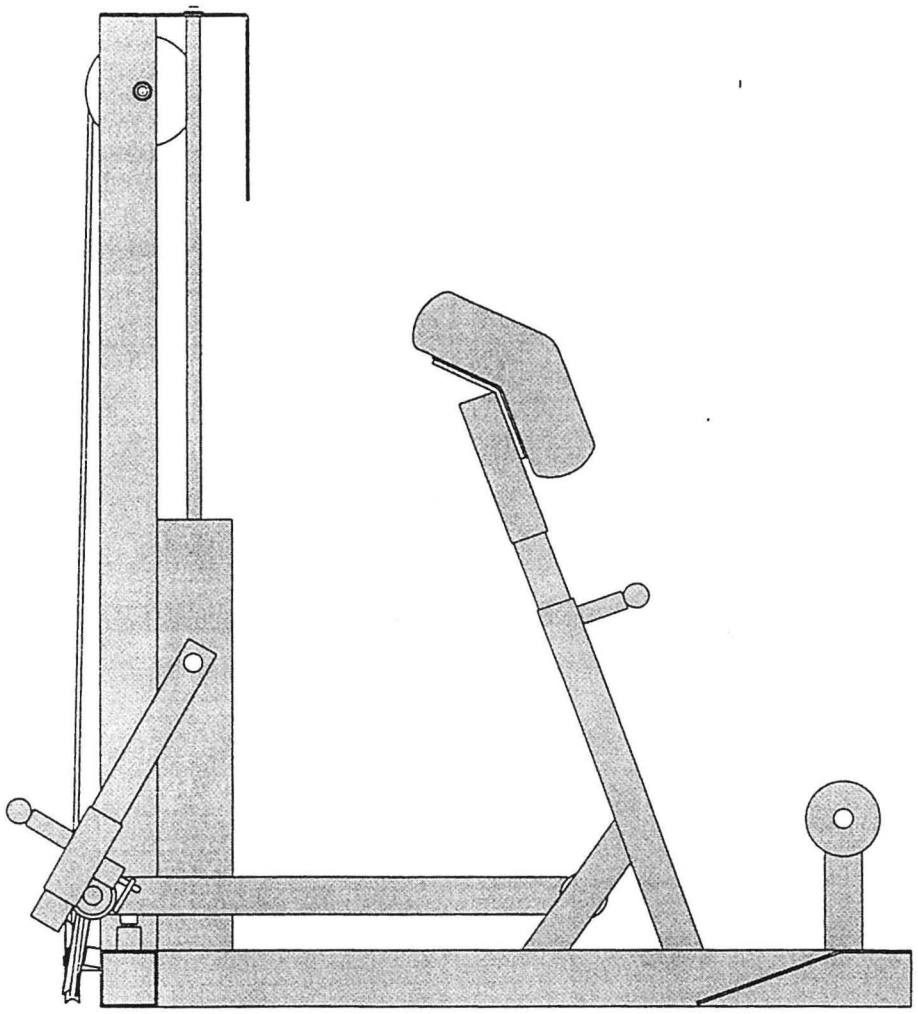


**Figure 1. Fitness Plus Low Back Unit**

Femoris (BF), and Erector Spinae (ES). These muscles were chosen as per machine manufacturer's claims of muscles trained during exercise on their machines.

Electromyographic activity was recorded via pre-gelled, silver-silver chloride, self adhesive surface electrodes (Multi Bio-Sensors, El Paso, TX 79913). Electrode placement was set according to the motor points of selected muscles, determined according to Vakos et al [7] to be the anatomical points in the muscles where the greatest amount of isolated muscle contraction was elicited. (Table 4, Figure 2)

To reduce skin impedance and ensure optimal contact with the electrodes, the skin over each electrode site was prepared with isopropyl alcohol, and shaved of hair if needed, before application of the EMG surface electrodes. Two surface electrodes were centered around one motor point of each individual muscle and placed one inch apart. The pairs of electrodes were applied parallel to the direction of the selected muscle fibers at the anatomical points suggested by Vakos et al [7] for optimal motor unit recording. A single ground electrode was placed over the proximal sacrum.

The center of the electrogoniometer was placed over the center of motion of each subject's right hip joint, using double sided adhesive tape. The distal arm of the electrogoniometer was aligned with the longitudinal axis of the femur, with the proximal arm aligned with the longitudinal axis of the trunk.

To record EMG and electrogoniometer activity, the EMG signals were transmitted from the surface electrodes and electrogoniometer to the receiver unit, and then into the computer for display. The EMG data for each subject was recorded by the computer, and stored on disk, for later analysis.

**Table 4. Electrode Placement**

| Muscle | Electrode Position |
|---|---|
| Erector Spinae | Over the muscle belly horizontally aligned with $L_3$-$L_4$ interspace, 4 centimeters lateral to midline. |
| Biceps Femoris | Over the junction of its middle and distal thirds. |
| Gluteus Maximus | On the midpoint of the line running from the inferior lateral angle of the sacrum to the greater trochanter. |
| Rectus Abdominus | Two centimeters superior and two centimeters lateral to the superior border of the navel. |

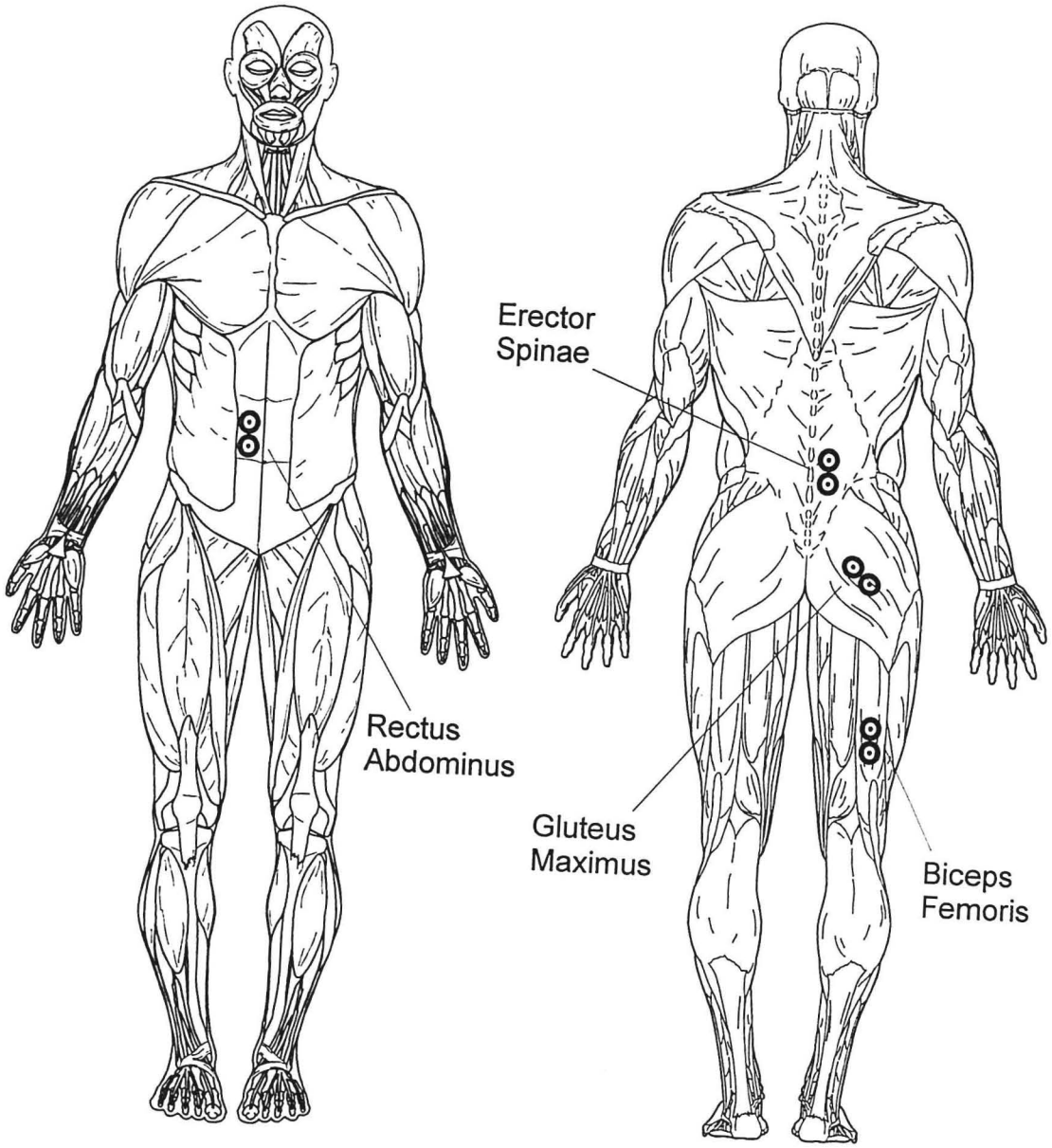



**Figure 2. Electrode Placement**

Since EMG raw data is not a representative measure of muscle contraction strength, [15] the EMG data was normalized. Maximum voluntary contractions (MVCs) were tested to provide a consistent base for normalization so that subject data could be compared. Many studies have been performed to determine the optimum position for testing MVCs, and these are some common results:

**Rectus Abdominus (RA)** - Most active with supine bilateral straight leg-raise. [11,13,17]

**External Oblique (EO)** - Most active during straining (valsalva maneuver), and supine bilateral straight leg-raise, [11,17,18] as well as lateral bending to the ipsilateral side, and trunk rotation to the contralateral side. [11,18]

**Internal Oblique (IO)** - Most active during straining [11,17] and supine bilateral straight leg-raise. [11,13,17]

**Erector Spinae (ES)** - Most active in resisted prone back extension. [7]

**Gluteus Maximus (GM)** - Most active during resisted prone lying leg extension and abduction. [7]

**Biceps Femoris (BF)** - Most active in prone position with knee flexed to 90 degrees against manual resistance against further flexion. [7]

The positions used to obtain the MVCs in this study were taken from Vakos, et al.[7] (Table 5) Each subject was told to resist the tester maximally, holding the contraction for 5 seconds. The same tester was used for all MVC testing. The MVCs were tested in the following order: ES, GM, BF, and RA.

Each subject was instructed on how to perform the exercise repetition and the timing of the trials. Each subject began the exercise in relaxed standing to obtain a baseline reading of EMG activity. The subjects then positioned themselves in the

**Table 5. MVC Positions**

| Muscle | Position Used |
|---|---|
| Erector Spinae | Subjects were positioned in prone with their hands behind their heads. Subjects were instructed to arch their backs, lifting their chests off the floor. Resistance was placed at the $T_7$ vertebral level while stabilizing the thighs. |
| Rectus Abdominus | Subjects were positioned in supine with their arms at their sides. The subjects were instructed to raise their feet six inches off the floor and hold. Resistance was placed at the level of the femoral epicondyles and over the clavicle. |
| Gluteus Maximus | Subjects were positioned in prone. Their right leg was placed into extension and abduction. The subjects were instructed to hold that position while the tester applied resistance into flexion and adduction. Resistance was placed at the malleoli of the ankle and the femoral epicondyles. |
| Biceps Femoris | Subjects were positioned in prone with their right knee flexed to 90°. The subjects were instructed to attempt to further flex their knee while the tester applied resistance at the level of the malleoli of the ankle. |

machine as recommended by the manufacturer (Figure 3) with their trunk parallel to the floor and arms extended, grasping the weight bar with their hands. Each subject was told to relax, and EMG activity was recorded with the flexed position as the starting point. Each subject performed 3 sets of 3 repetitions with 5 pounds of resistance, 25 pounds of resistance, and 50 pounds of resistance, respectively, using the manufacturer's suggested technique. (Figure 4) The final set was also performed with 50 pounds of resistance, but the subjects were asked to forcibly extend their knees during the entire movement phase of the exercise. The pace of each trial was set by a metronome at 48 bpm. The subjects were to raise for two beats, obtaining neutral flexion of the spine, hold at neutral for 2 beats, return to their starting position in 2 beats, and finally relax for 2 beats. Continuous verbal instructions for timing and position were given throughout all of the exercises.

**Data Analysis**

Descriptive statistical analysis was utilized for the electrogoniometric and EMG data during all trials. The Myosoft and Norquest software programs average the 50 highest peaks of integrated EMG activity within a time interval specified by the researcher. For the MVC data, I chose to analyze a two second time period where there was the greatest activity between the second and fourth seconds of each MVC trial. This procedure eliminated the ramp up and ramp down that occurred during the exercise. The time interval analyzed for the EMG activity during each of the four exercise sets was defined as the repetition (defined by the interval between maximal hip flexion, moving into neutral

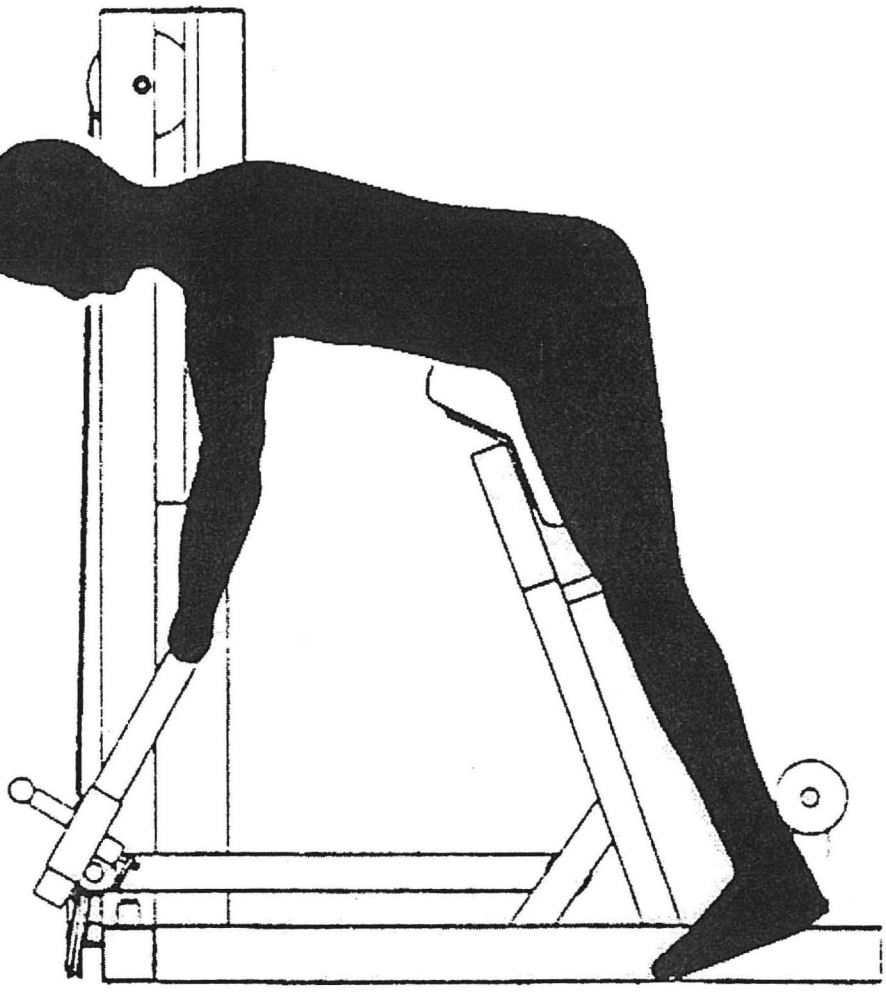
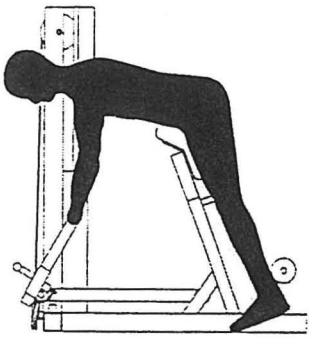
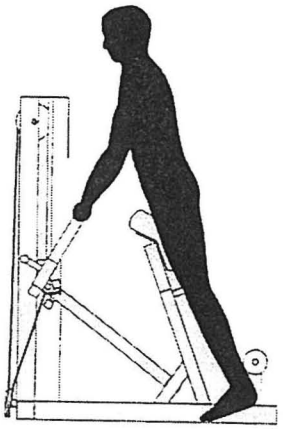


**Figure 3. Starting position of subject**

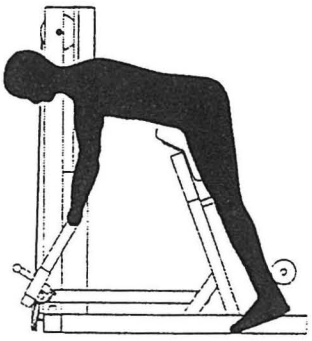
The subjects were instructed to:



Bend forward at the hips with a straight back and grasp the lift bar.



Slowly extend trunk to neutral while keeping a straight back.



Slowly return to the starting position.

**Figure 4. Technique for Lifting**

extension, and the return to maximal hip flexion of the right hip) which elicited the greatest amount of EMG activity.

To compare the data between subjects, the mean EMG activity obtained for each muscle during the exercise trials was converted to a percentage of that individual's MVC for that muscle (%MVC). I used the formula %MVC=A/MVC to normalize the data, where A is the average muscle activity during the exercise, and MVC is the average maximum voluntary contraction, both expressed in microvolts as analyzed by the Myosoft and Norquest software. Finally, an average of all the subjects normalized EMG data for each muscle during each exercise trial was calculated. These averages were used to describe the muscle activity during the use of this unit.

# RESULTS

## Chapter 3

All subjects successfully completed this study. However, a recording error occurred in one subject's electrogoniometer channel during the exercise trials. Therefore, all data gathered from that subject was eliminated from the analysis. The EMG analysis represents data averaged from the remaining fourteen subjects. Figure 5 shows the normalized EMG activity in all of the muscles and under the various loads. Figure 6 shows the integrated EMG and goniometric activity during one repetition of the 10 plates set in one subject.

### Rectus Abdominus

No consistent pattern was evident in the RA activity during these exercises. As the resistance increased, the amount of RA activity elicited by the exercise did not change accordingly. Also, actively extending the knees during the activity had no effect on the average EMG activity of the RA. Standard deviations for the RA were high compared to the elicited activity (Table 6).

### Erector Spinae

The ES showed a consistent increase in activity with an increase in resistance (Figure 5). Actively extending the knees during the exercise further increased the activity of the ES. The average %MVC activity of the ES increased from 48% to 65% with

increasing resistance, and an additional 3% with active knee extension (Table 6). Also, most of the EMG activity was elicited during the concentric phase of the exercise (Figure 6).

**Gluteus Maximus**

The GM also showed a consistent increase in activity with an increase in resistance (Figure 5). As with the ES, actively extending the knees during the exercise elicited increased activity. The average %MVC activity of the GM increased from 11% to 17% with increased resistance, and an additional 6% with active knee extension (Table 6). Again, the GM was most active during the concentric phase of the exercise (Figure 6).

**Biceps Femoris**

The BF also consistently increased its activity with increased resistance (Figure 5). However, when the subjects actively extended their knees during the exercise, the activity of the BF decreased. The average %MVC of the BF increased from 29% to 44% with increased resistance, but decreased 7% with active knee extension (Table 6). As with the ES and GM, most EMG activity for the BF was elicited during the concentric phase of the exercise (Figure 6).

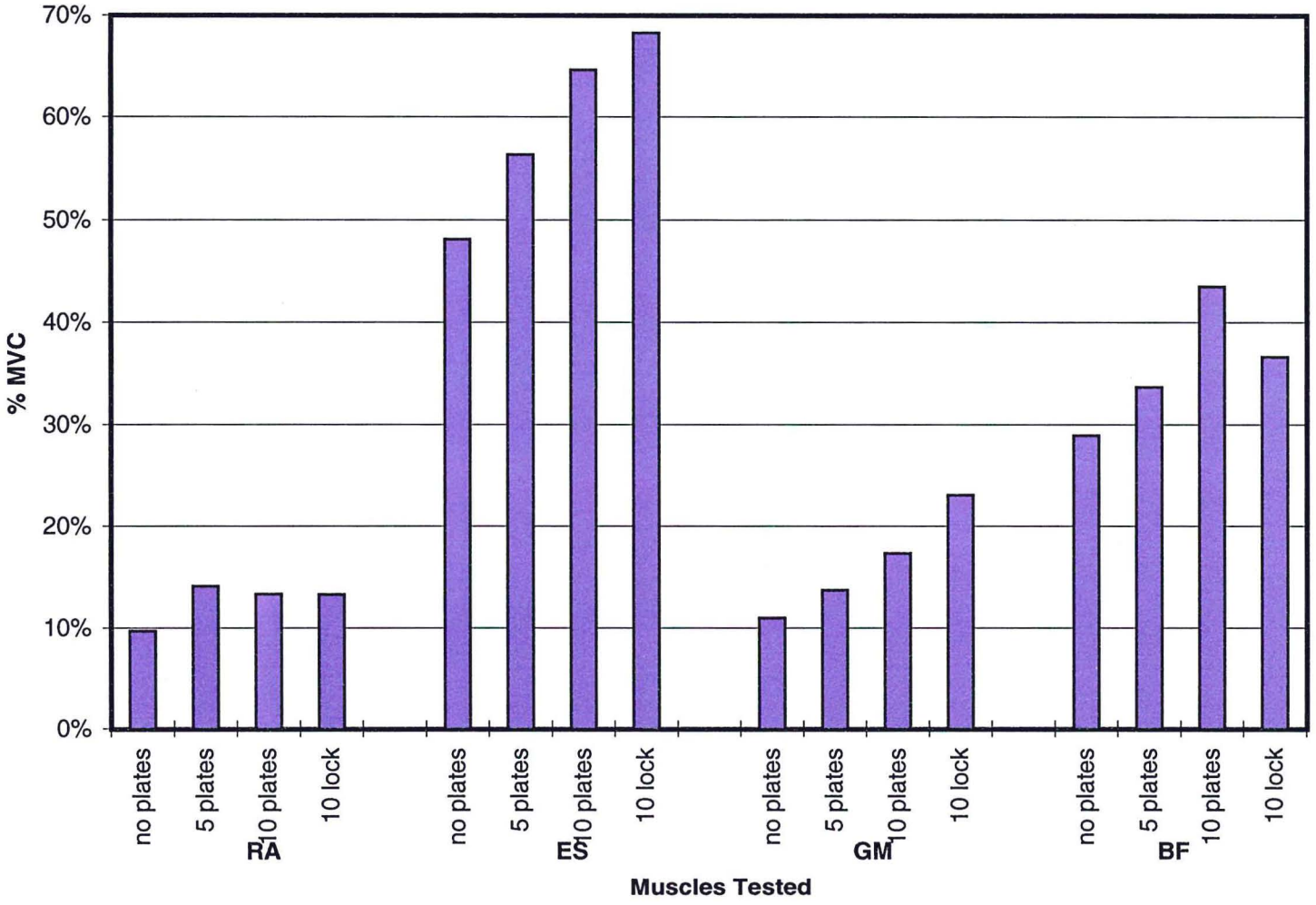



**Figure 5. Muscle Activity During the Use of Fitness Plus Low Back Unit**

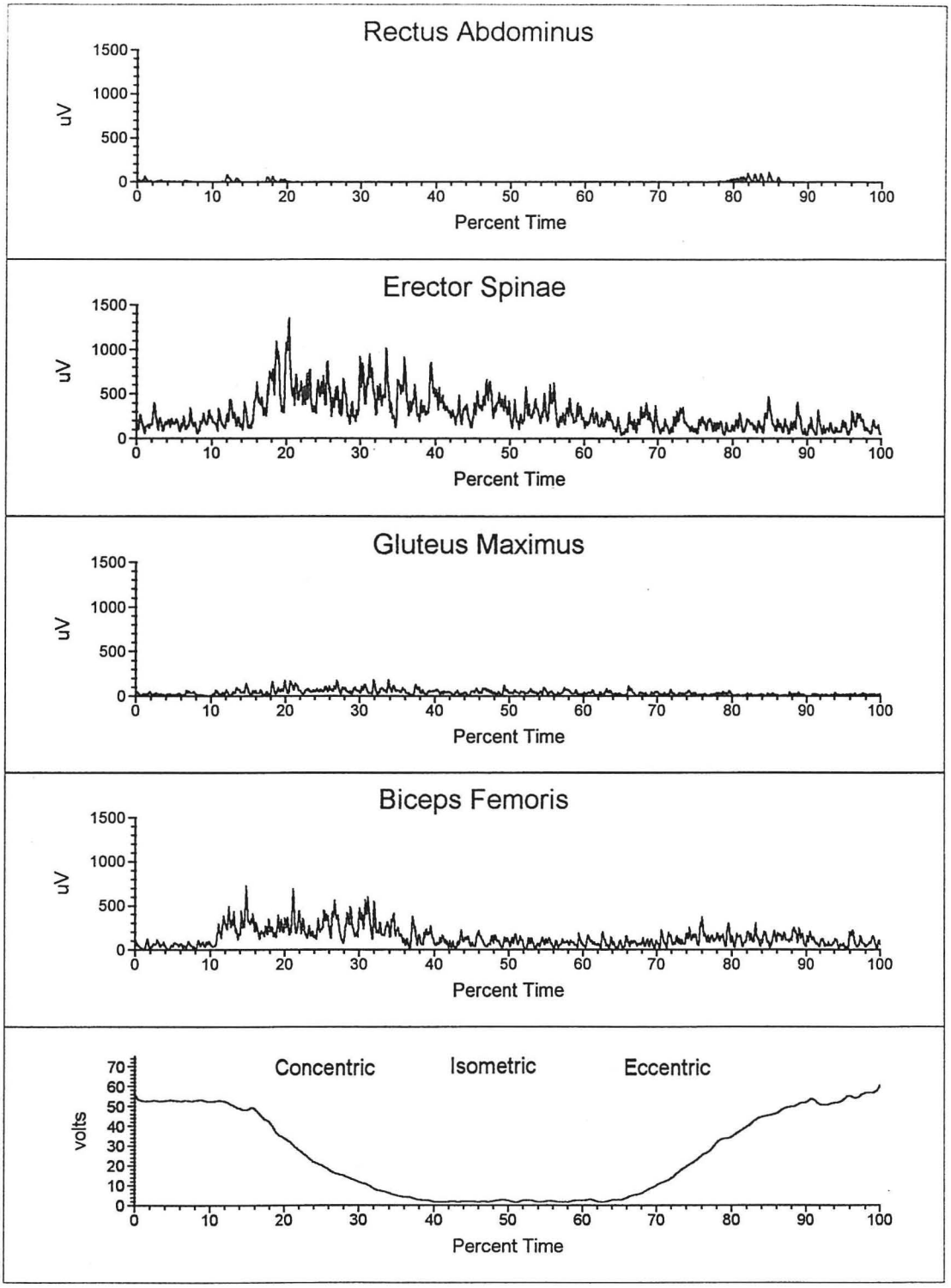



**Figure 6. Integrated EMG During One Repetition of 10 Plates**

**Table 6. Normalized EMG Data**

| No Plates | | %MVC RA | %MVC ES | %MVC GM | %MVC BF |
|---|---|---|---|---|---|
| Subject | 1 | 10% | 33% | 9% | 47% |
| | 2 | 6% | 22% | 10% | 32% |
| | 3 | 1% | 31% | 10% | 32% |
| | 4 | 1% | 72% | 7% | 25% |
| | 5 | 8% | 51% | 2% | 26% |
| | 6 | 7% | 27% | 11% | 25% |
| | 7 | 21% | 60% | 7% | 16% |
| | 8 | 8% | 70% | 3% | 22% |
| | 9 | 6% | 46% | 5% | 24% |
| | 10 | 35% | 68% | 19% | 32% |
| | 11 | 2% | 35% | 14% | 18% |
| | 12 | 16% | 46% | 22% | 33% |
| | 13 | 2% | 54% | 20% | 56% |
| | 14 | 13% | 58% | 14% | 16% |
| **Average** | | **10%** | **48%** | **11%** | **29%** |
| **Std. Dev.** | | **9%** | **16%** | **6%** | **11%** |
| **Range** | | **1% - 35%** | **22% - 72%** | **2% - 22%** | **16% - 56%** |

| 5 Plates | | %MVC RA | %MVC ES | %MVC GM | %MVC BF |
|---|---|---|---|---|---|
| Subject | 1 | 2% | 30% | 17% | 60% |
| | 2 | 5% | 20% | 15% | 39% |
| | 3 | 0% | 33% | 10% | 32% |
| | 4 | 4% | 83% | 10% | 29% |
| | 5 | 19% | 68% | 5% | 48% |
| | 6 | 10% | 32% | 20% | 30% |
| | 7 | 72% | 72% | 9% | 19% |
| | 8 | 4% | 80% | 4% | 18% |
| | 9 | 17% | 80% | 14% | 28% |
| | 10 | 17% | 69% | 20% | 31% |
| | 11 | 1% | 31% | 17% | 22% |
| | 12 | 12% | 54% | 23% | 35% |
| | 13 | 0% | 55% | 14% | 56% |
| | 14 | 34% | 81% | 13% | 25% |
| **Average** | | **14%** | **56%** | **14%** | **34%** |
| **Std. Dev.** | | **19%** | **23%** | **6%** | **13%** |
| **Range** | | **0% - 72%** | **20% - 83%** | **4% - 23%** | **18% - 60%** |

| 10 Plates | | %MVC RA | %MVC ES | %MVC GM | %MVC BF |
|---|---|---|---|---|---|
| Subject | 1 | 4% | 34% | 20% | 65% |
| | 2 | 12% | 27% | 35% | 56% |
| | 3 | 0% | 38% | 12% | 45% |
| | 4 | 3% | 104% | 14% | 41% |
| | 5 | 33% | 79% | 6% | 54% |
| | 6 | 3% | 34% | 25% | 48% |
| | 7 | 55% | 80% | 9% | 21% |
| | 8 | 3% | 95% | 7% | 26% |
| | 9 | 29% | 86% | 20% | 48% |
| | 10 | 12% | 92% | 16% | 34% |
| | 11 | 2% | 33% | 21% | 30% |
| | 12 | 3% | 48% | 22% | 41% |
| | 13 | 8% | 67% | 19% | 67% |
| | 14 | 19% | 88% | 17% | 34% |
| **Average** | | **13%** | **65%** | **17%** | **44%** |
| **Std. Dev.** | | **16%** | **28%** | **8%** | **14%** |
| **Range** | | **0% - 55%** | **27% - 104%** | **6% - 35%** | **21% - 67%** |

| 10 Lock | | %MVC RA | %MVC ES | %MVC GM | %MVC BF |
|---|---|---|---|---|---|
| Subject | 1 | 5% | 43% | 15% | 94% |
| | 2 | 3% | 28% | 32% | 59% |
| | 3 | 0% | 37% | 14% | 33% |
| | 4 | 3% | 94% | 29% | 25% |
| | 5 | 7% | 90% | 13% | 36% |
| | 6 | 9% | 42% | 29% | 34% |
| | 7 | 78% | 87% | 15% | 20% |
| | 8 | 2% | 93% | 8% | 17% |
| | 9 | 15% | 67% | 15% | 40% |
| | 10 | 30% | 107% | 27% | 23% |
| | 11 | 1% | 40% | 18% | 22% |
| | 12 | 8% | 56% | 32% | 11% |
| | 13 | 4% | 68% | 27% | 65% |
| | 14 | 21% | 103% | 48% | 32% |
| **Average** | | **13%** | **68%** | **23%** | **37%** |
| **Std. Dev.** | | **20%** | **27%** | **11%** | **22%** |
| **Range** | | **0% - 78%** | **28% - 107%** | **8% - 48%** | **11% - 94%** |

# DISCUSSION

## Chapter 4

### EMG Activity of RA

The sporadic activity of the RA was inconsistent. The RA is a primary flexor of the lumbar spine, so this spinal extension exercise should not have caused significant RA activity. [11] This trend was most likely the result of mechanical stimulation of the electrodes during the exercise due to their position on the abdomen and the abdomen's position over the pelvic cushion.

### EMG Activity of the ES, GM, and BF

The increase of EMG activity with increased loads of the ES during the exercises is consistent with the results of previous studies. [7, 11] It is understood that increased resistance will cause increased muscle activity, due to the change in force required to move the load. This can be explained by the simple equation, Work = Force x Distance. If the distance remains constant while the amount of work required to perform a task increases, as in my study, the force applied to the load must increase. This increase in force produced elicits an increase of EMG activity in the utilized muscles. [11]

### Knees Locked

During the fourth set of repetitions, the subjects actively extended their knees during the entire motion phase of the exercise. The EMG data showed a decrease in the

BF activity when compared to not actively extending their knees under the same load (Figure 4). This decrease in BF activity may be the result of reciprocal inhibition by the quadriceps femoris muscles. The quadriceps and the hamstrings have an agonist-antagonist relationship in knee function. As the quadriceps increase activity, an impulse is sent to the dorsal root ganglion in the spinal cord via the IA afferent nerve fibers, and subsequently synapses with an inhibitory interneuron in the spinal cord. This interneuron then synapses with an alpha motor neuron innervating the antagonist muscle (in this case, the hamstring group), causing an inhibition of that muscle. In this manner, smooth, controlled movement by the agonist group is promoted with minimal resistance from antagonist groups. [18] Therefore, by actively contracting the quadriceps muscles, the subjects were inhibiting their hamstrings.

It is hypothesized that if the BF muscle activity decreases during an activity, other muscles may be recruited to substitute for the BF. Because Work = Force x Distance, the decrease in force produced by the BF during this exercise had to be made up by other musculature in order to successfully lift the load. During this exercise, the BF and GM would begin to posteriorly rotate the pelvis as the ES moves the lumbar spine into extension, overcoming the bending moment produced by the resistance. [19] With a decrease in activity of the BF, the GM would have to work harder to achieve the same pelvic motion. In addition, if there was less torque force on the pelvis due to the inhibition of the BF, the ES would have to work harder to lift the load and maintain the necessary amount of spinal extension. The EMG data showed an increase in activity of the GM and the ES during the fourth set of exercises (10 lock in Figure 4), which could be a result of the decrease in BF activity during this exercise.

**Limitations**

One major limitation of this study was the inability to elicit consistent RA activity. The position of the electrodes between the stabilizing bar and the body during the exercise caused the possible mechanical stimulation of the electrodes, which confounded the results of this study. Also, further research is needed to determine the posterior pressure of the intervertebral discs elicited during the use of this machine.

**Design Considerations**

The prototype Fitness Plus, Inc. Low Back Unit can elicit increased activity in the GM, BF, and ES muscles. However, for strength training of this musculature, a larger load is needed. All subjects who participated in this study could lift the maximum weight the machine would allow. If a weight program were centered around a percentage of a person's maximum lift, as many are, this machine would not be able to provide such resistance. Also, as the subjects flexed their trunks over the stabilizing pad (abdominal pad), their lumbar spines tended to be forced into flexion, making it difficult to maintain a lordotic lumbar spine. Changing the angle of the stabilizing pad from $45^0$ to $90^0$ could eliminate this problem. Another possibility would be to change the amount of vertical adjustment of the stabilizing pad so that it could go even lower on the thigh, thus eliminating the pressure on the abdomen.

**Clinical Implications**

Forward bending to lift loads may be an efficient way to strengthen the erector spinae, but it is usually not recommended for patients with back pathology. [2,10] It has been found that lifting in this manner significantly increases the posterior pressure in the intervertebral discs, [20] therefore possibly predisposing the lifter to a posterior herniation

of the disc. Caution should be used when strengthening the back and thigh musculature in patients with disc herniations, with emphasis placed on proper body mechanics and lifting techniques. [9,10] Although this researcher would not recommend this machine for patients with posterior disc herniations, the Fitness Plus Low Back Unit can be an effective tool to strengthen the BF, GM, and ES muscles for recreational strength training, or in patients where strength training is indicated.

# APPENDIX

**UNIVERSITY OF NORTH DAKOTA'S**
**INSTITUTIONAL REVIEW BOARD**

**DATE:** February 5, 1996 **PROJECT NUMBER** IRB-9602-139

**NAME:** Thomas M. Mohr **DEPARTMENT/COLLEGE** Physical Therapy

**PROJECT TITLE:** An Electromyographic Study of Trunk Muscle Activity During Exercise on the Fitness Plus Rehab Equipment

The above referenced project was reviewed by a designated member for the University's Institutional Review Board on 2/6/96 and the following action was taken:

☒ Project approved. **EXPEDITED REVIEW** NO. 3.
Next scheduled review is on February 1997.

☐ Project approved. **EXEMPT CATEGORY** NO. _____. No periodic review scheduled unless so stated in REMARKS SECTION.

☐ Project approved **PENDING** receipt of corrections/additions in ORPD and approval by the IRB. **This study may NOT be started UNTIL IRB approval has been received.** (See REMARKS SECTION for further information.)

☐ Project approval **deferred. This study may not be started until IRB approval has been received.** (See REMARKS SECTION for further information.)

☐ Project **denied.**
(See REMARKS SECTION for further information.)

**REMARKS:** Any changes in protocol or adverse occurrences in the course of the research project must be reported immediately to the IRB Chairman or ORPD.

Excellent Consent form!

cc: Dean, Medical School

Elvira Byzitis 2-6-96
Signature of Chairperson or designated IRB Member Date
UND's Institutional Review Board

If the proposed project (clinical medical) is to be part of a research activity funded by a Federal Agency, a special assurance statement or a completed 596 Form may be required. Contact ORPD to obtain the required documents. (7/93)

_X_ EXPEDITED REVIEW REQUESTED UNDER ITEM _3_ (NUMBER[S]) OF HHS REGULATIONS
___ EXEMPT REVIEW REQUESTED UNDER ITEM ____ (NUMBER[S]) OF HHS REGULATIONS

**UNIVERSITY OF NORTH DAKOTA**
**HUMAN SUBJECTS REVIEW FORM**
**FOR NEW PROJECTS OR PROCEDURAL REVISIONS TO APPROVED PROJECTS INVOLVING HUMAN SUBJECTS**

**PRINCIPAL INVESTIGATOR:** Thomas M. Mohr **TELEPHONE:** (701) 777-2831 **DATE:** 1-5-96

**ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT:** P.O. Box 9037, University of North Dakota

**SCHOOL/COLLEGE:** Medicine **DEPARTMENT:** Physical Therapy **PROPOSED PROJECT DATES:** 2/96 to 2/98

**PROJECT TITLE:** An Electromyographic Study of Trunk Muscle Activity During Exercise on the Fitness Plus Rehab Equipment

**FUNDING AGENCIES (IF APPLICABLE):** Fitness Plus, Inc., Valley City, ND

**TYPE OF PROJECT:** DISSERTATION OR
_X_ NEW PROJECT ___ CONTINUATION ___ RENEWAL ___ THESIS RESEARCH _X_ STUDENT RESEARCH PROJECT

___ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

**DISSERTATION/THESIS ADVISER, OR STUDENT ADVISER:** Thomas M. Mohr, Ph.D.

**PROPOSED PROJECT:** ___ INVOLVES NEW DRUGS (IND) ___ INVOLVES NON-APPROVED USE OF DRUG
_X_ INVOLVES A COOPERATING INSTITUTION

**IF ANY OF YOUR SUBJECTS FALL IN ANY OF THE FOLLOWING CLASSIFICATIONS, PLEASE INDICATE THE CLASSIFICATION(S):**
_ MINORS (<18 YEARS) _ PREGNANT WOMEN _ MENTALLY DISABLED _ FETUSES _ MENTALLY RETARDED

_ PRISONERS _ ABORTUSES _X_ UND STUDENTS (>18 YEARS)

**IF YOUR PROJECT INVOLVES ANY HUMAN TISSUE, BODY FLUIDS, PATHOLOGICAL SPECIMENS, DONATED ORGANS, FETAL MATERIAL, OR PLACENTAL MATERIALS, CHECK HERE ___**

---

**1. ABSTRACT:** (LIMIT TO 200 WORDS OR LESS AND INCLUDE JUSTIFICATION OR NECESSITY FOR USING HUMAN SUBJECTS.

A small company in North Dakota, Fitness Plus, Inc., has started to market a series of exercise machines targeted at chiropractic and physical therapy clinics. Although the machines are similar to other strengthening equipment, the new machines have some unique characteristics, which the company feels makes them more applicable for clinical use. Although the machines are starting to be marketed, there is no available research that describes the muscle activity during the exercise regimens. In order to study the effectiveness of these machines, the company has offered our Department a small contract to study select muscle activity during exercise on the various pieces of equipment. Since these machines are currently being sold to clinics for use with patients who have back pain and for other patients who are need of trunk and lower extremity muscle strengthening, it is imperative that we utilized human subjects in this research. The purpose of this research is to describe the muscle activity that occurs during exercise on the Fitness Plus Rehab Equipment. Currently, there are five machines that we will be studying: 1) low back unit, 2) abdominal unit, 3) cervical unit, 4) multi-hip unit, and 5) rotary torso unit. We will use telemetried electromyography to study muscle activity in the abdominal muscles, back muscles, hamstrings and gluteal muscles. The information gained from this study will be of use to clinical physical therapists in prescribing exercise programs for their patients. The study will be done at the Medical Center Rehab Hospital where the equipment is located.

PLEASE NOTE: Only information pertinent to your request to utilize human subjects in your project or activity should be included on th form. Where appropriate attach sections from your proposal (if seeking outside funding).

**2. PROTOCOL:** (Describe procedures to which humans will be subjected. Use additional pages if necessary.)

**SUBJECTS:**
It is anticipated that we will recruit 20 male and female volunteers, ages 19-40 years. The subjects will be recruited from physical therap students enrolled in the professional physical therapy program at the University of North Dakota.

**METHODS:**
We will measure the electromyographic (EMG) activity in these muscle groups: 1) abdominals (rectus and obliques), 2) erector spinae an latissimus dorsi, 3) hamstrings, 4) gluteus maximus, and 5) shoulder extensors. Trunk range of motion also be analyzed.

To record the EMG activity, surface electrodes will be placed over the motor points of each muscle under study. The EMG signals will b transmitted to the receiver unit (Noraxon Telemyo 8) and then relayed into a computer for display and for recording data. Prior to beginnin the experimental trials, each subject will be asked to perform a maximal voluntary contraction (MVC) of each monitored muscle. The activit recorded during the MVC will be considered as 100% EMG activity level, with which the EMG activity during the exercise can be compared This procedure is done to normalize the EMG data for later analysis.

An electrogoniometer (Penny & Giles Model 180) will be used to measure trunk range of motion during the exercise. The electrogoniometer will be attached to the trunk and thigh above and below the hip joint, respectively using double sided adhesive tape. This will allow measurement of trunk flexion during the exercise. The electrogoniometer will be calibrated prior to beginning the experimental trial to assure accuracy of measurement.

Prior to the trials, each subject's age, height, and weight will be recorded. During the experimental trials, the subject's right sided muscles will be used for data collection. Before beginning the experiment, each of the subjects will be given a short training session on proper exercise using the machine.

The actual experiment involves applying the electrogoniometer device to each subject. The skin overlying the muscles will be cleansed with alcohol before attachment of the self-adhesive pre-gelled EMG electrodes over the motor points. The subject will be asked to elicit a MVC of each monitored muscle which will be recorded on the computer as a reference voltage level. The actual experiment will consist of the following trials: 1) 3 trials of using the machine with no weights attached, 2) 3 trials of using the machine with weights attached, and 3) 3 trials with changes in body position. The speed of the exercise will be timed using a metronome.

Subjects will be allowed two minute rest periods between the experimental trials to avoid a fatigue factor. Finally, the subjects will be given a rest period while the electrodes and electrogoniometer devices are removed.

Descriptive statistics characterizing the subject's anthropometric profiles will be provided. Statistical analysis (t-test & ANOVA) will be performed on the following dependent variables: 1) normalized EMG activity, and 2) electrogoniometric measurements. The electromyographic data will also be analyzed to determine the optimal body position and motion with each of the machines.

3. **BENEFITS:** (Describe the benefits to the individual or society.)

The results of this study will help to determine if the Fitness Plus Rehab equipment is effective in recruiting selected trunk and lower extremity musculature. At the present time, there is no available research data on these machines, and therefore their use in the clinic is unsupported. If these machines are found to recruit the selected muscles during use, it will validate their use with patients.

4. **RISKS:** (Describe the risks to the subject and precautions that will be taken to minimize them. The concept of risk goes beyond physical risk and includes risks to the subject's dignity and self-respect, as well as psycho-logical, emotional or behavioral risk. If data are collected which could prove harmful or embarrassing to the subject if associated with him or her, then describe the methods to be used to insure the confidentiality of data obtained, including plans for final disposition or destruction, debriefing procedures, etc.)

The risk to the subjects in this experiment will be minimal. Machines similar to the ones we will be testing have been on the market for years and are currently used in many hospitals, sports medicine facilities and fitness centers. The timing and the resistance used for the exercises will be well controlled for these experiments, and should pose minimal, if any, risk to the normal subject. During the course of the experiment, subjects will be accompanied by an assistant for added safety. The EMG and electrogoniometer equipment will cause no discomfort to the subjects, since they are only monitoring devices. The subjects will be asked to wear gym shorts during the experiment, and every effort will be taken to preserve subject dignity during the course of the experiment. The experimental trials will be conducted at the Medical Center Rehabilitation Hospital, Department of Physical Therapy.

5. **CONSENT FORM:** A copy of the **CONSENT FORM** to be signed by the subject (if applicable) and/or any statement to be read to the subject should be attached to this form. If no **CONSENT FORM** is to be used, document the procedures to be used to assure that infringement upon the subject's rights will not occur.

Describe where signed consent forms will be kept and for what period of time.

The consent forms will be kept by Dr. Thomas Mohr at the University of North Dakota, Department of Physical Therapy, Room 148, Medical Science Building for a period of two (2) years. A copy of the consent form is attached.

6. For **FULL IRB REVIEW** forward a signed original and thirteen (13) copies of this completed form, and where applicable, thirteen (13) copies of the proposed consent form, questionnaires, etc. and any supporting documentation to:

Office of Research & Program Development
University of North Dakota
Box 8138, University Station
Grand Forks, North Dakota 58202

On campus, mail to: Office of Research & Program Development, Box 134, or drop it off at Room 101 Twamley Hall.

For **EXEMPT** or **EXPEDITED REVIEW** forward a signed original and a copy of the consent form, questionnaires, etc. and any supporting documentation to one of the addresses above.

---

The policies and procedures on Use of Human Subjects of the University of North Dakota apply to all activities involving use of Human Subjects performed by personnel conducting such activities under the auspices of the University. No activities are to be initiated without prior review and approval as prescribed by the University's policies and procedures governing the use of human subjects.

**SIGNATURES:**

James Mosh **DATE:** 2/20/96

Principal Investigator

_____ **DATE:** _____

Project Director or Student Adviser

(Revised 8/1992)

Grand Forks Medical Park

# Institutional Review Board

## Research Project Action Report

Date: March 4, 1996 IRB#: MI-010

Principal Investigator: Thomas M. Mohr Department: Physical Therapy Phone #: 777-2831

Research Coordinator: _____ Phone #: _____

Project Title: An Electromyographic Study of Trunk Muscle Activity During Exercise on the Fitness Plus Rehab Equipment

The above referenced project protocol and informed consent was reviewed by the Medical Park Institutional Review Board on _____ and the following action was taken:

☐ Project approved. Next Scheduled review is on _____
If no date is given, then review will be required in 12 months. (See REMARKS SECTION for any special condition.)

☒ Project approved. EXPEDITED REVIEW NO. 3
Next scheduled review is on _____

☐ Project approved. EXEMPT CATEGORY NO. _____
No periodic review scheduled unless so stated in REMARKS SECTION.

☐ Project approval deferred. (See REMARKS SECTION for further information.)

☐ Project denied. (See REMARKS SECTION for further information.)

☐ Amendment approved

**REMARKS:**

Any changes in protocol, adverse occurrences or deaths in the course of the research project must be reported immediately to the IRB chairperson or the IRB office (780-6161).

Signature of Chairperson or Designated IRB Member
Medical Park Institutional Review Board

3/5/96
Date

If the proposed project is to be part of a research activity funded by a federal agency, a special assurance statement or a completed 596 Form may be required. Contact IRB office to obtain the required documents.

Grand Forks Medical Park

# Institutional Review Board

## Human Subjects Review Form

***For new projects or procedural revisions to approved projects involving human subjects.***

Principal Investigator: Thomas M. Mohr Phone #: (701)777-2831 Date: 1-5-96

Institution: University of North Dakota Department: Physical Therapy

Research Coordinator: Rick Ness, P.T. Phone #: (701)780-2315

Proposed Project Dates: 2/96 to 2/98

Project Title: An Electromyographic Study of Trunk Muscle Activity During Exercise on the Fitness Plus Rehab Equipment

Funding Agencies (if applicable): Fitness Plus, Inc., Valley City, ND

Type of Project: ☒ New Project ☐ Continuation ☐ Renewal ☐ Student Research Project
☐ Dissertion or Thesis Research ☐ Completed Project
☐ Reports (Adverse events, deaths, complications)
☐ Amendments or change in project

Dissertation/Thesis Adviser, or Student Advisor: Thomas M. Mohr, Ph.D.

Proposed Project: ☐ Involves New Drugs (IND) ☐ Involves Non-Approved Use of Drug ☒ Involves a Cooperating Institution
☐ None of the Above

If any of your subjects fall in any of the following classifications, please indicate the classification:

☐ Minors (< 18 Years) ☐ Pregnant Women ☐ Mentally Disabled ☐ Fetuses ☐ Mentally Retarded
☐ Prisoners ☒ Students ☐ Abortuses ☐ Control Group

If your project involves any human tissue, body fluids, pathological specimens, donated organs, fetal material, or placental materials, check here ____ .

__X__ Expedited Review requested under item __3__ (number) of HHS Regulations (see attached explanation)

_____ Exempt Review requested under item _____ (number) of HHS Regulations (see attached explanation)

---

1. **ABSTRACT** (Limit to 200 words or less and include justification or necessity for using human subjects. Attach additional sheet if necessary.)

A small company in North Dakota, Fitness Plus, Inc., has started to market a series of exercise machines targeted at chiropractic and physical therapy clinics. Although the machines are similar to other strengthening equipment, the new machines have some unique characteristics, which the company feels makes them more applicable for clinical use. Although the machines are starting to be marketed, there is no available research that describes the muscle activity during the exercise regimens. In order to study the effectiveness of these machines, the company has offered our Department a small contract to study select muscle activity during exercise on the various pieces of equipment. Since these machines are currently being sold to clinics for use with patients who have back pain and for other patients who are need of trunk and lower extremity muscle strengthening, it is imperative that we utilized human subjects in this research. The purpose of this research is to describe the muscle activity that occurs during exercise on the Fitness Plus Rehab Equipment. Currently, there are five machines that we will be studying: 1) low back unit, 2) abdominal unit, 3) cervical unit, 4) multi-hip unit, and 5) rotary torso unit. We will use telemetried electromyography to study muscle activity in the abdominal muscles, back muscles, hamstrings and gluteal muscles. The information gained from this study will be of use to clinical physical therapists in prescribing exercise programs for their patients. The study will be done at the Medical Center Rehab Hospital where the equipment is located.

PLEASE NOTE:

Only information pertinent to your request to utilize human subjects in your project or activity should be included on this form. Where appropriate attach sections from your proposal including data collection instruments where applicable.

2. **PROTOCOL:** (Describe procedures to which humans will be subjected.)

**SUBJECTS**:
It is anticipated that we will recruit 20 male and female volunteers, ages 19-40 years. The subjects will be recruited from physical therapy students enrolled in the professional physical therapy program at the University of North Dakota.

**METHODS**:
We will measure the electromyographic (EMG) activity in these muscle groups: 1) abdominals (rectus and obliques), 2) erector spinae and latissimus dorsi, 3) hamstrings, 4) gluteus maximus, and 5) shoulder extensors. Trunk range of motion also be analyzed.

To record the EMG activity, surface electrodes will be placed over the motor points of each muscle under study. The EMG signals will be transmitted to the receiver unit (Noraxon Telemyo 8) and then relayed into a computer for display and for recording data. Prior to beginning the experimental trials, each subject will be asked to perform a maximal voluntary contraction (MVC) of each monitored muscle. The activity recorded during the MVC will be considered as 100% EMG activity level, with which the EMG activity during the exercise can be compared. This procedure is done to normalize the EMG data for later analysis.

An electrogoniometer (Penny & Giles Model 180) will be used to measure trunk range of motion during the exercise. The electrogoniometer will be attached to the trunk and thigh above and below the hip joint, respectively using double sided adhesive tape. This will allow measurement of trunk flexion during the exercise. The electrogoniometer will be calibrated prior to beginning the experimental trial to assure accuracy of measurement.

Prior to the trials, each subject's age, height, and weight will be recorded. During the experimental trials, the subject's right sided muscles will be used for data collection. Before beginning the experiment, each of the subjects will be given a short training session on proper exercise using the machine.

The actual experiment involves applying the electrogoniometer device to each subject. The skin overlying the muscles will be cleansed with alcohol before attachment of the self-adhesive pre-gelled EMG electrodes over the motor points. The subject will be asked to elicit a MVC of each monitored muscle which will be recorded on the computer as a reference voltage level. The actual experiment will consist of the following trials: 1) 3 trials of using the machine with no weights attached, 2) 3 trials of using the machine with weights attached, and 3) 3 trials with changes in body position. The speed of the exercise will be timed using a metronome.

Subjects will be allowed two minute rest periods between the experimental trials to avoid a fatigue factor. Finally, the subjects will be given a rest period while the electrodes and electrogoniometer devices are removed.

Descriptive statistics characterizing the subject's anthropometric profiles will be provided. Statistical analysis (t-test & ANOVA) will be performed on the following dependent variables: 1) normalized EMG activity, and 2) electrogoniometric measurements. The electromyographic data will also be analyzed to determine the optimal body position and motion with each of the machines.

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The results of this study will help to determine if the Fitness Plus Rehab equipment is effective in recruiting selected trunk and lower extremity musculature. At the present time, there is no available research data on these machines, and therefore their use in the clinic is unsupported. If these machines are found to recruit the selected muscles during use, it will validate their use with patients.

4. **RISKS:** (Describe the risks to the subject and precautions that will be taken to minimize them. The concept of risk goes beyond physical risk and includes risks to the subject's dignity and self respect, as well as psychological, emotional or behavioral risk. If data are collected which could prove harmful or embarrassing to the subject if associated with him or her, then describe the methods to be used to insure the confidentiality of data obtained, including plans for final disposition or destruction, debriefing procedures, etc.)

The risk to the subjects in this experiment will be minimal. Machines similar to the ones we will be testing have been on the market for years and are currently used in many hospitals, sports medicine facilities and fitness centers. The timing and the resistance used for the exercises will be well controlled for these experiments, and should pose minimal, if any, risk to the normal subject. During the course of the experiment, subjects will be accompanied by an assistant for added safety. The EMG and electrogoniometer equipment will cause no discomfort to the subjects, since they are only monitoring devices. The subjects will be asked to wear gym shorts during the experiment, and every effort will be taken to preserve subject dignity during the course of the experiment. The experimental trials will be conducted at the Medical Center Rehabilitation Hospital, Department of Physical Therapy.

5. **CONSENT FORM:** A copy of the CONSENT FORM to be signed by the subject (if applicable) and/or any statement to be read to the subject should be attached to this form. If no CONSENT FORM is to be used, document the procedures to be used to assure that infringement upon the subject's rights will not occur.

   Describe who will be obtaining consent, where signed consent forms will be kept, and for what period of time.

The consent forms will be kept by Dr. Thomas Mohr at the University of North Dakota, Department of Physical Therapy, Room 1521, Medical Science North Building for a period of two (2) years. A copy of the consent form is attached.

6. For FULL IRB REVIEW, forward the signed original of this completed form and, copies as outlined in the attached instructions to:

   For EXEMPT or EXPEDITED REVIEW forward a signed original and a copy of the consent form, questionnaires, etc., and any supporting documentation to:

   Eleanor Tveit, IRB Secretary
   1000 South Columbia Road
   Grand Forks, ND 58201
   701-780-6161

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The policies and procedures on Use of Human Subjects in Medical Park Institutions apply to all activities involving use of Human Subjects performed by personnel conducting such activities. No activities are to be initiated without prior review and approval of the Medical Park Institutional Review Board.

Signatures:

Principal Investigator: Thomas Mohr Date: 3/1/96

Project Director: (Same) Date: _____

Student Advisor
(where applicable): — Date: _____

## INFORMATION AND CONSENT FORM

**TITLE:** An Electromyographic Study of Trunk Muscle Activity During Exercise on the Fitness Plus Rehab Equipment.

You are being invited to participate in a study conducted by Thomas Mohr, a physical therapy professor at the University of North Dakota. The purpose of this study is study muscle activity in your lower extremity and trunk while you are exercising on some specialized strengthening equipment. We hope to describe the muscle activity to determine which muscles are active and when they are active during the course of an exercise bout on the various Fitness Plus machines. Only normal, healthy subjects will be asked to participate in this study.

You will be asked to exercise on the Fitness Plus equipment for nine (9) trials consisting of the following: 1) 3 trials of using the machine with no weights attached, 2) 3 trials of using the machine with weights attached, and 3) 3 trials with changes in body position.. The speed of the exercise will be timed using a metronome. Each trial will last approximately 30 seconds. You will be given a short rest period between trials.

The study will take approximately one hour of your time. You will be asked to report to the Physical Therapy Department at the Medical Center Rehabilitation Hospital at an assigned time. You will then be asked to change into gym shorts for the experiment. We will first record your age, gender, height and weight. During the experiment, we will be recording the amount of muscle activity you have when you exercise on one of five exercise machines.

Although the process of physical performance testing always involves some degree of risk, the investigator in this study feels that the risk of injury or discomfort is minimal. In order for us to record the muscle activity, we will be placing nine electrodes on your trunk and lower extremity. Before we can apply the electrodes, we will use a small stimulator to electrically stimulate the muscles to locate the best spot to place the electrodes. The stimulator will cause a mild tingling sensation. The recording electrodes are attached to the surface of the skin with an adhesive material. We will also attach a measuring device to your trunk and thigh with adhesive material. These devices only record information from your muscles and joints, they do not stimulate the skin. After we get the electrodes attached, we will give you a brief training session to teach you how to exercise on the particular machine. The amount of exercise you will be asked to perform will be minimal.

Your name will not be used in any reports of the results of this study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. The data will be identified by a number known only be the investigator. The investigator or participant may stop the experiment at any time if the participant is experiencing discomfort, pain, fatigue, or any other symptoms that may be detrimental to his/her health. Your decision whether or not to participate will not prejudice your future relationship with the Physical Therapy Department or the University of North Dakota. If you decide to participate, you are free to discontinue participation at any time without prejudice.

The investigator involved is available to answer any questions you have concerning this study. In addition, you are encouraged to ask any questions concerning this study that you may have in the future. Questions may be asked by calling Dr. Thomas Mohr at (701) 777-2831. A copy of this consent form is available to all participants in the study.

In the even that this research activity (which well be conducted at the Medical Center Rehabilitation Hospital) results in a physical injury, medical treatment will be available, including first aid, emergency treatment and follow up care as it is to member of the general public in similar circumstances. Payment for any such treatment must be provided by you and your third party payment, if any.

**ALL OF MY QUESTIONS HAVE BEEN ANSWERED AND I AM ENCOURAGED TO ASK ANY QUESTIONS THAT I MAY HAVE CONCERNING THIS STUDY IN THE FUTURE. MY SIGNATURE INDICATES THAT, HAVING READ THE ABOVE INFORMATION, I HAVE DECIDED TO PARTICIPATE IN THE RESEARCH PROJECT.**

I have read all of the above and willingly agree to participate in this study explained to me by Dr. Thomas Mohr.

_____

Participant's Signature Date

_____

Witness (not the scientist) Date

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