Laboratory #3 ➔ Prediction of 1-RM & Musculoskeletal Fitness

Introduction

Many people, even professionals in exercise science, use the terms strength, force, power, and endurance almost interchangeably. However, it is important to understand that each of these terms has a distinct meaning. Musculoskeletal fitness has three components: muscular strength, muscular endurance, and flexibility. Therefore, the principle objective for this laboratory investigation is to become comfortable with the procedures for calculating each of these components.
Procedures to measure static balance will also be considered.

Learning Objectives

1. To determine isotonic muscular strength of the upper body using a prediction method.
2. To determine hand and forearm isometric strength using a grip dynamometer.
3. To understand the difference between muscular strength, power, and endurance.
4. To study the relationship between body weight and muscular strength.
5. To determine balance and flexibility using field tests to assess these measurements.

NOTE: Do NOT perform any of these lifts without spotters.

A. Bench Press 5RM & Lat-Pull Down

- Lie supine on a bench with the barbell in the rack position. Using a slightly wider than shoulder width grip, lift the weight off the rack into the lockout position.
- Lower the weight until it touches the lower portion of the chest. Keep feet on the floor and buttocks on the bench throughout the lift. Do not bounce the weight on your chest.
- Lift the weight in a semi-arc until the arms are fully extended in the lockout position.
- After proper warm up, find a weight which you can lift for 5 repetitions to the point of muscular failure.
- Count the number of repetitions correctly performed without the help of a spotter and use the prediction equation to determine your 1RM.

Prediction Equation to predict 1-RM for bench press

1-RM = (1 + 0.0333 x reps) x rep weight

Record in Data Table 1.0

Box 1.0
Procedures for performing the Bench Press, Leg Press and Lat-Pull Down.

Bench Press

1. Assume a supine position on the bench with your eyes just under the front edge of the bar.
2. Grip the bar using a grip width a little wider than shoulder width (some people have difficulty balancing the bar if the grip width is too narrow).
3. With help from a spotter, raise the bar to a position directly over the shoulder joint.
4. In a controlled manner, lower the bar to the chest just below the inferior border of the pectoralis.
5. Pause for an instant (do not bounce the bar) and press the bar back up to full arm extension directly over the shoulder.

Lat-Pull

1. Sit erect, face the machine so that the front of the head is directly under the back edge of the bar.
2. Hold the hands up so the thumbs just touch the outside of the shoulder and reach straight up, grasping the bar with an overhand grip that is slightly wider than shoulder width.
3. Leaning back slightly (approximately 30˚ from upright), pull the bar until it is below the chin with head facing directly forward and not up. The bar should be pulled under control and not jerked down.
4. Lower the weight under control until the weight stack is down.

Data Table 1.0

Subject	Predicted Bench Press (1RM)	Predicted Lat-Pull (1RM)	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
Mean			
SD			

Student Activities

A. Definitions

Define the following key terms. For those terms which are measurable variables, describe in your own words what they mean (not how they are obtained or calculated). Indicate the unit(s) of measurement.

1. Muscular Strength:

2. Muscular Endurance:

3. One Repetition Maximum (1 RM):

Discussion Questions

What is the difference between muscular strength, muscular endurance and muscular power?

Was there a relationship between body mass and muscular strength? Provide a physiological basis for your answer.

Was there a difference between strength scores for males and females? Explain possible physiological/biomechanical reasons for your answer.

What are some physiological factors that contribute to muscular strength? How does training enhance these factors?

Related Readings

1. Plowman, S.A. & Smith, D.L. (2003). Exercise Physiology for Heath, Fitness and Performance (2nd ed.). San Francisco: Benjamin Cummings.
2. Powers, S.K. & Howley, E.T. (2001). Exercise Physiology: Theory and Application to Fitness and Performance (4th ed.) (pp. 399-400). Boston: McGraw-Hill.
3. McArdle, W.D., Katch, F.I. & Katch, V.L. (2001). Exercise Physiology: Energy, Nutrition and Human Performance (5th ed.) (pp. 502-503, 506-507). Baltimore: Williams & Wilkins.

Muscular Fitness

Field Tests

Student Learning Objectives

After completing this lab, you should be able to:

1. Define, explain and correctly use key terms.
2. Distinguish between muscular strength, muscular endurance and muscular power.
3. Explain how to assess muscular strength, muscular endurance, muscular power, flexibility and balance using field tests.
4. Distinguish between relative and absolute muscular endurance.

Equipment

- Bench
- Cardboard Strips or Board (4.5 in wide/ 11.4 cm)
- Free Weights (2.5-25 lbs./ 1-12 kg)
- Goniometer
- Hand Grip Dynamometer
- Mats
- Measuring Tape/ Ruler (12 inches/ 30.5 cm)
- Metronome/ Stopwatches
- Pacing Tape/ CD and Tape/ CD player (optional)
- Sit and Reach Box

Procedure

Muscular strength, muscular endurance, muscular power, flexibility and balance will be assessed using field tests. All students will be subjects; students should work with a partner and test each other. Begin with the balance test. Thereafter, proceed in any order, but complete all parts of each test before continuing on to the next one. Record your data in Data Table 1.0.

Protocols

A. Balance Test: 1 Foot or "Stork" Stand[2]

1. Remove your shoes and determine which foot will be the supporting foot.

2. Stand on the supporting foot and place the other foot flat against the inside of the supporting leg's knee. Place your hands on hips.
3. When instructed by your partner to begin, raise the heel of your supporting foot off the floor and balance for as long as possible without moving the supporting foot, touching the heel to the group or removing yours hands from hips.
4. Record the length of time proper balance is maintained (up to a maximum of 60 seconds) in Data Table 1.0 (to the nearest tenth of a second).
5. Perform one practice trial and two test trials. The best of the two test trials is taken as the final score.

B. The Back Saver Sit and Reach[1]

1. Remove your shoes and sit down at the sit and reach box.
2. Set the sit and reach box tape so that the level of the foot reads 9 inches (23 cm).
3. Fully extend one leg, with the foot flat against the end of the box. Bend the other knee, with the sole of the foot flat of the floor and 2-3 inches to the side of the extended knee. Sit with both hips square to the box.
4. Extend your arms forward over the measuring scale with the hands placed one on top of the other, palms down.
5. A partner makes sure that your extended knee remains straight and that both hands remain together and in contact with the measuring tape.
6. Reach forward with both hands along the scale for times and hold the position on the fourth reach for at least one second. If necessary, the bent knee may move to the side as the body bends forward.
7. A partner reads the point of furthest extension.

8. Repeat steps 2-7 using the opposite leg.
9. Record the distance (to the last whole inch or centimeter) in Data Table 1.0.

The test is repeated if:

- Your extended knee flexes (a partner may place one hand on your knee to remind you to keep the knee straight).
- Your hands do not reach forward evenly.
- Your hips do not remain square to the box.

C. Hand Grip

1. Adjust the dynamometer to fit your hand.
2. Perform a maximal contraction in a standing position, making sure that the test arm is neither touching any other body part, nor is in contact with any of your surroundings.
3. Perform 3 maximal contractions with the right and left hand, alternating hands to allow for a rest period.
4. Record grip strength (the highest of the 3 trials for each hand) in Data Table 1.0.

D. National Back Fitness Test (NBFT)[4]

> Note to Student: This test should not be performed if you have had significant back problems, including surgery, in the past or if you are experiencing back pain at this time.

Three of the tests (the straight leg raise, sling test and lateral lift) require only one attempt. The fourth test (the sit-up) requires you to attempt successively easier versions of a sit-up if the proper form cannot be achieved. Place a check next to the grade of the exercise that you are able to complete correctly. The total score is the sum the grades on the individual tests.

(a) Straight Leg Raise Test

The goal of this test is to raise both legs simultaneously 6 inches off the floor for 10 seconds in the supine position. Terminate the test as soon as your lower back begins to curve away from the floor. A partner places his/her hand in the lordotic curve of your back to judge this. Begin each attempt with a pelvic tilt to flatten the back.

__**Grade 1**
Raised both legs 6 inches and held for 10 seconds while the back remained flat.

__**Grade 2**
Raised both legs 6 inches but back curved before 10 seconds elapsed.

__**Grade 3**
Raised both legs 6 inches, but back curved immediately.

__**Grade 4**
Unable to lift legs due to discomfort.

(b) Sling Test

The goal of this test is to maintain one leg straight, knee flat against the floor, while the other leg is flexed and pulled to the chest in a supine position. Test both the right and left leg. Average the scores if different scores are obtained for the right and left leg. A partner measures the distance between the straight leg knee and the floor.

__**Grade 1**
With one leg, held at the knee, pulled to the chest, the other leg remained flat on the floor.
Right: ____ Left: ____

__**Grade 2**
With one leg, held at the knee, pulled to the chest, the other knee was bent 2-4 inches off the floor.
Right: ____ Left: ____

__**Grade 3**
With one leg, held at the knee, pulled to the chest, the other knee was bent 4-8 inches off the floor.
Right: ____ Left: ____

__**Grade 4**
Could not get one left to the chest without discomfort. The other left was 8 inches or more off the floor.
Right: ____ Left: ____

(c) Lateral Lift Test

The goal of this test is to raise the shoulders and trunk laterally off the floor as far as possible without starting twisting the body either forward or backward. The starting body position is lying on your side with the legs straight, one on top of the other, and the arms folded across the chest. One partner is needed to stabilize the feet, while a second partner measures the height of the "down" shoulder above the ground. Average the scores if different scores are obtained for the right and left shoulder.

__**Grade 1**
Raised shoulder 12 inches off the floor without difficulty.
Right: ____ Left: ____

__**Grade 2**
Raised shoulder 6-12 inches off the floor, but it was difficult.
Right: ____ Left: ____

__**Grade 3**
Raised shoulders 2-6 inches off the floor, and it was difficult.
Right: ____ Left: ____

__**Grade 4**
Could not raise the shoulders off the floor.
Right: ____ Left: ____

(d) Sit-Up Test

The goal of this test is to complete a sit-up with proper form. This is the only one of the 4 tests which may require multiple trials. Begin with Grade 1. If you cannot perform Grade 2, try Grade 3. Finally, if you cannot perform Grade 3, try Grade 4. If you are unable to perform Grade 4 sit-up, record a score of 5. Make sure that your feet are free and not anchored or held in any way.

__**Grade 1**
Completed on sit-up with hands over ears, knees bent and feet flat on the floor.

__**Grade 2**
Completed on sit-up with arms crossed over chest, knees bent and feet flat on the floor.

__**Grade 3**
Completed on sit-up with arms held out straight in front of body, knees bend and feet flat on the floor.

__**Grade 4**
Completed one sit-up with arms held straight out in front of body and legs straight.

__**Grade 5**
Unable to complete any sit-up form.

E. 90˚ Push-Up[1]

1. Set a metronome to 40 beats•min^{-1}. Counting "push-up (1), lower-down (2)," each push-up takes 3 seconds.

> Note to Instructor: A pre-recorded tape or CD, such as that provided with the FITNESSGRAM® Test Kit[1], may also be used; see Appendix B.

2. Assume a prone position with the shoulders placed directly over the hands, arms fully extended, legs parallel, straight and slightly apart with the toes supporting the lower body.
3. Push up with your arms until fully extended, keeping both your legs and back straight.
4. Lower the body using your arms, keeping the back in a straight line from head to toes until the elbows reach 90˚ and the upper arms are parallel to the floor.
5. Maintain a controlled pace with the metronome of one push-up per 3 seconds until fatigue.
6. A partner checks to make sure that the 90˚ angle is achieved by placing his/her hand under your shoulder or chest at the appropriate height.
7. Count the number of pus-ups performed and record in Data Table 1.0.

There is no time limit for the test, but the push-ups must be performed rhythmically, correctly and continuously (to a maximum of 75). Terminate the test if:

- You experience severe discomfort or pain.
- You are unable to maintain a rhythmic movement and must rest.
- You consistently display poor technique.

A partner attempts to correct your poor technique: however, if after 3 corrections you still display incorrect form, terminate the test. Poor technique is defined as:

- Knees touching the floor.
- Upper or lower back swaying.
- Failure to reach a complete arm extension.
- Failure to reach an approximate 90˚ bend at the elbow.
- The movement is too jerky.

F. Partial Curl-Up[1]

1. Make sure your feet are free and not anchored or held in any way.
2. Set a metronome to 40 beats•min^{-1}. Counting "curl-up (1), curl-down (2)," each partial curl takes 3 seconds.

> *Note to Instructor: A pre-recorded tape or CD, such as that provided with the FITNESSGRAM® Test Kit[1], may also be used; see Appendix B.*

3. Assume a supine position with the knees flexed to approximately 90-140˚ (a partner checks this angle between your thigh and lower leg with a Goniometer), heels on the mat, arms extended on the floor parallel to the thigh, palms facing down.
4. Place your tips at the leading edge (edge closest to your buttocks) of a 4.5 inch piece of cardboard or on the platform of a curl-up tester.
5. Curl up (tilting the pelvis should be the first part of the motion) until your finger tips (sliding 4.5 inches) touch the end of the board or curl-up tester (angle of trunk ≤ 30˚).
6. Return to the supine starting position.
7. Maintain a controlled pace with the metronome of one curl per 3 seconds until fatigue.

8. Count the number of partial curl-ups performed and record data in Data Table 1.0.

No pauses between curls are permitted, and your heels must remain in contact with the floor at all times. There is no time limit, but the test stops at a maximum of 75 curls. Terminate the test if:

- You experience severe discomfort or pain.
- You complete 75 correct partial curl-ups.
- You are unable to maintain correct rhythm for more than 3 repetitions and/or must rest.
- You consistently display poor technique.

A partner attempts to correct your poor technique; however, if after 3 corrections you still display incorrect form, terminate the test. Poor technique is defined as:

- Lifting the heels off the floor.
- Failure to slide the hands along the floor.
- Failure to slide the hands 4.5 inches along the floor.
- Failure to maintain knee angle.
- "Walking" of the buttocks.

G. Static Push-Up[3]

1. Assume a prone position with the shoulders placed directly over the hands, arms fully extended, legs parallel, straight and slightly apart with the toes supporting the lower body.
2. Lower your body by bending the elbows 90˚, making sure your body is straight between the shoulders and toes.
3. A partner times how long you can maintain the 90˚ push-up position.
4. Terminate the test when you can no longer maintain the proper position (i.e., when the body is not maintained in a straight line between the shoulders and toes, or anything other than your hands or toes tough the floor).
5. Record the time in Data Table 1.0.

H. Trunk Extension Test[1]

1. Assume a prone position with your hands under the thighs.
2. Using a slow, controlled motion, raise your head and upper body off the floor, making sure the pelvis maintains contact with the floor.
3. A partner measures the distance (to the nearest inch) from your chin to the floor using a tape measure.
4. Perform the test twice.

> *Note to Student: Heights greater than 12 inches/30.5 cm should not be encouraged.*

5. Record distance in Data Table 1.0.

I. Standing Long Jump[2]

1. Mark a take-off line on the floor using tape.
2. Position your toes close to, but not touching, the take-off line.
3. Jump as far forward as possible, making sure that both feet leave the ground simultaneously.
4. A partner measure the distance jumped (in inches) from the front of the take-off line to the back of the closest heel where landing contact was made.
5. Record distance in Data Table 1.0.

Data Table 1.0			
Test	Score	Classification*	Healthy Fitness Criterion Achieved?*
Balance(s)			
Back Saver Sit and Reach (in/cm)			yes/no
Hand Grip (lbs.kg)			
Straight Leg Raise			
Sling			
Lateral Lift			
Sit-Up			
Total Score for NBFT			
90˚ Push-Up			
Partial Curl			yes/no
Static Push-Up			
Trunk Extension			yes/no
Standing Long Jump			
** Note to Student: See Appendix A for classification based on gender.*			

Student Activities

A. Definitions.

Define the following key terms. For those terms which are measurable variables, describe in your own words what they mean (not how they are obtained or calculated). Indicate the unit(s) of measurement.

1. Balance:

2. Flexibility:

3. Power:

4. Muscular Strength:

B. Analysis.

1. Based on the results of this lab, what is the level of your muscular fitness (for all TEAM members)?