HHPK 460

Fitness Assessment

LABORATORY MANUAL

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<Lab 1> Height / Weight, Heart rate, Blood pressure

Purpose

To be able to measure a client's height, weight, heart rate, and blood pressure.

Introduction

One of the priority steps before doing fitness testing is collecting data on the participant's basic information, such as height, weight, heart rate, and blood pressure. This will allow us to determine the athlete's overall health status. In this lab, we will go over how these are measured.

Methods

1. **Height and Weight**

Height will be measured using a wall-mounted stadiometer. It has a long vertical ruler and a wide horizontal headboard that can be moved up and down. The client will be tested without shoes and hair ornaments. They will stand straight, facing forward, with their back on the stadiometer. Pull down the headboard to their head. Before measuring, ask the client to take a deep breath and hold it. Height will be recorded in centimeters(cm).

Weight will be measured using an electronic scale. Let the client step on the scale without their shoes. The client should be in minimal clothing and empty pockets. Ask them to distribute their weight evenly on both feet. Stay until the scale stops at a certain number. Weight will be recorded in kilograms(kg).

* Conversions

centimeters (cm) / 2.54 = inches (in)

kilograms (kg) * 2.2 = pounds (lbs)

You can calculate your client's Body Mass Index (BMI) by using their height and weight. The BMI is calculated using the following formula:

$$BMI = kg/m^2$$

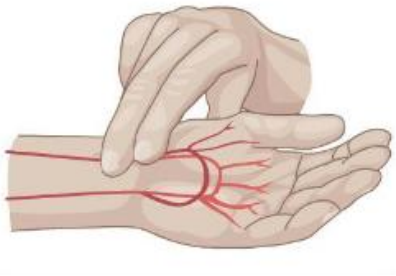
In most cases, those who weigh a lot for their height will have a high percentage of fat. However, researchers say BMI is not a good indicator because it does not provide a body fat percentage. For example, if a person weighs 100kg and is 170cm tall, this person would be considered obese, class 1, following the ACSM classification. However, BMI would not be a good indicator if this person has greater muscle mass with a low body fat percentage.

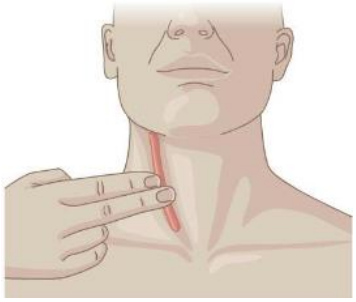
2. **Heart rate**

There are multiple methods to measure heart rate. The easiest method is to use your smartwatch. Another method is to use the pulse oximeter. However, if we are not able to get both of those technological devices, we should use the radial pulse method or the carotid pulse method.

The radial pulse is taken at the base of the thumb. Using two fingers, gently touch and feel the pulse. Use a stopwatch to measure the time. You can rather take it for 10,15, or 30 seconds and multiply it by 6,4, or 2 to know the beats for a minute.

The carotid pulse is taken at the side of the larynx. Using two fingers, gently touch and feel the pulse. If you apply excessive pressure, the client can feel dizziness due to less blood flowing to the brain. As with the radial pulse, a stopwatch is used to measure the time and calculate it using the same method.
(Erin A. McGill, Ian Montel. (2019). Essentials of Sports Performance Training. NASM)





3. Blood Pressure

Have the client seated with both feet on the ground. Using the sphygmomanometer, place the cuff on the client's left upper arm so that it can be over the cubital fossa. The arm should be resting on a table or a chair. Apply the bell of the stethoscope over the brachial artery. Fully close the valve on the hand pump and pump it up to 160 mmHg. Do not exceed 180 mmHg.

Open the valve slightly to release the pressure off the cuff slowly. Listen to the sound of the pulse and read the scale when it begins and fades out. The beginning point will be the client's systolic pressure, and the ending point will be the client's diastolic pressure. Repeat on the right arm after one minute. Blood pressure will be recorded as a fraction: systolic/diastolic. According to the American Heart Association, healthy systolic pressure is <120 mmHg and healthy diastolic pressure is <80 mmHg.

A pulse pressure represents the condition of your heart. A healthy pulse pressure is about 40 mmHg. A pulse pressure greater than or less than 40 mmHg indicates a potential heart condition. You calculate your pulse pressure using the following formula:

Pulse Pressure = Systolic BP - Diastolic BP

<Pre-Lab 1> Height/Weight, Heart rate, Blood pressure

Name: _____ Class: _____ Grade: _____

1. The client is 160cm tall and weighs 70kg. Provide the client's height and weight in inches and pounds. SHOW your work. (Remember to include units.)

2. You measured a client's heart rate for 15 seconds, and you counted 28. What will be the client's beats for a minute? SHOW your work.

3. Circle on the right answer.
   True / False A sphygmomanometer is used to measure heart rate.

4. Explain in your own words how you would position the client when taking blood pressure.

5. What is a normal response of heart rate and blood pressure with exercise?

<Post-Lab 1> Height/Weight, Heart rate, Blood pressure

Name: _____ Gender : _____

Height (cm)	
Weight (kg)	

Heart rate (rest)	
Heart rate (after exercise)	

	1st trial	2nd trial	Average
Systolic			
Diastolic			

1. Calculate your BMI. (SHOW your work. Remember to include units.)

2. What is the range of healthy blood pressure?

3. Explain, in your own words, what is pulse pressure and what does it indicate.

4. Calculate your pulse pressure at rest. (SHOW your work. Remember to include units.)

<Lab 2> Body Composition

Purpose

Be familiar with the assessments of body composition by practicing them with your peers. You should be able to measure BIA, circumferences, and skin folds.

Introduction

Gathering body composition provides the client's starting point for training. Body composition is a significant part of the overall fitness evaluation. It is well established that excess body fat can lead to many harmful effects on individual health, such as chronic conditions.

In our last lab, we learned how to calculate BMI using a client's weight and height. However, there are more accurate methods to assess body composition. In this lab, first, you will measure the client's bioelectrical impedance analysis (BIA). BIA method results may vary depending on hydration. Second, you will measure the client's wait-to-hip ratio (WHR). ASCM says that as the WHR increases, health risk increases. This WHR can be initially used to indicate health risks because waist fat becomes the primary issue. Lastly, you are going to do skinfolds. Among various methods of measuring body composition, such as DEXA, underwater weighting, or Bod Pod, skinfolds are a cheap and easy way to do it. However, you will need practice to be skilled and accurate.

Dual-energy X-ray Absorption Spectroscopy (DEXA) uses a small amount of radiation to measure bone mineral density, muscle mass, and body fat. It is commonly used in a clinical setting but not in routine health/fitness testing because it is expensive and requires specialized equipment and trained technicians.

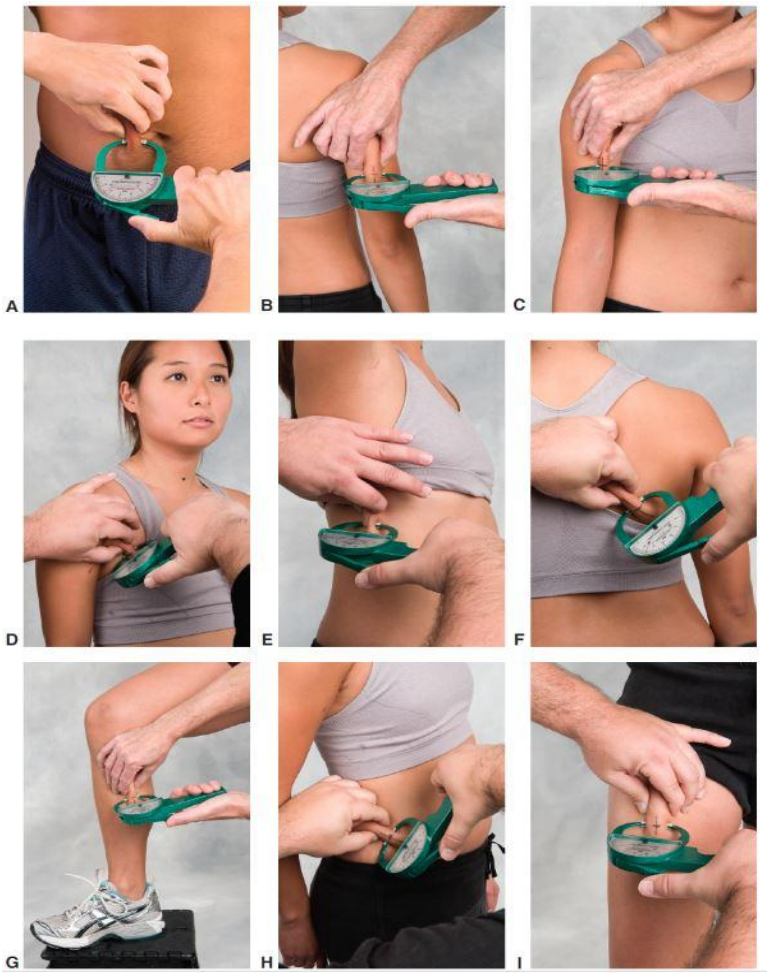
Method

1. **Bioelectrical Impedance Analysis (BIA)**
   BIA will send a minimal amount of electricity to your body. To analyze the body fat percentage, you will use the Omron body fat analyzer HBF-306. Here are the steps.
   1) Turn the device on.
   2) Select 'Guest' and press Set.
   3) Using the Down/Up, select athlete or normal.
   4) Set up the height, weight, age, and gender.
   5) Position the client to stand with both feet on the ground, shoulder-length, and both arms straight forward.
   6) Press start and wait until it gets the body fat.

2. **Wait-to-hip Ratio (WHR)**
   You will measure the client's waist and hip using the tape measure. Position the client standing, with arms at the side, feet together, and the abdomen relaxed.
   - Waist: Measure the narrowest part of your abdomen.
   - Hip: Measure the widest part of your glutes.

Measure them in centimeters twice. You will get the WHR using the following formula:
Waist (cm) / Hip (cm)

3. **Skinfold**
   Skinfolds are the double thickness of skin plus the adipose tissue between the parallel layers of skin. They are well correlated with body composition determination. The concept of the skinfold is that the amount of subcutaneous fat is proportional to the total body fat. All of the measuring will be on the client's right side. Pinch the site with your thumb and finger and read 1cm away from it. You will pinch the site, and after 1-2 seconds, you will read the caliper while remaining the pinch. You will take two trials and get the average.



A. Abdominal

B. Triceps

C. Biceps

D. Chest

E. Midaxillary

F. Subscapular

G. Medial calf

H. Suprailiac

I. Thigh

<u>Jackson Pollock 3 site skinfolds</u>
Males: A. Abdominal/ D. Chest/ I. Thigh
Females: B. Triceps/ H. Suprailiac/ I. Thigh

Magyari, P., Lite, R., Kilpatrick, M., & Schoffstall, J. (2018). *ACSM's resources for the exercise physiologist: A practical guide for the health fitness professional*. Wolters Kluwer Health.

Factors that may cause error with skinfold assessments:

- Poor skinfold site identification
- Poor measurement technique
- The caliper is not calibrated

- An extremely obese or extremely lean subject

<Pre-Lab 2> Body Composition

Name: _____ Class: _____ Grade: _____

1. In your own words, define body composition.

2. Circle on the right answer.
   True / False BIA results can differ depending on the participant's hydration level.

3. You measured Chad's waist equal to 90 cm, and hip equal to 110cm. Calculate the waist-to-hip ratio of Chad. (SHOW your work. Remember to include units.)

4. Which side of the body should you take the skin fold on?

5. Where are the three sites for females and males following Jackson pollock?

<Post-Lab 2> Body Composition

Name: _____ Gender : _____

BIA (Body Fat %)	

	Waist (cm)	Hip (cm)	Ratio
Trial 1			
Trial 2			

Trial 1	Trial 2	Average
Chest :	Chest :	Chest :
Abdomen :	Abdomen :	Abdomen :
Thigh :	Thigh :	Thigh :
Suprailiac :	Suprailiac :	Suprailiac :
Triceps :	Triceps :	Triceps :

Males:

$Bd= 1.10938 - (0.0008267(X_2)) + (0.0000016(X_2)^2) - (0.0002574(X_4))$

% body fat = (457/Bd) - 414.2

X_2 = sum of chest, abs, and thigh skinfold in mm X_4 = age in years

Females:

$Bd= 1.099421 - (0.0009929(X_3)) + (0.0000023(X_3)^2) – (0.0001392(X_4))$

% body fat = (457/Bd) - 414.2

X_3 = sum of thigh, suprailiac, and triceps skinfold in mm X_4 = age in years

% BODY FAT _____

1. Explain two of the methods that you can use for body composition.

2. List at least two factors that may cause an error when doing a skinfold measurement.

3. What body fat category do you fall into based on ACSM guidelines?

TABLE 3.4 • Fitness Categories for Body Composition (% Body Fat) for Men by Age

		Age (yr)					
%		20–29	30–39	40–49	50–59	60–69	70–79
99	Very lean[a]	4.2	7.3	9.5	11.1	12.0	13.6
95		6.4	10.3	13.0	14.9	16.1	15.5
90	Excellent	7.9	12.5	15.0	17.0	18.1	17.5
85		9.1	13.8	16.4	18.3	19.2	19.0
80		10.5	14.9	17.5	19.4	20.2	20.2
75	Good	11.5	15.9	18.5	20.2	21.0	21.1
70		12.6	16.8	19.3	21.0	21.7	21.6
65		13.8	17.7	20.1	21.7	22.4	22.3
60		14.8	18.4	20.8	22.3	23.0	22.9
55	Fair	15.8	19.2	21.4	23.0	23.6	23.6
50		16.7	20.0	22.1	23.6	24.2	24.1
45		17.5	20.7	22.8	24.2	24.9	24.5
40		18.6	21.6	23.5	24.9	25.6	25.2
35	Poor	19.8	22.4	24.2	25.6	26.4	25.7
30		20.7	23.2	24.9	26.3	27.0	26.3
25		22.1	24.1	25.7	27.1	27.9	27.1
20		23.3	25.1	26.6	28.1	28.8	28.0
15	Very poor	25.1	26.4	27.7	29.2	29.8	29.3
10		26.6	27.8	29.1	30.6	31.2	30.6
5		29.3	30.2	31.2	32.7	33.5	32.9
1		33.7	34.4	35.2	36.4	37.2	37.3
n		1,938	10,457	16,032	9,976	3,097	571

TABLE 3.5 • Fitness Categories for Body Composition (% Body Fat) for Women by Age

		Age (yr)					
%		20–29	30–39	40–49	50–59	60–69	70–79
99	Very lean[a]	11.4	11.0	11.7	13.8	13.8	13.7
95		14.1	13.8	15.2	16.9	17.7	16.4
90	Excellent	15.2	15.5	16.8	19.1	20.1	18.8
85		16.1	16.5	18.2	20.8	22.0	21.2
80	Good	16.8	17.5	19.5	22.3	23.2	22.6
75		17.7	18.3	20.5	23.5	24.5	23.7
70		18.6	19.2	21.6	24.7	25.5	24.5
65		19.2	20.1	22.6	25.7	26.6	25.4
60		20.0	21.0	23.6	26.6	27.5	26.3
55	Fair	20.7	22.0	24.6	27.4	28.3	27.1
50		21.8	22.9	25.5	28.3	29.2	27.8
45		22.6	23.7	26.4	29.2	30.1	28.6
40		23.5	24.8	27.4	30.0	30.8	30.0
35	Poor	24.4	25.8	28.3	30.7	31.5	30.9
30		25.7	26.9	29.5	31.7	32.5	31.6
25		26.9	28.1	30.7	32.8	33.3	32.6
20		28.6	29.6	31.9	33.8	34.4	33.6
15	Very poor	30.9	31.4	33.4	34.9	35.4	35.0
10		33.8	33.6	35.0	36.0	36.6	36.1
5		36.6	36.2	37.0	37.4	38.1	37.5
1		38.4	39.0	39.0	39.8	40.3	40.0
n		1,342	4,376	6,392	4,496	1,576	325

<Lab 3> Submaximal Cardiopulmonary Testing (Step test, Cooper test)

Purpose

To be able to conduct a submaximal cardiopulmonary exercise test on an individual in order to assess their aerobic fitness. Also, to be able to interpret test results.

Introduction

Aerobic fitness is the ability to exercise continuously for extended periods without tiring. Also known as cardiovascular endurance, aerobic fitness is an important component in many endurance sports, like distance running, cycling, and rowing. Aerobic fitness is dependent on the amount of oxygen that can be transported by the body to the muscles performing work and the amount of oxygen that can be taken up and utilized by the working muscles.

Factors that influence the amount of oxygen transported include: the amount of oxygen brought into the lungs, the effective surface area of the alveoli in the lungs, the saturation level of the hemoglobin in the red blood cells (RBCs) with oxygen, the movement of blood through the circulatory system. The efficiency of the working muscles to utilize the oxygen transported also affects aerobic fitness. Factors that affect utilization include: the intensity of work being performed, the sources of energy (carbohydrates and fats) available to the cells in the muscles; and, the metabolic pathways used to make the energy required by the muscles.

As the exercise intensity increases, blood levels of lactate begin to rise in an exponential fashion. The anaerobic threshold (lactate threshold) is defined as the level of exercise intensity at which lactic acid builds up in the body faster than it can be cleared away. This appears in untrained and moderately trained individuals around 50-60% of VO_2Max, whereas it occurs at higher work rates in trained subjects (65-80% VO_2Max). A Metabolic Equivalent Task (MET) is a term used to represent exercise intensity and is 3.5 ml/kg/min.

There are set recommendations for aerobic fitness training for frequency, intensity, time and volume. The frequency for moderate intensity is 5–7 days/week, for vigorous intensity 3–5 days/week, or a combination of the two. Moderate intensity is 40–60% of HRR and should be performed for 30–60 min/day (≥150 min/week). Vigorous intensity is 60–90% of HRR and should be performed for 20–60 min/day (≥75 min/week). Again, a combination of these two intensity levels can be utilized for aerobic fitness training. Volume should be ≥500–1,000 MET–min/week.

MET-min/week can be calculated as METs * time (mins) * frequency (days/week) = MET-min/week.

For example: 85 kg male jogging (at ~8 METs) for 30 min on 3 days/week

- 8 METs * 30 min * 3x/wk = 720 MET-min/week

Intensity can be measured using the Ratings of Perceived Exertion (RPE scale). It can be used to regulate intensity of aerobic endurance training across changes in fitness level and typically uses the Borg scale (6-20).

The Karvonen Method is the most accurate method for prescribing aerobic exercise intensity. It can be calculated by:

Target HR = (Intensity * HRR) + HRrest.

HRR = HRmax – HRrest. HRmax = 220 – age (estimated)

Methods

Materials:

- Outdoor track/running surface (of known distance)
- Stop watch
- Steps
- Metronome (download a free one on your smartphone)
- ACSM guidelines for exercise testing and prescription (11 th edition)

Procedures for Submaximal VO_2 Tests:

1. **Queens College Step Test** is a 3-min long test where participants step up and down a single step at a constant rate with the help of a metronome. Heart rate is taken immediately after the test. A slower heart rate is associated with a higher predicted VO_2max.

2. **Cooper 1.5 mile Run/Walk** is a field test designed to predict maximal oxygen consumption rate (VO_2max) by having the individual run/walk 1.5 miles while recording their overall time upon finishing. A faster pace during this test will result in a higher predicted VO_2max. After the test the run is completed and the time is recorded, an equation is used to predict VO_2max and aerobic capacity of the individual.. The Cooper 1.5 mile run/walk test is inexpensive and a great way to test large groups at the same time.

Reference

Liguori, G. (Ed.). (2021). ACSM's Guidelines for exercise testing and prescription (11th ed.). Wolters Kluwer.

<Pre-Lab 3> Submaximal Cardiopulmonary Testing (Step test, Cooper test)

Name: _____ Class: _____ Grade: _____

1. In your own words, describe the purpose of performing a submaximal cardiopulmonary fitness test on a patient or client:

2. What are the two submaximal tests you will be performing in the lab?

3. What ACSM fitness category would a 34 year old female with a VO2max of 29ml/kg/min (Treadmill) be in? (Next page, Table 3.8)

4. What is the ACSM recommended volume per week of physical activity in METs?

5. A 28 year old male has come to you because he wishes to increase his cardiorespiratory endurance in order to participate in a 10k race. You measure his resting heart rate to be 72. If a majority of your prescription calls for him to engage in jogging activity at a moderate intensity of 60%HRR, what is the heart rate goal of your client during exercise? **SHOW your work.**

TABLE 3.8 • Treadmill-Based Cardiorespiratory Fitness Classifications ($\dot{V}O_{2max}$) by Age and Sex

$\dot{V}O_{2max}$ (mL $O_2 \cdot kg^{-1} \cdot min^{-1}$)

		MEN Age Group (yr)				
Percentile		**20–29**	**30–39**	**40–49**	**50–59**	**60–69**
95	Superior	66.3	59.8	55.6	50.7	43.0
90		61.8	56.5	52.1	45.6	40.3
85	Excellent	59.3	54.2	49.3	43.2	38.2
80		57.1	51.6	46.7	41.2	36.1
75		55.2	49.2	45.0	39.7	34.5
70	Good	53.7	48.0	43.9	38.2	32.9
65		52.1	46.6	42.1	36.3	31.6
60		50.2	45.2	40.3	35.1	30.5
55		49.0	43.8	38.9	33.8	29.1
50	Fair	48.0	42.4	37.8	32.6	28.2
45		46.5	41.3	36.7	31.6	27.2
40		44.9	39.6	35.7	30.7	26.6
35		43.5	38.5	34.6	29.5	25.7
30	Poor	41.9	37.4	33.3	28.4	24.6
25		40.1	35.9	31.9	27.1	23.7
20		38.1	34.1	30.5	26.1	22.4
15		35.4	32.7	29.0	24.4	21.2
10	Very poor	32.1	30.2	26.8	22.8	19.8
5		29.0	27.2	24.2	20.9	17.4

		WOMEN Age Group (yr)				
Percentile		**20–29**	**30–39**	**40–49**	**50–59**	**60–69**
95	Superior	56.0	45.8	41.7	35.9	29.4
90		51.3	41.4	38.4	32.0	27.0
Download	Excellent	48.3	39.3	36.0	30.2	25.6
80		46.5	37.5	34.0	28.6	24.6
75		44.7	36.1	32.4	27.6	23.8
70	Good	43.2	34.6	31.1	26.8	23.1
65		41.6	33.5	30.0	26.0	22.0
60		40.6	32.2	28.7	25.2	21.2
55		38.9	31.2	27.7	24.4	20.5
50	Fair	37.6	30.2	26.7	23.4	20.0
45		35.9	29.3	25.9	22.7	19.6
40		34.6	28.2	24.9	21.8	18.9
35		33.6	27.4	24.1	21.2	18.4
30	Poor	32.0	26.4	23.3	20.6	17.9
25		30.5	25.3	22.1	19.9	17.2
20		28.6	24.1	21.3	19.1	16.5
15		26.2	22.5	20.0	18.3	15.6
10	Very poor	23.9	20.9	18.8	17.3	14.6
5		21.7	19.0	17.0	16.0	13.4
		(n = 410)	(n = 608)	(n = 843)	(n = 805)	(n = 408)

Queens College (McArdle) Step Test

Data Collection Worksheet

Participant's name: _____ Date: _____

Age (y): _____ Sex: _____ Height (cm) _____ Weight (kg): _____

Step Height: _____ (recommend 16.25 in or 41.25 cm)

Cadence: ☐ For men: 24 steps/min, set metronome to 96 bpm

☐ For women: 22 steps/min, set metronome to 88 bpm

Duration: 3 minutes

Stop and palpate pulse (radial) while standing, within the first 5 seconds. Take 15-s pulse, then multiply by 4.

HR: _____ bpm

For men: VO_2max (mL/kg/min) = 111.33 – (0.42 x HR)
For women: VO_2max (mL/kg/min) = 65.81 – (0.1847 x HR)

VO_2max = _____ ml/kg/min

Category: _____ (GETP 11, Table 3.8)

Cooper 1.5-mile Run/Walk

Data Collection Worksheet

Participant's name: _____ Date: _____

Age (y): _____ Sex: _____ Weight (kg): _____

Run time (min: sec): ____ : ____

VO_2 max = 3.5 + = _____ ml/kg/min

Category: _____ (GETP 11, Table 3.8)

<Post-Lab 3> Submaximal Cardiopulmonary Testing (Step test, Cooper test)

1. When should heart rate be taken after an individual completes the 3 minute duration of the Queens College (McArdle) Step Test?
    a. After the individual has fully recovered from the submaximal test.
    b. Within the first 5 seconds after completing the submaximal test.
    c. Whenever the individual tells you they are ready.

2. You just completed the step test on a 36 year old female in order to assess her cardiorespiratory fitness before designing a training program. Her heart rate directly after the submaximal test was 162bpm. What is her predicted VO_2max and what category does this place her in? **Show your work.**

3. What are the cadences required for both male and female subjects performing the Queens College (McArdle) Step Test? (In bpm)

4. What was yours or your partners' predicted VO_2max for this lab?

5. If you have to perform a VO_2max test to an individual, which one would you use and why?

<Lab 4> Submaximal Cardiopulmonary Testing (Treadmill)

Purpose

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Introduction

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- 8 METs * 30 min * 3x/wk = 720 MET-min/week

Intensity can be measured using the Ratings of Perceived Exertion (RPE scale). It can be used to regulate intensity of aerobic endurance training across changes in fitness level and typically uses the Borg scale (6-20).

The Karvonen Method is the most accurate method for prescribing aerobic exercise intensity. It can be calculated by:

Target HR = (Intensity * HRR) + HRrest.

HRR = HRmax – HRrest. HRmax = 220 – age (estimated)

Methods

1. **Balke Submaximal Treadmill Test** is a submaximal test used for predicting maximal oxygen consumption rate (VO_2max) using a treadmill. During this test, the participant is required to walk on a treadmill at a constant pace of 3 mph with a 2.5% grade increase every two minutes. The participants estimated heart rate max (HRmax) and 85% of HRmax should be calculated before the start of the test.

2. **Ebbeling Single-Stage Submaximal Treadmill Walking Test** is a treadmill test used for predicting maximal oxygen consumption rate (VO_2max) using a treadmill. During this test, the participant will walk on the treadmill for 4 minutes at a given speed with a 5% grade. Steady state heart rate (SSHR) will be recorded by averaging the participants heart rate during the end of the last two minutes. An equation is then used in order to predict VO_2max.

<Pre-Lab 4> Submaximal Cardiopulmonary Testing (Treadmill)

Name: _____ Class: _____ Grade: _____

1. When conducting the Balke Submaximal Treadmill test, the grade should be increased ____ % each stage.

2. Circle the correct answer.
   True / False Exercise intensity can be measured by using Rating of Perceived Exertion (RPE scale). A commonly used RPE scale is the Borg scale, which uses a range of 6-20.

3. What factors influence oxygen transportation to working muscles?

4. ACSM recommends that individuals engage in _____ min/week of moderate intensity or _____ min/week of vigorous intensity cardiorespiratory exercise.

5. Circle the correct answer.
   True or False Blood lactate levels will increase as exercise intensity increases.

Balke Submaximal Treadmill Test

Data Collection Worksheet

Participant's name: _____ Date: _____

Age (y): _____ Sex: _____ Height (cm) _____ Weight (kg): _____

Estimated HRmax: _____ 85% HRmax: _____

*****3mph, 2.5% grade increase every 2 min

	HR	VO_2 (if measuring)
Stage 1 (0%):	_____bpm	_____ml/kg/min
Stage 2 (2.5%):	_____bpm	_____ml/kg/min
Stage 3 (5%):	_____bpm	_____ml/kg/min
Stage 4 (7.5%):	_____bpm	_____ml/kg/min
Stage 5 (10%):	_____bpm	_____ml/kg/min
Stage 6 (12.5%):	_____bpm	_____ml/kg/min
Stage 7(15%):	_____bpm	_____ml/kg/min
Stage 8 (17.5%):	_____bpm	_____ml/kg/min

Graph: x-axis: %Grade and VO_2; y-axis: HR

(if not measured, use Table 6.3: VO_2 = 3.5 ml/kg/min + (0.1 * 80.5 m/min) + (1.8 * 80.5 m/min * % grade)

Extrapolate HR to estimated HRmax (linear part starting around 7.5% grade)

Drop vertical line down to x-axis and read VO_2

Estimated VO_2max = _____ ml/kg/min
Category: _____ (GETP 11, Table 3.8)

Ebbeling Single-Stage Treadmill Walking Test

Data Collection Worksheet

Participant's name: _____ Date: _____

Age (y): _____ Sex: _____ Estimated HRmax: _____

Protocol:

1. Warm up for 4 minutes at 0% grade and a walking speed between 2.0 and 4.5 mph. The speed should be chosen in order to elicit a heart rate between 50% and 70% of the subjects' age predicted max HR. Speed may be adjusted after the first minute as needed.
2. After the warm up is complete, elevate the treadmill to a 5% grade while the subject continues to walk for an additional 4 minutes at a speed of 2.0, 3.0, 4.0, or 4.5 mph. Steady state heart rate (SSHR) is calculated by recording the participants heart rate during the final 30s of the last two minutes and averaging the two. If heart rate differs by more than 5 bpm, the test should be extended by an additional minute and record the SSHR from the new final two minutes.
3. Enter SSHR and other information into the equation below.

Time	HR
Minute 3	_____ bpm
Minute 4	_____ bpm
Minute 5 (if needed)	_____ bpm

Steady State heart rate (SSHR): _____ bpm

Ebbeling Estimated VO_2max equation:

VO_2max (ml/kg/min) = 15.1 + (21.8 × speed in mph) - (0.327 × SSHR in bpm) - (0.263 × speed in mph × age in yr) + (0.00504 × SSHR in bpm × age in yr) + (5.98 × gender: female = 0, male = 1)

Estimated VO_2max = _____ ml/kg/min

Category: _____ (GETP 11, Table 3.8)

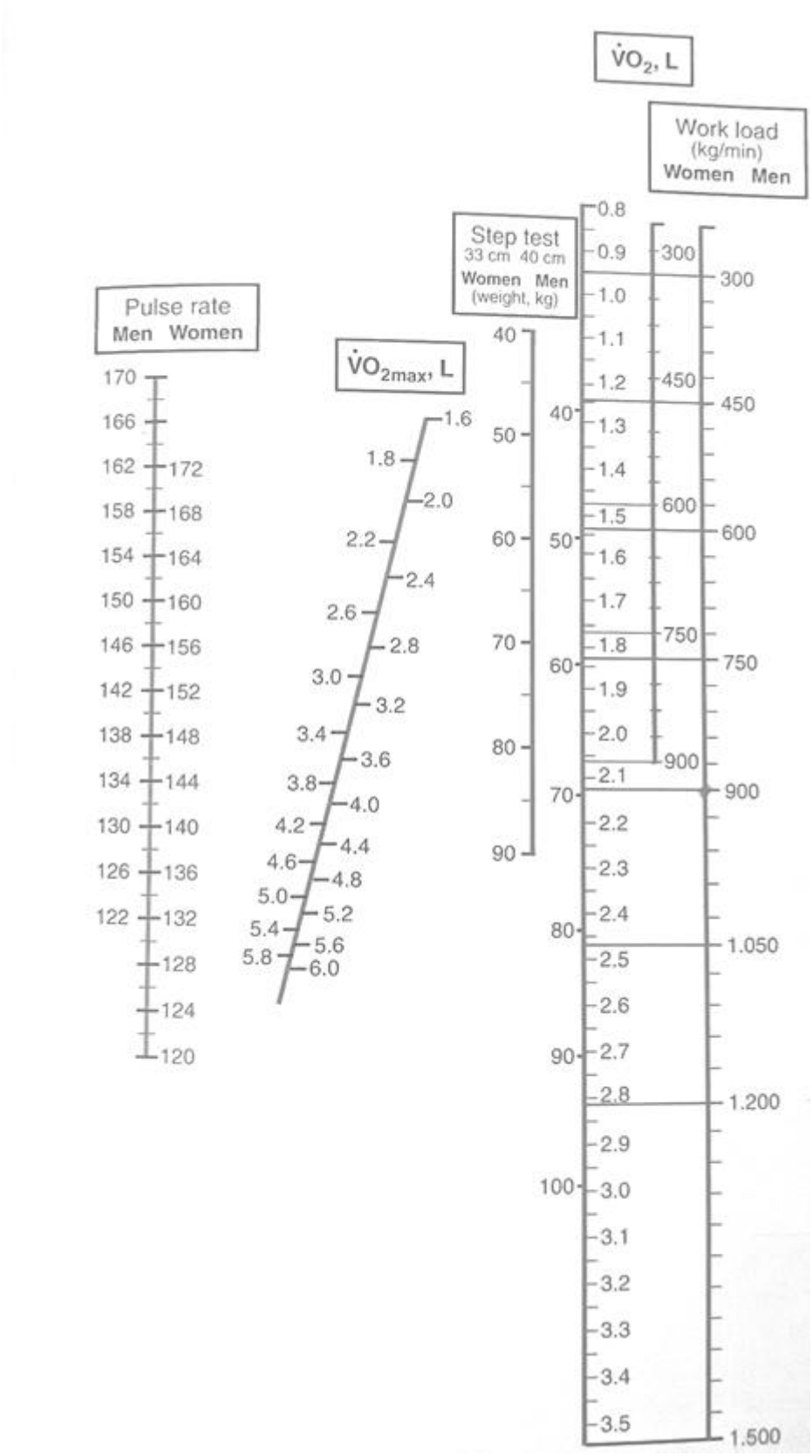


TABLE 3.8 • Treadmill-Based Cardiorespiratory Fitness Classifications ($\dot{V}O_{2max}$) by Age and Sex

$\dot{V}O_{2max}$ (mL $O_2 \cdot kg^{-1} \cdot min^{-1}$)

MEN		Age Group (yr)				
Percentile		**20–29**	**30–39**	**40–49**	**50–59**	**60–69**
95	Superior	66.3	59.8	55.6	50.7	43.0
90		61.8	56.5	52.1	45.6	40.3
85	Excellent	59.3	54.2	49.3	43.2	38.2
80		57.1	51.6	46.7	41.2	36.1
75		55.2	49.2	45.0	39.7	34.5
70	Good	53.7	48.0	43.9	38.2	32.9
65		52.1	46.6	42.1	36.3	31.6
60		50.2	45.2	40.3	35.1	30.5
55		49.0	43.8	38.9	33.8	29.1
50	Fair	48.0	42.4	37.8	32.6	28.2
45		46.5	41.3	36.7	31.6	27.2
40		44.9	39.6	35.7	30.7	26.6
35		43.5	38.5	34.6	29.5	25.7
30	Poor	41.9	37.4	33.3	28.4	24.6
25		40.1	35.9	31.9	27.1	23.7
20		38.1	34.1	30.5	26.1	22.4
15		35.4	32.7	29.0	24.4	21.2
10	Very poor	32.1	30.2	26.8	22.8	19.8
5		29.0	27.2	24.2	20.9	17.4

WOMEN		Age Group (yr)				
Percentile		**20–29**	**30–39**	**40–49**	**50–59**	**60–69**
95	Superior	56.0	45.8	41.7	35.9	29.4
90		51.3	41.4	38.4	32.0	27.0
Download	Excellent	48.3	39.3	36.0	30.2	25.6
80		46.5	37.5	34.0	28.6	24.6
75		44.7	36.1	32.4	27.6	23.8
70	Good	43.2	34.6	31.1	26.8	23.1
65		41.6	33.5	30.0	26.0	22.0
60		40.6	32.2	28.7	25.2	21.2
55		38.9	31.2	27.7	24.4	20.5
50	Fair	37.6	30.2	26.7	23.4	20.0
45		35.9	29.3	25.9	22.7	19.6
40		34.6	28.2	24.9	21.8	18.9
35		33.6	27.4	24.1	21.2	18.4
30	Poor	32.0	26.4	23.3	20.6	17.9
25		30.5	25.3	22.1	19.9	17.2
20		28.6	24.1	21.3	19.1	16.5
15		26.2	22.5	20.0	18.3	15.6
10	Very poor	23.9	20.9	18.8	17.3	14.6
5		21.7	19.0	17.0	16.0	13.4
		(n = 410)	(n = 608)	(n = 843)	(n = 805)	(n = 408)

<Post-Lab 4> Submaximal Cardiopulmonary Testing (Treadmill)

Name: _____ Class: _____ Grade: _____

1. **True or False:** The Balke Submaximal Treadmill Test is a submaximal test used for predicting maximal oxygen consumption rate (VO_2max) using a treadmill.

2. Calculate the relative VO_2max (ml/kg/min) of your client who is a 28 year old male, weighs 75kg, and has an absolute VO_2max of 3.8L/min. Also, what would be his cardiorespiratory fitness classification (Table 3.8)? **Show you work.**

3. When conducting the Ebbeling treadmill test on a participant, the warm up should elicit a heart rate between ____% and ____% of age predicted heart rate max.

4. **True or False:** For both the Balke and Ebbeling treadmill tests, heart rate should be monitored and recorded in order to calculate VO_2max?

5. After completing the Ebbeling treadmill test on a client, you wish to calculate and find their predicted VO_2max. The client is a 32 year old female who completed her submaximal test by walking at 3.0 mph (5% grade) with a steady state heart rate of 165 bpm. What is your client's predicted VO_2max and what category does this place her in?

<Lab 5> Submaximal Cardiopulmonary Testing (Cycle)

Purpose

To be able to conduct a submaximal cardiopulmonary exercise test on an individual in order to assess their aerobic fitness. Also, to be able to interpret test results.

Introduction

Aerobic fitness is the ability to exercise continuously for extended periods without tiring. Also known as cardiovascular endurance, aerobic fitness is an important component in many endurance sports, like distance running, cycling, and rowing. Aerobic fitness is dependent on the amount of oxygen that can be transported by the body to the muscles performing work and the amount of oxygen that can be taken up and utilized by the working muscles.

Factors that influence the amount of oxygen transported include: the amount of oxygen brought into the lungs, the effective surface area of the alveoli in the lungs, the saturation level of the hemoglobin in the red blood cells (RBCs) with oxygen, the movement of blood through the circulatory system. The efficiency of the working muscles to utilize the oxygen transported also affects aerobic fitness. Factors that affect utilization include: the intensity of work being performed, the sources of energy (carbohydrates and fats) available to the cells in the muscles; and, the metabolic pathways used to make the energy required by the muscles.

As the exercise intensity increases, blood levels of lactate begin to rise in an exponential fashion. The anaerobic threshold (lactate threshold) is defined as the level of exercise intensity at which lactic acid builds up in the body faster than it can be cleared away. This appears in untrained and moderately trained individuals around 50-60% of VO_2Max, whereas it occurs at higher work rates in trained subjects (65-80% VO_2Max). A Metabolic Equivalent Task (A MET) is a term used to represent exercise intensity and is 3.5 ml/kg/min.

There are set recommendations for aerobic fitness training for frequency, intensity, time and volume. The frequency for moderate intensity is 5–7 days/week, for vigorous intensity 3–5 days/week, or a combination of the two. Moderate intensity is 40–60% of HRR and should be performed for 30–60 min/day (≥150 min/week). Vigorous intensity is 60–90% of HRR and should be performed for 20–60 min/day (≥75 min/week). Again, a combination of these two intensity levels can be utilized for aerobic fitness training. Volume should be ≥500–1,000 MET–min/week.

MET-min/week can be calculated as METs * time (mins) * frequency (days/week) = MET-min/week.

For example: 85 kg male jogging (at ~8 METs) for 30 min on 3 days/week

- 8 METs * 30 min * 3x/wk = 720 MET-min/week

Intensity can be measured using the Ratings of Perceived Exertion (RPE scale). It can be used to regulate intensity of aerobic endurance training across changes in fitness level and typically uses the Borg scale (6-20).

The Karvonen Method is the most accurate method for prescribing aerobic exercise intensity. It can be calculated by:

Target HR = (Intensity * HRR) + HRrest.

HRR = HRmax – HRrest. HRmax = 220 – age (estimated)

Methods

1. **Astrand-Ryhming Cycle Ergometer** is a cycling test used to predict maximal oxygen consumption rate (VO_2max) by measuring how long you can last on the Lode with the amount of weight (Watts) added to the ergometer. Heart rate will be taken at minute 5 and 6. The average of the two heart rates will be used to measure VO_2max as well as the amount of Watts used for the test.
2. **YMCA's Submaximal Cycle Ergometer test** is a cycling test used to predict maximal oxygen consumption rate (VO2 max) by increasing workloads every 3 minutes depending on the participant's heart rate. Heart rate will be taken at the end of minutes 2 and 3 of each stage. With the average heart rate, you will decide how much workload you would add to the previous stage. The participant will maintain a cadence of 50 rpm.

<Pre-Lab 5> Submaximal Cardiopulmonary Testing (Cycle)

Name: _____ Class: _____ Grade: _____

1. You are about to conduct the Astrand-Rhyming Cycle Ergometer test on an unconditioned male in order to assess his cardiorespiratory fitness level. Before the test, he tells you that he has not regularly participated in any aerobic activities in a couple years and is 'out of shape' at the moment. Based on this information, what work rate would you have him perform his exercise test at?

2. Why would you conduct a submaximal test rather than a maximal VO2 max test?

3. Explain in your own words, what is the difference between the Astrand and YMCA cycle ergometer test?

4. Circle the correct answer.
   True / False During the YMCA's submaximal cycle ergometer test, heart rate will be taken at minute 5 and 6.

5. During the Astrand-Rhyming cycle ergometer test, you have got 145 bpm of HR during minute 5, and 149 bpm of HR during minute 6. What is the average HR you would use to calculate estimated VO2 max? (SHOW your work. Remember to include units.)

Astrand-Ryhming Cycle Ergometer Test

Data Collection Worksheet

Participant's name: _____ Date: _____

Age (y): _____ Sex: _____ Weight (kg): _____ Cycle Seat Height: _____

Work rate: _____ Watts (suggested work rate: Men, unconditioned: 50 or 100 W

Men, conditioned: 100 or 150 W

Women, unconditioned: 50 or 75 W

Women, conditioned: 75 or 100 W)

Pedal rate: 50 rpm

Duration: 6 min

HR during minute 5: _____ bpm

HR during minute 6: _____ bpm

Average HR: _____ bpm

Use nomogram (**Figure 3.1**) to estimate VO_2max.

VO_2max = _____ L/min

Adjust VO_2max (if necessary)

Corrected VO_2max = _____ L/min = _____ ml/kg/min

Category: _____ (GETP 11, Table 3.9)

Age	Correction Factor
15	1.10
25	1.00
35	0.87
40	0.83
45	0.78
50	0.75
55	0.71
60	0.68
65	0.65

YMCA Submaximal Cycle Ergometer Test
Data Collection Worksheet

Participant's name: _____ Date: _____

Age(y): _____ Weight (kg): _____ Estimated HRmax: _____ 85% HR max: _____

Maintain a cadence of 50 rpm. Take HR at the end of minutes 2 and 3.

Heart Rate and Loading Sequence					**Average HR**
1st stage	25 W (HR for the last minute of the 1st stage determines subsequent workloads)				
	HR<80bpm	HR=80-89bpm	HR=90-100bpm	HR > 100 bpm	
2nd stage	125W	100W	75W	50W	
3rd stage	150W	125W	100W	75W	
4th stage	175W	150W	125W	100W	
Additional stages	If additional workloads are required to achieve within 10 bpm of 85% HR max, add 25W to the previous workload				

VO_2 = [(1.8 x work rate) / body weight in kg)] + 7

VO_21 = submaximal predicted VO_2 at 2nd to last workload

VO_22 = submaximal predicted VO_2 at last workload

Slope (a) = (VO_22 – VO_21) / (HR2 – HR1)

HR1 = average of last two heart rates from the 2nd to last workload

HR2 = average of last two heart rates last workload

Estimated VO_2max (mL/kg/min) = a (HRmax – HR2) + VO_22 = _____ ml/kg/min

Category: _____ (GETP 11, Table 3.9)

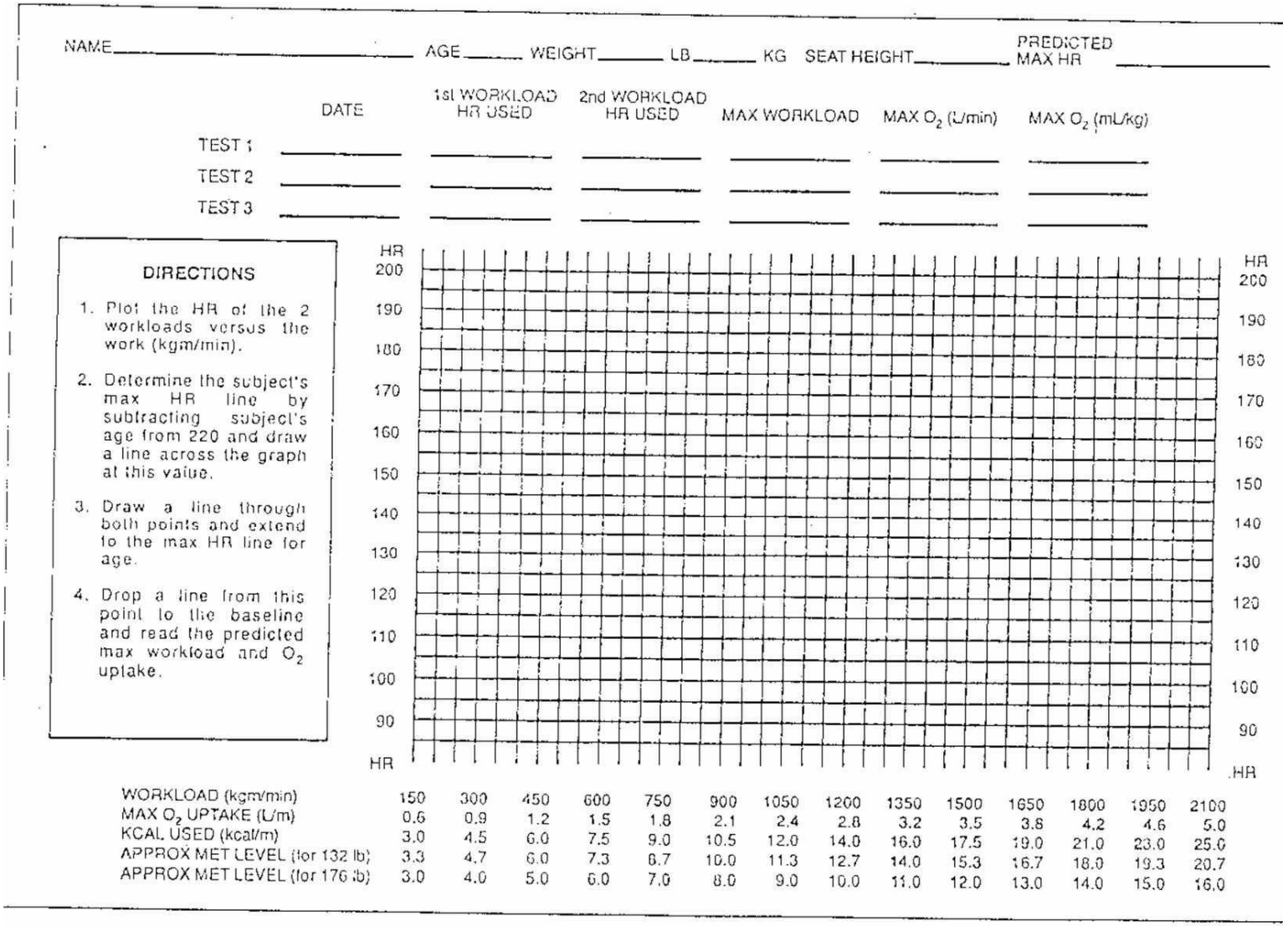


Figure 4.13 Graph for determining $\dot{V}O_{2max}$ from submaximal heart rates obtained during the YMCA's submaximal bicycle test. *Source:* Reprinted from The Y's Way to Physical Fitness (3rd Ed. Champaign, Il, Human Kinetics Publisher, 1989), with permission of the YMCA of the U.S.A., 101 N. Wacker Drive, Chicago, IL 60606.

TABLE 3.9 • Cycle Ergometer-Based Cardiorespiratory Fitness Classifications ($\dot{V}O_{2max}$) by Age and Sex

$\dot{V}O_{2max}$ (mL $O_2 \cdot kg^{-1} \cdot min^{-1}$)

MEN		Age Group (yr)				
Percentile		20–29	30–39	40–49	50–59	60–69
95	Superior	58.5	44.7	41.9	37.4	32.4
90		55.5	41.7	37.1	34.0	29.9
85	Excellent	53.9	38.1	34.9	32.1	27.8
80		51.4	36.2	34.2	30.7	26.7
75		49.5	35	31.8	29.3	25.5
70	Good	47.9	33.9	30.4	28.2	24.5
65		46	31.8	29.3	27.1	24
60		44.5	31.1	28.6	26.3	23.2
55		43.1	30.7	28	25.7	22.9
50	Fair	41.9	30.1	27.1	24.8	22.4
45		40.2	29.4	26.2	24.2	21.9
40		38.3	28.1	25.4	23.6	21.4
35		37.6	27.5	24.9	23	21
30	Poor	36.2	26.9	24.0	22.6	20.2
25		34.7	26.2	22.9	22.1	19.7
20		33.2	25.4	22.2	21.5	19.0
15		31.8	23.9	21.6	20.8	18.4
10	Very poor	29.5	21.8	20.6	20.4	17.3
5		25.5	19.3	18.9	18.1	15.3

WOMEN		Age Group (yr)				
Percentile		20–29	30–39	40–49	50–59	60–69
95	Superior	45.2	33.2	29.3	25	22
90		42.6	30.0	26.2	22.6	20.5
85	Excellent	40.9	27.8	24.4	21.5	19.3
80		38.8	26.0	23.4	20.7	18.8
75		37.1	25.1	22.6	20.1	18.3
70	Good	35.6	24.2	22.0	19.3	17.8
65		34.6	23.3	21.4	18.9	17.3
60		33.6	22.5	20.7	18.2	16.7
55		32.4	22.1	20	17.7	16.3
50	Fair	31.0	21.6	19.4	17.3	16.0
45		29.8	21	18.8	17	15.7
40		28.1	20.1	18.4	16.6	15.4
35		26.6	19.5	17.9	16.2	15.1
30	Poor	25.6	18.8	17.1	15.7	14.7
25		23.2	17.9	16.5	15.3	14.4
20		21.6	17.0	15.8	14.9	14.0
15		20.4	16.3	15.4	14.4	13.5
10	Very poor	19.3	15.2	14.6	13.7	13.0
5		17.1	14.4	13.5	12.8	12.2
		(n = 410)	(n = 608)	(n = 843)	(n = 805)	(n = 408)

<Post-Lab 5> Submaximal Cardiopulmonary Testing (Cycle)

Name: _____ Class: _____ Grade: _____

1. You are about to conduct the Astrand-Rhyming Cycle Ergometer test on an unconditioned male in order to assess his cardiorespiratory fitness level. Before the test, he tells you that he has not regularly participated in any aerobic activities in a couple years and is 'out of shape' at the moment. Based on this information, what work rate would you have him perform his exercise test at?

2. A pedal rate of ____ rpm should be held when performing the Astrand-Rhyming Cycle Ergometer test.

3. What was the estimated VO2 max on both Astrand-Rhyming Cycle ergometer test and YMCA cycle ergometer test?

4. Which submaximal cycle testing do you prefer more and why?

5. You have conducted a YMCA cycle ergometer test on a 43 years old woman. She has an estimated VO2 max of 24 ml/kg/min. Which category is she in based on the ACSM guidelines? (Table 3.9)

<Lab 6> Muscular Strength: Upper Body

Purpose

To understand how muscular strength is measured and be able to perform the tests related to upper body muscular strength.

Introduction

There are various types of training you can perform depending on the adaptations you want to achieve. For example, you can perform resistance training in order to improve strength, you can perform sprint interval training in order to improve your power, or you can go for jogs in order to improve your endurance.

Muscular strength is the ability of a muscle group to exert force to overcome the most resistance in one effort (1 rep maximum testing). Initially, adaptations to resistance training (such as increases in strength) are due to adaptations in nervous system function that elevate motor neuron output without increasing muscle size or cross-sectional area. Resistance training increases both Type I and Type II muscle fiber area, but Type II fibers have the greatest increase in size. This increase in Type II fibers increases your glycolytic capacity but reduces your oxidative capacity, mitochondrial, and capillary density. Therefore, sprinters and power athletes will have more Type II muscle fibers than Type I fibers.

Muscles produce force by recruiting motor units (a group of muscle fibers innervated by a motor neuron) along a gradient. During voluntary isometric and concentric contractions, the orderly pattern of recruitment is controlled by the size of the motor unit, a condition known as the size principle. Small motor units, which contain slow-twitch muscle fibers, have the lowest firing threshold and are recruited first. Demands for larger forces are met by the recruitment of increasingly larger motor units. The largest motor units that contain the fast-twitch B fibers have the highest threshold and are recruited last. If the workout intensity is low, these motor units may be the only ones that are recruited. If the workout intensity is high, such as when lifting heavy, slow- twitch motor units are recruited first, followed by fast-twitch A and fast- twitch B, if needed.

Methods

Materials:

Power racks in NHS 175
Handgrip Dynamometers

Muscular Strength Testing

Procedure for handgrip test: Adjust the grip bar on the dynamometer so the second joint of the fingers fits snugly over the handle. The participant stands with feet slightly apart and holds the dynamometer in line with the forearm at the level of the thigh, away from the body. The participant then squeezes the dynamometer as hard as possible without holding the breath (to avoid the Valsalva maneuver). Neither the hand nor the dynamometer should touch

the body or any other object. Record their grip strength in kilograms and repeat the test with the same hand. Then switch hands. The maximum grip strength is the highest value recorded from either hand (to the nearest kilogram). Compare the numbers to table 3.10 (GETP 11).

Procedure for 1 RM bench press: The participant should warm up by completing 2-3 submaximal repetitions. The 1 RM should be determined within four trials with rest periods of 2-4 minutes between trials. An initial weight should be selected based on the subject's perceived capacity (50-70% of capacity). Progressively increase weight by 5-10% until the participant cannot complete the selected weight. All reps need to be performed at the same speed and range of motion. Record the final weight lifted successfully as the absolute 1-RM. Find the bench press weight ratio and compare to the table 3.11 (GETP 11).

TABLE 3.10 • Fitness Categories for Grip Strength[a] by Sex and Age

	5th	10th	25th	50th	75th	90th	95th
Age (yr)				Males			
20–24	32	34	38	43	48	52	55
25–29	34	37	41	45	50	54	57
30–34	36	38	42	47	52	56	59
35–39	37	39	43	48	53	57	60
40–44	37	40	44	48	53	57	60
45–49	37	39	43	48	53	57	60
50–54	36	39	43	47	52	56	59
55–59	34	37	41	46	50	54	57
60–64	32	35	39	44	48	52	55
65–69	29	32	36	41	45	49	52
70–74	25	29	33	38	42	46	49
75–79	21	25	29	34	38	42	44
				Females			
20–24	20	22	24	27	29	32	34
25–29	21	22	25	28	30	33	35
30–34	22	23	25	28	31	34	35
35–39	22	23	26	28	31	34	36
40–44	22	23	26	29	31	34	36
45–49	22	23	25	28	31	34	36
50–54	21	23	25	28	31	33	35
55–59	20	22	24	27	30	32	34
60–64	19	21	23	26	29	31	33
65–69	17	19	22	25	27	30	31
70–74	15	18	21	23	25	28	29
75–79	13	16	19	21	23	26	27

[a]Norms use the best score measured in kilograms for left or right hands.
Adapted with permission from (133).

<Pre-Lab 6> Muscular Strength: Upper Body

Name: _____ Class: _____ Grade: _____

1. T/F : Increase in Type II fibers increases your glycolytic capacity but reduces your oxidative capacity, mitochondrial, and capillary density.

2. Define Muscular Strength and how it is different from muscular power.

3. Explain the difference between static and dynamic muscular contractions.

4. List two ways muscular strength can be tested in the upper body.

5. Circle on the right answer.
   True/ False Initial increases in strength, from resistance training, are from adaptations of the nervous system rather than muscular hypertrophy.

<Post-Lab 6> Muscular Strength: Upper Body

Name: _____ Class: _____ Grade: _____

Handgrip results table

Left hand:	Right hand:	Combined:	Category:

Bench press results table

Trial 1:	Trial 2:	Trial 3:	Trial 4:	Weight ratio (=1RM/body weight):	Category:

1. According to the _____ _____demands for larger forces are met by the recruitment of increasingly larger motor units.

2. Sprinters have more _____ muscle fibers.
   a. Type I A
   b. Type II
   c. Type III x

3. What category are you in for handgrip strength? Bench Press weight ratio? How do these compae?

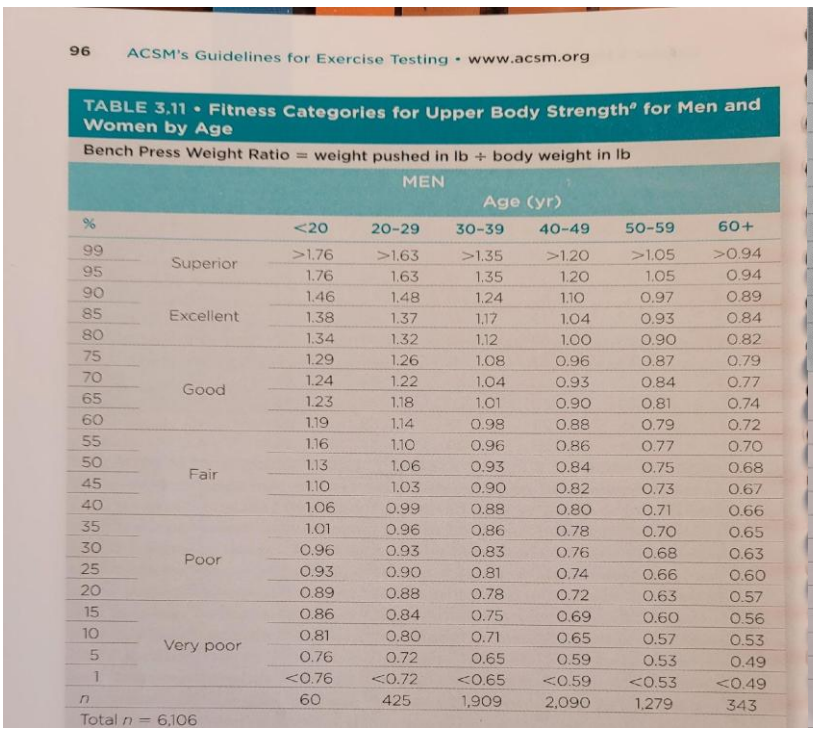


TABLE 3.11 • Fitness Categories for Upper Body Strength[a] for Men and Women by Age

Bench Press Weight Ratio = weight pushed in lb ÷ body weight in lb

		MEN Age (yr)					
%		<20	20–29	30–39	40–49	50–59	60+
99	Superior	>1.76	>1.63	>1.35	>1.20	>1.05	>0.94
95		1.76	1.63	1.35	1.20	1.05	0.94
90	Excellent	1.46	1.48	1.24	1.10	0.97	0.89
85		1.38	1.37	1.17	1.04	0.93	0.84
80		1.34	1.32	1.12	1.00	0.90	0.82
75	Good	1.29	1.26	1.08	0.96	0.87	0.79
70		1.24	1.22	1.04	0.93	0.84	0.77
65		1.23	1.18	1.01	0.90	0.81	0.74
60		1.19	1.14	0.98	0.88	0.79	0.72
55	Fair	1.16	1.10	0.96	0.86	0.77	0.70
50		1.13	1.06	0.93	0.84	0.75	0.68
45		1.10	1.03	0.90	0.82	0.73	0.67
40		1.06	0.99	0.88	0.80	0.71	0.66
35	Poor	1.01	0.96	0.86	0.78	0.70	0.65
30		0.96	0.93	0.83	0.76	0.68	0.63
25		0.93	0.90	0.81	0.74	0.66	0.60
20		0.89	0.88	0.78	0.72	0.63	0.57
15	Very poor	0.86	0.84	0.75	0.69	0.60	0.56
10		0.81	0.80	0.71	0.65	0.57	0.53
5		0.76	0.72	0.65	0.59	0.53	0.49
1		<0.76	<0.72	<0.65	<0.59	<0.53	<0.49
n		60	425	1,909	2,090	1,279	343

Total *n* = 6,106

		WOMEN Age (yr)					
%		<20	20–29	30–39	40–49	50–59	60+
99	Superior	>0.88	>1.01	>0.82	>0.77	>0.68	>0.72
95		0.88	1.01	0.82	0.77	0.68	0.72
90	Excellent	0.83	0.90	0.76	0.71	0.61	0.64
85		0.81	0.83	0.72	0.66	0.57	0.59
80		0.77	0.80	0.70	0.62	0.55	0.54
75	Good	0.76	0.77	0.65	0.60	0.53	0.53
70		0.74	0.74	0.63	0.57	0.52	0.51
65		0.70	0.72	0.62	0.55	0.50	0.48
60		0.65	0.70	0.60	0.54	0.48	0.47
55	Fair	0.64	0.68	0.58	0.53	0.47	0.46
50		0.63	0.65	0.57	0.52	0.46	0.45
45		0.60	0.63	0.55	0.51	0.45	0.44
40		0.58	0.59	0.53	0.50	0.44	0.43
35	Poor	0.57	0.58	0.52	0.48	0.43	0.41
30		0.56	0.56	0.51	0.47	0.42	0.40
25		0.55	0.53	0.49	0.45	0.41	0.39
20		0.53	0.51	0.47	0.43	0.39	0.38
15	Very poor	0.52	0.50	0.45	0.42	0.38	0.36
10		0.50	0.48	0.42	0.38	0.37	0.33
5		0.41	0.44	0.39	0.35	0.31	0.26
1		<0.41	<0.44	<0.39	<0.35	<0.31	<0.26
n		20	191	379	333	189	42

Total *n* = 1,154

<Lab 7> Muscular Strength: Lower Body

Purpose

To understand how muscular strength is measured and be able to perform the tests related to lower body muscular strength.

Introduction

There are various types of training you can perform depending on the adaptations you want to achieve. For example, you can perform resistance training in order to improve strength, you can perform sprint interval training in order to improve your power, or you can go for jogs in order to improve your endurance.

Muscular strength is the ability of a muscle group to exert force to overcome the most resistance in one effort (1 rep maximum testing). Initially, adaptations to resistance training (such as increases in strength) are due to adaptations in nervous system function that elevate motor neuron output without increasing muscle size or cross-sectional area. Resistance training increases both Type I and Type II muscle fiber area, but Type II fibers have the greatest increase in size. This increase in Type II fibers increases your glycolytic capacity but reduces your oxidative capacity, mitochondrial, and capillary density. Therefore, sprinters and power athletes will have more Type II muscle fibers than Type I fibers.

Muscles produce force by recruiting motor units (a group of muscle fibers innervated by a motor neuron) along a gradient. During voluntary isometric and concentric contractions, the orderly pattern of recruitment is controlled by the size of the motor unit, a condition known as the size principle. Small motor units, which contain slow-twitch muscle fibers, have the lowest firing threshold and are recruited first. Demands for larger forces are met by the recruitment of increasingly larger motor units. The largest motor units that contain the fast-twitch B fibers have the highest threshold and are recruited last. If the workout intensity is low, these motor units may be the only ones that are recruited. If the workout intensity is high, such as when lifting heavy, slow- twitch motor units are recruited first, followed by fast-twitch A and fast- twitch B, if needed.

Methods

Materials:

Power racks in NHS 175

Procedure for 1 RM squat: The participant should warm up by completing 2-3 submaximal repetitions. The 1 RM should be determined within four trials with rest periods of 2-4 minutes between trials. An initial weight should be selected based on the subject's perceived capacity (50-70% of capacity). Progressively increase weight by 10-20% until the participant cannot complete the selected weight. All reps need to be performed at the same speed and range of motion. Record the final weight lifted successfully as the absolute 1-RM. Find the bench press weight ratio and compare to the table 3.11 (GETP 11).

<Pre-Lab 7> Muscular Strength: Lower Body

Name: _____ Class: _____ Grade: _____

1. What fitness category would a Woman, age 37, be placed in if her weight ratio on a lower body 1 RM test is 1.45?

2. Other than 1 rep max squat, what other method(s) can be used to obtain lower body strength?

3. T/F: The size principle causes larger motor units to be recruited first.

4. Describe the series of lifts someone should go through before attempting a 1 RM.

TABLE 3.12 • Fitness Categories for Leg Strength by Age and Sex[a]

Leg Press Weight Ratio = weight pushed in lb ÷ body weight in lb

MEN

Percentile		Age (yr) 20–29	30–39	40–49	50–59	60+
90	Well above average	2.27	2.07	1.92	1.80	1.73
80	Above average	2.13	1.93	1.82	1.71	1.62
70		2.05	1.85	1.74	1.64	1.56
60	Average	1.97	1.77	1.68	1.58	1.49
50		1.91	1.71	1.62	1.52	1.43
40	Below average	1.83	1.65	1.57	1.46	1.38
30		1.74	1.59	1.51	1.39	1.30
20	Well below average	1.63	1.52	1.44	1.32	1.25
10		1.51	1.43	1.35	1.22	1.16

WOMEN

Percentile		Age (yr) 20–29	30–39	40–49	50–59	60+
90	Well above average	1.82	1.61	1.48	1.37	1.32
80	Above average	1.68	1.47	1.37	1.25	1.18
70		1.58	1.39	1.29	1.17	1.13
60	Average	1.50	1.33	1.23	1.10	1.04
50		1.44	1.27	1.18	1.05	0.99
40	Below average	1.37	1.21	1.13	0.99	0.93
30		1.27	1.15	1.08	0.95	0.88
20	Well below average	1.22	1.09	1.02	0.88	0.85
10		1.14	1.00	0.94	0.78	0.72

<Post-Lab 7> Muscular Strength: Lower Body

Name: _____ Class: _____ Grade: _____

Squat results table

Trial 1:	Trial 2:	Trial 3:	Trial 4:	Weight ratio (=1RM/body weight):	Category:

1. What fitness category are you in for lower body strength? How does this compare to the results from the upper body testing?

2. List some restrictions or limitations that can affect your results from 1 rep max testing?

3. When should 1 RM testing be performed? How often should 1 RM testing be done?

<Lab 8> Muscular endurance, Muscular power

Purpose

To be able to measure muscular endurance and power.

Introduction

Muscular endurance refers to the capacity of a muscle group of muscles to sustain repeated contractions or a specific muscular activity over an extended duration without fatigue. For example, you will perform push-ups or curl-ups as much as you can without rest. That will tell you your upper body muscular endurance. Endurance training improves the amount of Type I muscle fibers in your body. Elevated levels of Type I fibers coincide with heightened oxidative capacity, greater mitochondrial density, and enhanced capillarization. That is why endurance running athletes have a greater amount of Type I fibers than Type II fibers in their bodies.

The rate of performing work is muscular power. It refers to how strong and fast your muscles are. Increasing muscular power will make you jump higher, run faster, or lift heavy things quickly. To measure muscular power, you can do tests like vertical jumps or forward and backward standing long jump.

Methods

1. **Muscular endurance**
    1) Push-ups
       Push-ups will be performed on the mat. Men will start with both palms on the ground and fingers pointing forward, and women will perform a modified version called “knee push-ups.” They will perform the push-up with their back straight, bending their elbow to 90 degrees and raising up. The score is determined by how many push-ups you can do in a row without taking a break.

2. **Muscular power**
    1) Countermovement vertical jump
        a) The client stands flat-footed next to the Vertec and reaches as high as possible with the dominant hand.
        b) Adjust the Vertec with the allen key (L key) so that the client’s fingertip can just reach the lowest marker.
        c) The client will do a vertical jump using the arms for momentum. They can not do a running start or have a preparatory step.
        d) Inform the client to touch the marker slightly when they are at the highest point during the jump.
        e) Repeat three times. Use the best.
        f) If the client reaches the top on the first or second trial, lift 6 inches more.
        g) Each red marker is 6 in, the blue marker is 1 in, and the white is 0.5 in.

<Pre-Lab 8> Muscular endurance, Muscular power

Name: _____ Class: _____ Grade: _____

1. Circle on the right answer.
   True / False Muscular endurance is the rate of performing work.

2. Circle on the right answer.
   True / False A pushup test measures upper body muscular endurance.

3. Explain in your own words what are the advantages of increasing muscular endurance?

4. List at least two tests that you can perform to measure muscular power.

5. On the Vertec, each red marker is ___ in, the blue marker is ___ in, and the white is ___ in.
   a. 1,6,0.5
   b. 6,1,0.5
   c. 6,1,0.5
   d. 0.5,1,6

<Post-Lab 8> Muscular endurance, Muscular power

Name: _____ Gender : _____

Push-ups	

	Trial 1	Trial 2	Trial 3
Vertical Jump Height (in)			
Best Result			

1. What category are you in with push-ups?

2. What category are you in with vertical jump?

3. Endurance athletes have more _____ muscle fibers.
   a. Type I
   b. Type II
   c. Type III

TABLE 3.13 • Fitness Categories for the Push-up by Age and Sex

Category	Age (yr) 20–29		30–39		40–49		50–59		60–69	
Sex	M	W	M	W	M	W	M	W	M	W
Excellent	≥36	≥30	≥30	≥27	≥25	≥24	≥21	≥21	≥18	≥17
Very good	29–35	21–29	22–29	20–26	17–24	15–23	13–20	11–20	11–17	12–16
Good	22–28	15–20	17–21	13–19	13–16	11–14	10–12	7–10	8–10	5–11
Fair	17–21	10–14	12–16	8–12	10–12	5–10	7–9	2–6	5–7	2–4
Poor	≤16	≤9	≤11	≤7	≤9	≤4	≤6	≤1	≤4	≤1

M, men; W, women.
Reprinted with permission from the Canadian Society for Exercise Physiology (141).

TABLE 3.14 • Fitness Categories for the Countermovement Vertical Jump by Age and Sex

	Age (yr): 15–19	20–29	30–39	40–49	50–59	60–69
Males						
Excellent	≥56	≥58	≥52	≥43	≥41	≥33
Very good	51–55	54–57	46–51	36–42	34–40	29–32
Good	46–50	48–53	40–45	32–35	28–33	25–28
Fair	42–45	42–47	31–39	26–31	18–27	18–24
Poor	≤41	≤41	≤30	≤25	≤17	≤17
Females						
Excellent	≥40	≥38	≥36	≥31	≥25	≥19
Very good	36–39	34–37	32–35	27–30	21–24	15–18
Good	32–35	29–33	28–31	23–26	16–20	11–14
Fair	28–31	25–28	24–27	18–22	10–15	7–10
Poor	≤27	≤24	≤23	≤17	≤9	≤6

All values are in centimeters.
Adapted with permission from (147).

<Lab 9> Agility and Anaerobic Capacity

Purpose

To understand how agility and anaerobic capacity are measured and be able to perform the tests to peers.

Introduction

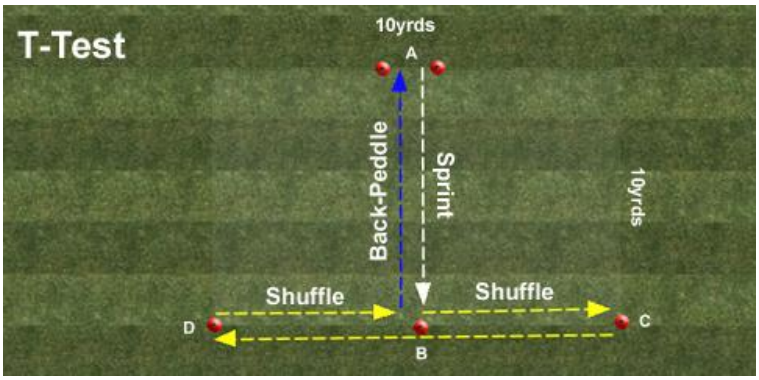
You have learned some fitness or health-related components of fitness testing in your previous labs. Fitness and health-related components are body composition, cardiorespiratory fitness, muscular strength, muscular endurance, and flexibility. In this lab and the next lab, you will learn skills related to the components of fitness testing. Skills-related components are agility, speed, coordination, balance, and power.

Agility is the ability to stop, move, and change direction quickly of the whole body while maintaining control. More recently, the definition of agility has been changed to include more perceptual qualities, and it is now considered "a rapid, whole-body change of direction or speed in response to a sports-specific stimulus." Agility testing includes T-test, 505 agility, and pro agility test.

Anaerobic capacity is the body's maximal energy output during moderate-duration activities by combining phosphagen and anaerobic glycolytic energy systems. The difference between anaerobic power tests and anaerobic capacity tests is that anaerobic capacity is the maximal power output during muscular activity between 30 and 90 seconds, while anaerobic power tests last a few seconds.

Methods

1. **Agility**
    1) T-test



You will set the cones as the picture shows. You will start the stopwatch as soon as your participant sprints from cone A to cone B. Stop the stopwatch when they pass the starting line after performing all the actions they have to do. Compare the results with previous studies.

2. **Anaerobic capacity**
    1) 300-yard shuttle run

    Place two cones 25 yards apart. Participants will run between the cones for six rounds as quickly as possible. You will take the client's time and determine how long it took to finish with a stopwatch. Compare the results with previous studies.

<Pre-Lab 9> Agility and Anaerobic Capacity

Name: _____ Class: _____ Grade: _____

1. Define the following words in your own words.
    a. Agility:

    b. Anaerobic capacity:

2. Circle the correct answer.
   True / False Agility is a skill-related component of fitness testing.

3. List at least two tests that you can perform to measure agility.

4. List the equipment you need to perform a 300-yard shuttle run.

5. For a 300-yard shuttle run, the participant will run _____ rounds of 25 yards.
    a. four
    b. six
    c. eight
    d. twelve

<Post-Lab 9> Agility and Anaerobic Capacity

Name: _____ Grade : _____

T-test time	

300-yard shuttle run

Trial 1	Trial 2	Average time

1. What category are you in with the T-test?

2. What category are you in with the 300-yard shuttle run?

3. Explain in your own words the difference between anaerobic power and anaerobic capacity.

(NSCA Essentials, 4th ed)

Group, sport	Number of participants	T-Test time (seconds)
Junior national volleyball (women)	15	10.33 ± 0.13
Junior national volleyball (men)	14	9.90 ± 0.17
College athletes (women)	56	10.94 ± 0.60
College athletes (men)	47	9.94 ± 0.50
Recreational athletes (women)	20	11.70 ± 0.67
Recreational athletes (men)	24	10.31 ± 0.46
College students (women)	34	11.92 ± 0.52
College students (men)	52	10.08 ± 0.46

300-yard shuttle run

Group, sport, or position	Number of athletes	Time (s)
High school volleyball (women) (98)	27	68.0 ± 6.3
NCAA Division 1 volleyball (women) (98)	26	67.7 ± 3.8
National soccer (men) (107)	18	56.7 ± 1.7
Recreational men and women (121)	81	72.8 ± 9.1
National badminton (men) (120)	12	73.3 ± 3.4

*The values listed are means ± standard deviation. The data should be regarded as only descriptive, not normative.

<Lab 10> Static & Dynamic Balance

Purpose

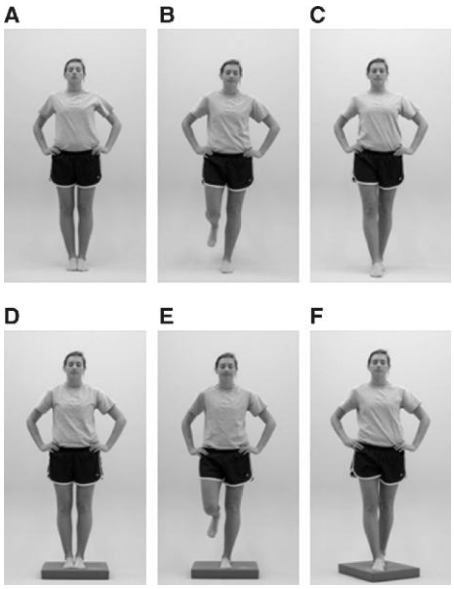
To be able to properly conduct the Balance Error Scoring System and Y-balance test to assess static and dynamic balance of an individual.

Introduction

Balance is the ability to maintain a desired position and is divided into static and dynamic balance. Static balance occurs when an individual maintains postural stability while stationary, while dynamic balance is the ability to maintain postural stability as the body parts are in motion. Historically, balance has not been included in health-related test batteries for physical fitness. However, balance training is recommended for fall prevention and to reduce the risk of ankle sprains in athletes. High technology computerized systems, such as force plates, can measure center of pressure data providing direct measures of balance. These sophisticated systems are costly, so inexpensive alternatives to assess static and dynamic balance include field tests such as the Balance Error Scoring System and Y-balance test, respectively.

Method

Balance Error Scoring System (BESS)



1. Start by having the individual take off their shoes as this test is performed barefoot. The first three tests will be conducted on the floor, then are repeated while standing on a foam pad. All tests are done with the eyes closed, hands placed on hips, and for a duration of 20 seconds.
2. Test 1 (stance 1): Individual places feet side by side (Romberg stance).
3. Test 2 (stance 2): Individual stands on nondominant foot (unipedal stance).
4. Test 3 (stance 3): Individual stands heel-to-toe with the nondominant foot placed behind the dominant foot (tandem stance).
5. The examiner counts the number of errors the individual makes on each of the six tests. Errors include: (a) lifting hands off of the hips, (b) opening eyes, (c) stepping/stumbling, (d) excessive hip flexion or abduction (>30 degrees) to correct balance, and (e) lifting foot or heel. If an error is made, the individual should correct it immediately. The maximal number of errors counted for each of the 20s trials is 10. Failure to maintain the stance position for at least 5s of the 20s trial results in a maximal error score of 10.

Y-balance Test (YBT) - Lower Quarter

1. Start by having the individual take off their shoes as this test is performed barefoot.

2. Next, have the individual lay down flat on their back in order to measure leg length.
3. Leg length is measured using a measuring tape (cm) starting at the anterior superior iliac spine (ASIS) to the medial malleolus. After measurements are taken the assessment will be performed.
4. Have the individual stand on one leg at the center of the block with toes up to, but not over the red line. The leg supporting the body weight is the one being tested.
5. The toes of the opposite foot will be used to push the anterior block as far forward as possible while maintaining balance on the center block. Record the final distance the block is moved.
6. The individual will move the posteromedial and posterolateral blocks in the same manner. Each direction is tested three times with both the dominant and nondominant leg.
7. The best anterior, posteromedial, and posterolateral scores for each leg will be used for final calculations.

References:

1. Liguori, G. (Ed.). (2021). ACSM's Guidelines for exercise testing and prescription (11th ed.). Wolters Kluwer.
2. University of North Carolina's Sports Medicine Research Laboratory. (n.d.). *Balance Error Scoring System (BESS)*. https://atriumhealth.org/documents/carolinasrehab/bess_manual_.pdf

<Pre-Lab 10> Static & Dynamic Balance

Name: _____ Class: _____ Grade: _____

1. In your own words, explain the difference between static and dynamic balance

2. Circle on the right answer.
   True / False The Y-balance test is a commonly used field assessment used to examine static balance of an individual.

3. In your own words, explain why balance training may be beneficial for certain populations.

4. Circle on the right answer.
   True / False When conducting the Balance Error Scoring System (BESS), you should have the individual perform each balancing task with their eyes closed.

5. Both tests require the participant to perform the tasks
   a. With shoes
   b. Barefoot

Balance Error Scoring System (BESS)

Data Collection Worksheet

Participant's name: _____ Date: _____

Balance Error Scoring System - Types of Errors

1. Hands lifted off of the hips
2. Opening eyes
3. Stepping/stumbling
4. Excessive hip flexion or abduction (>30 degrees)
5. Lifting forefoot or heel

Score Card (# of errors):	Firm Surface	Foam Surface
Test 1: Double leg stance		
Test 2: Single leg stance		
Test 3: Tandem stance		
Total Scores:		
BESS Total:		

Which foot was tested (non-dominant): ☐ Left ☐ Right

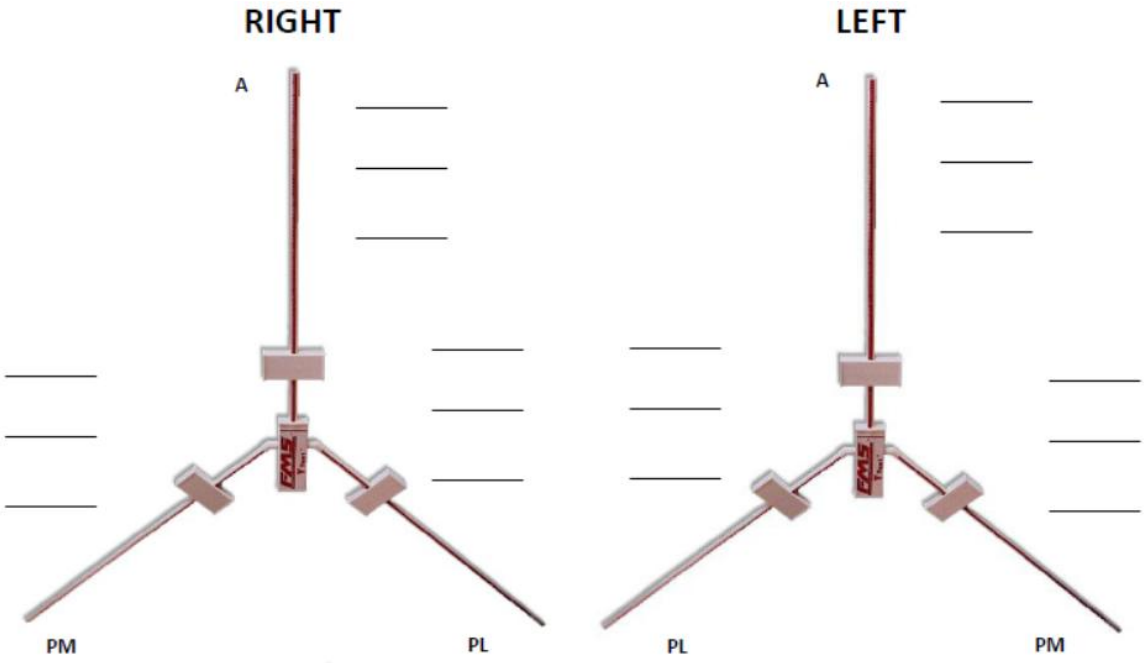
Y-Balance Test – Lower Quarter

Data Collection Worksheet

Participant's name: _____ Date: _____

Age (y): _____ Sex: _____ Height (cm): _____ Weight (kg): _____

Right Limb Length (cm): _____



Greatest Successful Reach

	Right	Left	Difference
Anterior (A)			
Posteromedial (PM)			
Posterolateral (PL)			

Composite Score

Right	
Left	

1. $(A + PM + PL) \div (3 \times Right\ Limb\ Length)$
2. $ANS \times 100$

<Post-Lab 10> Static & Dynamic Balance

Name: _____ Class: _____ Grade: _____

1. Which two bony landmarks are used when measuring leg length for the Y-Balance Test?

2. What three stances was the individual required to hold and balance when performing the BESS?

3. **True or False:** The Balance Error Scoring System (BESS) test is a commonly used field assessment used to examine dynamic balance of an individual.

4. Name 3 different types of errors you noticed you or your partner made when performing the BESS test.

5. The Y-Balance Test can be used to
    a. Identify individuals at risk for lower extremity injuries
    b. Design injury prevention and rehabilitation programs
    c. Monitor an individuals progress over time
    d. All the above