



... LABORATORY INVESTIGATION

Exercise, Conditioning and Pulse Rate

The American Heart Association reports that, in the United States, approximately 1.3 million individuals receive treatment for cardiovascular disease each year. Worse yet, more than 55% of the yearly deaths in this country result from cardiovascular disease. Because of the size of this health problem everyone should become aware of the risk factors associated with cardiovascular disease. One also should learn what one can personally do to reduce their likelihood of suffering from this disease.

Known cardiovascular disease risk factors include smoking, high blood pressure, elevated blood fats, family history, age, sex, obesity, diabetes melitus, stress, and physical condition. It is also known that proper exercise reduces the effects of the risk factors. Therefore, the chance of developing cardiovascular disease is reduced if one follows an active exercise program.

This association between cardiovascular disease and exercise was found during a study of Framingham, Massachusetts individuals where less coronary disease was detected among those physically fit. Now we know with certainty that it is time to turn off the TV and rise from the couch. But, where to start? This laboratory investigation will show you one way to achieve better cardiovascular fitness.

Vernier Equipment

Pulse sensor, LabPro interface



Figure 1

Materials

Step benches, classroom clock with sweep second hand, opaque cloth for each computer station, spreadsheet and graphing software, metronome or 96 beat per minute tape recording.

Safety

Carefully follow your teachers instructions for stepping onto and from the bench. Report any abnormal cardiovascular or skeletal conditions you have to your teacher before participating in the physical part of this laboratory.

PROCEDURE

You will start by predicting your present aerobic fitness through the use of a modified form of the famous Harvard step test. This test is suitable for members of either sex and it assumes you are motivated to do the test to the best of your ability. It also requires you to measure your pulse accurately. Once an estimate of your fitness is obtained you will calculate a target training heart rate based on the these results.

Resting pulse by palpation.

1. This measurement assumes that you are free of stress, that you have not exercised or eaten recently and that you are quietly seated. Place the tips of the first three fingers of one hand over the radial artery of the opposite wrist (See Figure 2). Accurately count the arriving pulse waves for 30 seconds. Multiply the pulse waves counted by 2 and record this value in data Table 1. Have two other members of your group measure your pulse without revealing prior results and record these new values. Find your average resting pulse rate from the three measurements.

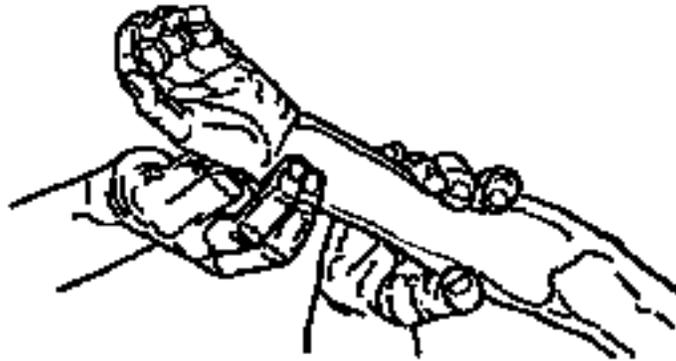


Figure 2.1

Computer recording of resting pulse.

1. This measurement requires the apparatus shown in Figure 1. The pulse pick-up clips to your finger and detects arriving pulse waves photo electrically. The pick-up houses a small incandescent bulb and a light detector mounted opposite from one another in a plastic clip. When living tissue is placed between the light source and the detector, blood in the tissue helps to block the passage of light from the bulb to the detector. Because the amount of blood in the tissue varies with the pulse wave, the amount of light passing through the tissue changes rhythmically. Light intensity changes detected by the pick-up are converted to an electrical signal and then displayed on the computer's screen as a wave. Because the device is so light sensitive it works best when both the hand and pick-up are covered by an opaque fabric of some kind. To measure and record your pulse follow the steps as listed below.
2. Work in groups of three. Decide who will run the computer and whom will be the first test subject.
3. Place the pulse pick-up over the subject's index finger and fingernail (See Figure 1). The subject should sit quietly facing away from the computer screen. The subject's arm should rest on a table. Cover the hand and pick-up with a cloth to block the light.
4. The computer operator should load and run GMBIOL10 using the procedure explained in *Alpha Experiment Tutorial*. A dialog box should appear on the screen.
5. When the first dialog box appears click on *Graph Frequency (Pulse) Sensor*. A message will appear, "Matching Computer Speed". When the second dialog box appears click on *Reset Auto Range*. When the third dialog box appears click on *Analyze*. When the fourth dialog box appears click on *Go-High Speed Read*. When the graph appears click on the green Light to start the pulse recording. To stop graphing click on the red light. The pulse frequency appears as a numerical value in the lower right-hand corner of the graph.

6. At regularly spaced intervals the computer calculates the average pulse rate based on the elapsed time for the last 20 pulses. An accurate pulse rate does not appear on the screen until 30 seconds have elapsed.
7. Continue observing the pulse wave as it is graphed on the screen. Record the pulse frequency of the test subject in Table 1 after the pulse has stabilized.
8. Stabilization usually takes 30 seconds at least. During this time the subject must be relaxed and motionless.

AEROBIC FITNESS PROFILE.

1. Here you will estimate your present aerobic fitness using the modified Harvard step test and a bench 12 inches high. The work task may seem simple but it will require some effort on your part to complete it. Place the bench in a location where you will have ample room to move around.
2. On the first command of **up** you will place either foot fully on the platform. On the second **up** command you will lift yourself onto the bench. Both feet must be on the bench and your back should be straight. On the first **down** command you should step down onto the floor with your first foot. This step returns your body to the floor level. On the second **down** command your second foot returns to the floor. If you step up onto the box with your right foot first you should step down with the right foot first.
3. The cadence or stepping rhythm will be **up. . .up. . .down. . .down. . .up. . .up. . .down. . .down etc.** This cycle is repeated 24 times each minute for 3 minutes.
4. One member of the team should count the cadence using the metronome or tape recording and another member of the team should encourage the test subject to keep up with the cadence. After the work period ends the subject must immediately sit and prepare to take his/her pulse using the palpation method.
5. Count the pulse waves, during the first minute, following the subject's three minutes of exercise. Record the pulse measurement in data Table 2.
6. Derive your personal fitness index category from Table 4 for men and women using the post exercise heart rate (pulse) value. For example, a post exercise pulse of 102 would be in the average range for both men and women. Record your personal fitness category in data Table 2.

Target training rate to improve aerobic fitness.

In this part of the laboratory you will calculate a target pulse rate that, when reached, will stress your heart to a level sufficient to develop greater cardiovascular fitness. This ideal target pulse rate is between 50% and 70% of your maximum aerobic power. Exercise above 70% of the maximum aerobic power produces little added benefit and below 50% there is very little gain for anyone.

1. Your maximum aerobic power will be estimated using the Korvonean method. Record all data in Table 3.
2. Record your resting pulse rate.
3. Estimate your maximum attainable heart rate by subtracting your age from 220.

4. Subtract your resting pulse rate from your estimated maximum heart rate.
5. Your target training rate should be between 50% and 70% of the value recorded on line 3.
6. Calculate and record your personal target training rate using the information in Table 3. You should find that between 15 and 30 minutes of continuous exercise within the target rate range will cause a gain in fitness. Remember though, the exercise activity must be carried out a minimum of 3 alternating days a week.

Analysis

1. Examine the risk factors mentioned in the introduction and comment on any of those that might apply to you.
2. Comment on your personal fitness inventory and on your target training rate values. What do they mean? What should you do about these estimates of your cardiovascular fitness now and in the future?
3. Enter the class resting pulse rate data into a spreadsheet. Find the average pulse rate for the males and the females.
4. Create a bar graph that shows a comparison of the average pulse rates of both sexes.
5. How does your resting pulse compare to the average of others of your sex? Compare the average pulse rates of the male and female members of your class. Is there a difference between the sexes? Can you think of any reasons for the difference if one is found?
6. Create a bar graph that shows a frequency distribution of the fitness categories in your class. It may be necessary to combine some of the categories if your graphing software does not support seven variables.
7. Describe the general fitness of your classmates as predicted by this laboratory investigation.

Going Further

1. Select one activity from the following list; brisk walking, jogging, treadmill, rowing machine, or stationary bicycle. Start the activity and continue it for approximately 5 minutes. Stop the exercise and take your pulse for 30 seconds. If you are below the target rate pick up the pace or if above slack off a bit. Continue the procedure until you get a "feeling" for your target pulse rate. This sensation will become apparent, as you repeat the activity during the 15 to 30 minutes of exercise.
2. As your cardiovascular fitness improves you will need to change your target training rate percentage. This is necessary because with training your resting pulse rate will decrease. Normally, the target rate is recalculated every 4 weeks and the level of exercise intensity adjusted as well. You may find for example, that rapid walking is all that you need initially to reach the pulse target rate. Later jogging or even running may become necessary to elevate the pulse to the desired level.
3. Find out if there is any association between body weight, height and leg length and the Personal Fitness Index.
4. Find out if there is any association between the ability to do "push ups" and the PFI scores of a large group of people.

5. Keep a systematic record of your resting pulse rate as you work your way through a cardiovascular fitness exercise program.

Table 1. Pulse Rate Data	
Measurement Number	Pulse Rate
1	
2	
3	
Average	
Computer Measurement	

Table 2. Personal Fitness	
Exercise Time (seconds)	
Pulse after exercise	
PFI Category	

Table 3. Target Training Pulse Rate	
Resting Pulse Rate	
Maximum Heart Rate	
Maximum Rate - Resting Rate	
Target Training Rate (50%)	
Target Training Rate (70%)	

Table 4. Norms for 3 Minute Step Test		
Fitness Category	Male Pulse	Female Pulse
Excellent	<79	<85
Good	79-89	85-98
Above Average	90-99	99-108
Average	100-105	109-117
Below Average	106-116	118-126
Poor	117-128	127-140
Very Poor	>128	>140