

Physiology of the Circulatory System

Experiment A: Blood Pressure and Heart Rate

Objectives

Before doing this lab you should understand the basic anatomy of the circulatory system.

After doing this lab you should be able to describe the effect of changing body position on heart rate and blood pressure.

Introduction

An important measurable aspect of the circulatory system is blood pressure. When the ventricles of the heart contract, pressure is increased throughout all the arteries. Arterial blood pressure is directly dependent on the amount of blood pumped by the heart per minute and the resistance to blood flow through the arterioles. The arterial blood pressure is determined using a device known as a **sphygmomanometer**. This device consists of an inflatable cuff connected by rubber hoses to a hand pump and a pressure gauge graduated in millimeters of mercury.

During physical exertion the cardiac rate (beats per minute) increases. This increase can be measured as an increase in pulse rate. Although the maximum cardiac rate is generally the same in people of the same age group, those who are physically fit have a higher stroke volume (millimeters per beat) than more sedentary individuals. A person who is in poor physical condition, therefore, reaches his/her maximum cardiac rate at a lower work level than a person of comparable age who is in better shape. Individuals who are in good physical condition can deliver more oxygen to their muscles (have a higher aerobic capacity) before reaching maximum cardiac rate than can those in poor condition. Thus the physically fit have a slower increase in their cardiac rate with exercise and a faster return to the resting cardiac rate after exercise. Physical fitness, therefore, involves not only muscular development but also the ability of the cardiovascular system to respond to sudden changes in demand.

You will be evaluating your fitness based not only on cardiac muscular development but also on the ability of the cardiovascular system to respond to sudden changes in demand. Work in pairs. Determine the fitness level for one member of the pair and then repeat the process for the other member, if there is time.

Test 1: Reclining Pulse Rate

1. The subject should recline for five minutes on a lab bench. (NOTE: Subject should remain reclined for the next test.)
2. Determine the subject's resting pulse rate. Count the number of beats for 30 seconds and multiply by 2. (NOTE: The subject should remain reclining for the next test.) Record the pulse rate in the fitness data box on page 4.
3. Assign fitness points and record them in the fitness data box on page 4.

Reclining Pulse Rate	
Pulse Rate (beats/min)	Fitness Points
50-60	3
61-70	3
71-80	2
81-90	1
91-100	0
101-110	-1

Test 2: Standing Systolic Compared with Reclining Systolic

1. While still reclining from Test 1, measure the systolic and diastolic pressure and record these values below.

reclining systolic pressure _____ mm Hg reclining diastolic pressure _____ mm Hg

2. Remain reclining for two minutes, then stand and **immediately** repeat measurements on the same subject (arms down). Record these values below. (NOTE: Also record the pulse from that same reading in Test 3 on the next page.)

Standing systolic pressure _____ mm Hg standing diastolic pressure _____ mm Hg

- Determine the change in systolic pressure from reclining to standing by subtracting the standing measurement from the reclining measurement. Assign fitness points and record in the fitness data box on page 4.

Change in Systolic Pressure from Reclining to Standing

<u>Change (mm Hg)</u>	<u>Fitness Points</u>
Rise of 8 or more	3
Rise of 2-7	2
No rise	1
Fall of 2-5	0
Fall of 6 or more	-1

Test 3: Baroreceptor Reflex (Pulse Rate Increase from Reclining to Standing)

- Record the pulse rate from the blood pressure reading in Test 2 below.

Pulse immediately upon standing = _____ beats per minute

The observed increase in pulse rate is initiated by baroreceptors (pressure receptors) in the carotid artery and in the aortic arch. When the baroreceptors detect a drop in blood pressure they signal the medulla of the brain to increase the heartbeat and consequently the pulse rate.

- Subtract the reclining pulse rate (Test 1) from the pulse rate immediately upon standing to determine the pulse rate increase upon standing. Record in the fitness data box on page 4.
- Assign fitness points and record in the fitness data box on page 4.

Pulse Rate Increase from Reclining to Standing

<u>Reclining Pulse Rate (beats/min)</u>	<u>Pulse Rate Increase on Standing (# beats)</u>				
	<u>0-10</u>	<u>11-18</u>	<u>19-26</u>	<u>27-34</u>	<u>35-43</u>
	<u>Fitness Points</u>				
50-60	3	3	2	1	0
61-70	3	2	1	0	-1
71-80	3	2	0	-1	-2
81-90	2	1	-1	-2	-3
91-100	1	0	-2	-3	-3
101-110	0	-1	-3	-3	-3

Test 4: Standing Pulse Rate

- The subject should stand at ease for two minutes after Test 3.
- After the two minutes, determine the subject's pulse. Count the number of beats for 30 seconds and multiply by 2. Record the pulse rate in the fitness data box on page 4.
- Assign fitness points and record them in the fitness data box on page 4.

Standing Pulse Rate

<u>Pulse Rate (beats/min)</u>	<u>Fitness Points</u>
60-70	3
71-80	3
81-90	2
91-100	1
101-110	1
111-120	0
121-130	0
131-140	-1

Test 5: Step Test -- Endurance

- The subject should do the following in the stairwell: Stand on the bottom step or landing. Place your right foot two steps up. Raise your body so that your left foot comes to rest by your right foot. Return your left foot to the original position. Repeat this exercise five times, allowing three seconds for each step up.
- Immediately** after the completion of this exercise, measure the subject's pulse for 15 seconds and record below; measure again for 15 seconds and record. Continue taking the subject's pulse only for 30 seconds now and record the rates at 60, 90, and 120 seconds.

Number of beats in the 0-15 second interval _____ x 4 = _____ beats per min

Number of beats in the 16-30 second interval _____ x 4 = _____ beats per min

Number of beats in the 31-60 second interval _____ x 2 = _____ beats per min

Number of beats in the 61-90 second interval _____ x 2 = _____ beats per min

Number of beats in the 91-120 second interval _____ x 2 = _____ beats per min

3. Observe the time it takes for the subject's pulse rate to return to approximately the level that was recorded in Test 4.
4. Assign fitness points and record them in the fitness data box on page 4.

Time Required for Return of Pulse Rate to Standing Level after Exercise

Time (seconds)	Fitness Points
0-30	4
31-60	3
61-90	2
91-120	1
121+	1
1-10 beats above standing pulse rate	0
11-30 beats above standing pulse rate	-1

4. Subtract the subject's normal standing pulse rate (recorded in Test 4) from his/her pulse rate immediately after exercise (the 0-15 second interval) to obtain pulse rate increase. Record this in the fitness data box on page 4.
5. Assign fitness points and record them in the fitness data box on page 4.

Pulse Rate Increase after Exercise

Standing Pulse Rate (beats/min)	Pulse Rate Increase Immediately after Exercise (# beats)				
	0-10	11-18	19-26	27-34	35-43
	Fitness Points				
60-70	3	3	2	1	0
71-80	3	2	1	0	-1
81-90	3	2	0	-1	-2
91-100	2	1	0	-2	-3
101-110	1	0	-1	-3	-3
111-120	1	-1	-2	-3	-3
121-130	0	-2	-3	-3	-3
131-140	0	-3	-3	-3	-3

Fitness Data Box

	Measurement	Points
Test 1: Reclining pulse rate	beats/min	
Test 2: Change in systolic pressure from reclining to standing	mm Hg	
Test 3: Baroreceptor reflex (pulse rate increase on standing)	beats/min	
Test 4: Standing pulse rate	beats/min	
Test 5: Step Test Return of pulse to standing rate after exercise	seconds	
Pulse rate increase immediately after exercise	beats/min	
	TOTAL SCORE	

Total Score

18-17

16-14

13-8

7 or less

Relative Cardiac Fitness

Excellent

Good

Fair

Poor

Analysis Questions:

1. Explain why blood pressure and heart rate differ when measured in a reclining position and in a standing position.

2. Explain why high blood pressure is a health concern.

3. Explain why an athlete must exercise harder or longer to achieve a maximum heart rate than a person who is not as physically fit.

4. Why does smoking cause a rise in blood pressure? (You might have to do some research.)
