

Activity 4.3.4: Cardiac Output

Introduction

Your heart beats to send blood out through your vessels to your tissues. After each heartbeat, a pressure wave or pulse, passes along an artery as its walls bulge and then relax to withstand the surge of blood. By pressing on an artery, the number of pulses or heartbeats per minute can be counted. Think about the arteries you built on your Maniken®. Which vessels do you think allow you to feel the strongest pulse?

Changes in heart rate influence the amount of blood that is pumped to our tissues.

Heart rate can be used to calculate another indicator of heart health called *cardiac output*. Changes in cardiac output, the amount of blood that is pumped out by the ventricles per minute, often signal disease of the heart. The body’s pump may no longer be able to meet the demands of the rest of the body.

In this activity, you will explore the movement of blood in the cardiovascular system and the measures used to assess overall heart health. You will feel the “pulse” through major arteries and monitor your own heart rate. Through math calculations, you will investigate the amount of blood that is pushed around the body every minute and relate this number to the overall strength of the heart. Factors such as exercise and heart damage both affect the movement of blood in your body and, consequently, can impact cardiac output. In the next activity, you will look at how the pressure of blood moving through the vessels also provides vital information about cardiovascular health.

Equipment

* Laboratory journal
* Calculator

Procedure

Part I: Pulses and Heart Rate

When blood flows through the major arteries, you can feel the pulse and count the rate at which the heart churns out blood.

1. Locate each of your pulse points as described below. Check them off as they are found. NOTE: Do not use your thumb to find pulse points, as it has a pulse of its own.
* **Carotid pulse**: Use your Maniken® to visualize the location of the carotid artery. Locate this pulse using your index and middle fingers on your neck. Slide your fingers alongside your jaw bone and down into the depression on the side of your neck.
* **Temporal pulse**: Think about where you built the temporalis muscle on your model. Locate this pulse in front of the ear, up slightly towards the eye. You may have felt this pulse throbbing when you had a headache.
* **Brachial pulse**: Use your Maniken® to visualize the brachial artery. Find this pulse, located at the bend of the arm, opposite the elbow.
* **Radial pulse**: Use your Maniken® to visualize the radial artery. Locate the radial pulse at the wrist. If you have trouble finding this pulse, turn the wrist being measured palm up. Wrap your other wrist (palm up also) around it until your fingers fold over the radial artery.
* **Popliteal pulse**: Use your Maniken® to visualize the popliteal artery. Find this pulse at the back of the knee. Roll up your pants if you have trouble feeling the pulse through clothes.
* **Posterior tibial pulse**: Use your Maniken® to visualize the posterior tibial artery. Find this pulse just behind the inner ankle bone. You will most likely have to remove your shoes to find this pulse point and the next.
* **Dorsalis pedis pulse**: Locate this pulse on the upper front surface of the foot right in front of the ankle. Try the area just outside of where your shoe crosses your foot.
1. Answer conclusion question 1 and 2.
2. Seated comfortably, find your carotid pulse. Your partner should act as a timer as you count the number of beats you feel in one minute (recorded in beats per minute (bpm)). We refer to this value as your *resting heart rate*. Each pulse you feel corresponds to one beat of your heart.
3. Switch roles and allow your partner to determine his/her heart rate.
4. Repeat this process until you have measured your resting heart rate three times. Record these values in your laboratory journal and calculate your average resting heart rate.
5. Compare heart rates with those in the class and discuss “normal” values for resting heart rate. The average adult has a resting heart rate of 72 beats per minute.
6. Answer conclusion question 3.

Part II: Cardiac Output

Heart rate can be used as an indicator of fitness. If your heart has to pump 120 beats per minute while you are at rest, think about how hard your heart will have to work during exercise. Heart rate can be used to calculate another indicator of heart health called *cardiac output*. Cardiac output is a measure of how much blood is pumped by both ventricles in one minute. It is computed by multiplying your heart rate by the stroke volume, the amount of blood being pumped out of the heart with each heart beat. On average, the stroke volume remains relatively stable at 75 ml/beat.

 **Cardiac output (ml/min) = stroke volume (ml/beat) x heart rate (beats/min)**

1. Use the equation above and your own resting heart rate to calculate your cardiac output. Clearly show your work in your laboratory journal.
2. Compare your cardiac output with your partner. Discuss why there may be differences.
3. Using the value you computed for your cardiac output, complete the following calculations. Show your work in your laboratory journal and record your final answers in **Liters**.
* Calculate the volume of blood your heart pumps in an hour.
* Calculate the volume of blood your heart pumps in a day.
* Calculate the volume of blood your heart pumps in a year.
* Calculate the volume of blood your heart pumps in the average lifespan of 75 years.
1. Complete the math problems or answer the following questions in your laboratory journal.
* Imagine you are late to class and you have to run down the halls. Your heart rate increases to 140 beats per minute. Show how this increase will affect your cardiac output. Explain why your body needs more blood pumped per minute.
* A male body contains 5 to 6 liters of blood, whereas a female body contains 4 to 5 liters. Why do you think there is a difference between the two?
* Assuming the above is true for your gender (5.5L in males and 4.5L in females), how long would it take for the entire volume to be pumped through **your** body one time. Refer to your calculations for cardiac output and show all of your work.
1. Answer the remaining conclusion questions.

Conclusion

1. Which do you think are the two, most common places to detect pulse and count the heart rate? Why?
2. What are some factors that can increase or decrease the heart rate and the beat you feel at each pulse point?
3. Athletes often have a very low resting heart rate. What does this tell you about the health of their heart? Explain.
4. What are consequences of having a low cardiac output? How will other body systems be affected?
5. Dehydration reduces blood volume. How would this affect cardiac output? Explain.
6. Describe how each of the following could impact stroke volume.
* Damage to the conduction system of the heart
* A blockage in one of the coronary arteries