

Activity 14

Beating Hearts

Objectives

- ◆ To understand the effect of exercise on heart rate
- ◆ To understand how to measure differences in heart rate

Materials

- ◆ TI-73
- ◆ Unit-to-unit cable
- ◆ CBL 2™
- ◆ Heart rate monitor (ear clip or belt) with DIN adapter
- ◆ Exercise equipment, such as jump rope or step
- ◆ Data Collection and Analysis pages (p. 126 - 129)

In this activity you will

- ◆ Do three different exercises and use the CBL 2™ with a heart rate monitor to measure your heart rate in beats per minute (BPM) while you exercise.
- ◆ Compare your heart rate when you are resting to your heart rate as you exercise.

Problem

How will your heart rate be affected by exercise?

Introduction

Your heart is a muscle that squeezes blood into the arteries. Blood pressure is the force of the blood pushing against the artery walls. This pressure pushes the blood through the blood vessels of your body. This activity uses a CBL 2 with a heart rate monitor to collect and analyze your heart rate data. The heart rate monitor works by sending out a light beam that detects the presence or absence of blood in an artery at any moment. The monitor records your heart rate by counting how many pulses occur in one minute.

Hypothesis

Before testing, complete the **Hypothesis** section on the **Data Collection and Analysis** page to predict how exercise will affect your heart rate. Then complete the **Experimental Design** section to help you understand this activity.

Procedure: Collecting the Data

1. Collect any exercise equipment you will use, such as a jump rope.
2. Plug the heart rate monitor into Channel 1 (CH 1) on the CBL 2 using the DIN adapter, if necessary.

3. Start the DATAMATE program.
4. The Main Screen is displayed. If **CH 1:HEART RT(BPM)** is displayed at the top of the screen, go to step 8. If **CH 1:HEART RT(BPM)** is not displayed, go to step 5.
5. Select **1:SETUP**.
6. Select **CH 1**. Select **6:HEART RATE**.
7. Select the type of heart rate monitor you are using. If you are using the heart rate monitor (not the exercise heart rate monitor), select **2:HEART RATE(BPM)**. Select **1:OK** to return to the Main Screen.
8. Select **1:SETUP**. Select **MODE**, and then select **2:TIME GRAPH**.
9. The **TIME GRAPH SETTINGS** are displayed. If the screen shows **TIME INTERVAL: 5** **NUMBER OF SAMPLES: 60**, and **EXPERIMENT LENGTH: 300**, go to step 11. If the settings are not correct, go to step 10.
10. Select **2:CHANGE TIME SETTINGS**. For **ENTER TIME BETWEEN SAMPLES IN SECONDS**, enter 5. For **ENTER NUMBER OF SAMPLES**, enter 60. The **TIME GRAPH SETTINGS** screen reappears, showing the new settings.
11. Select **1:OK** twice to return to the Main Screen.
12. Attach the ear clip to the person you are testing.
13. When you are ready to begin, select **2:START**. The CBL 2™ beeps twice and displays a graph, with the heart rate in beats per minute (BPM) in the upper right-hand corner.
14. Collect the data for the person at rest. The CBL 2 beeps twice when it has finished collecting the data.
15. The graph is displayed showing the data that was collected. Use \blacktriangleright and \blacktriangleleft to move to each data point. Record the heart rate for each 5-second interval in the table on the **Data Collection and Analysis** page.
16. Find the person's average heart rate for this exercise. Press 2^{nd} [STAT] \blacktriangleright \blacktriangleright **3:mean(** 2^{nd} [STAT] **2:L2** \blacktriangleright [ENTER]. Record the result on the **Data Collection and Analysis** page.
17. Repeat steps 10 through 16 for each exercise, such as doing 50 jumping jacks, running in place for one minute, and jumping rope for 1 minute. Be sure that the person doing the exercises rests for a few minutes after each exercise to allow his/her heart rate to return to normal.
18. To exit from the DATAMATE program, press [ENTER] to return to the Main Screen. Select **6:QUIT** and press [ENTER].
19. Using the data on the **Data Collection and Analysis** page, average your results with the other lab groups in your class and record the answers.

Procedure: Graphing the Data

1. Press **[LIST]** and create two lists using the data you recorded on the **Data Collection and Analysis** page. L1 contains the exercises you did (either number the exercises or use the Text Editor to name the exercises). L2 gives the average BPM for each exercise.
2. Press **[2nd] [PLOT] 4:PlotsOff [ENTER]** to turn off all stat plots.
3. Press **[2nd] [PLOT] [ENTER]** to select **Plot1**.
4. Press **[ENTER]** to select **On** (to turn on **Plot1**).
5. Select **[2nd] [Y=]** (the bar graph) for **Type**.
6. Plot L1 (exercise numbers) as the categorical list and L2 as data list 1 (average BPM values).
7. Press **[ZOOM] 7:ZoomStat** to set the window and display the graph.
8. Record the graph on the **Data Collection and Analysis** page.

```

Plot1 Off
Type: Bar
Cate9List:L1
DataList1:L2
DataList2:L3
DataList3:L4
Vert Hor 2 3
  
```

Data Analysis

After testing, answer the questions on the **Data Collection and Analysis** page to evaluate the heart rate data you collected.

Application

Create two modified box plots to display the heart rate data for two of the exercises, such as doing jumping jacks and running in place. Then answer the questions on the **Data Collection and Analysis** page.

Extensions

- ◆ Compare the heart rate data from several classes. Choose an appropriate graph in which to compare and communicate the results. Write a summary statement explaining which class is in the best cardiovascular shape based on the data.
- ◆ Use the Internet to gather heart rate data on different animals. Choose an appropriate graph with which to display this data. Explain any relationships or patterns in the data.

Data Collection and Analysis

Name _____

Date _____

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Problem

How will your heart rate be affected by exercise?

Hypothesis

1. Estimate your heart rate at rest and after 50 jumping jacks. _____
2. Do you think your heart rate will increase or decrease after running for one minute? _____
3. If I exercise, my heart rate will _____ compared to my resting heart rate.

Experimental Design

1. Independent Variable: _____
2. Dependent Variable: _____
3. Number of Trials: _____
4. Two Constants: _____

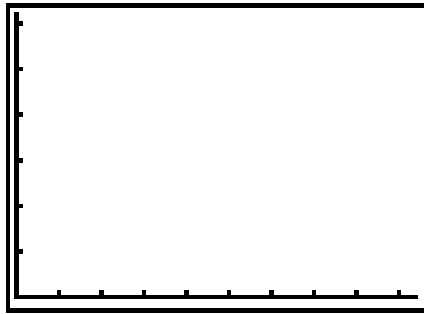
Data Collection

1. After the person finishes each exercise, record the values in the table below using the graph on the TI-73.

Time (Seconds)	At Rest (BPM*)	Jumping Jacks (BPM*)	Running in Place (BPM*)	Jumping Rope (BPM*)	Other Exercise (BPM*)
30					
60					
90					
120					
Individual's Average					

*Beats Per Minute

2. Sketch the bar graph of individual mean heart rates for each exercise and at rest. Label each bar and the axes. You may also print the graph on the computer and attach it to this page.



3. Use the results from the other lab groups in your class to find the average number of beats per minute for each exercise. Record the averages in the table below.

Activity	Class Average (Beats Per Minute)
At Rest	
Jumping Jacks	
Running in Place	
Jumping Rope	
Other ()	

Data Analysis

Using the data from the tables and graph, answer the following questions.

1. What general trend did you notice for each type of exercise?

2. What is your individual BPM range for each type of exercise?

Jumping Jacks _____

Running in Place _____

Jumping Rope _____

Other (_____) _____

3. Do the heart rate readings make sense for each type of exercise? Explain your answer.

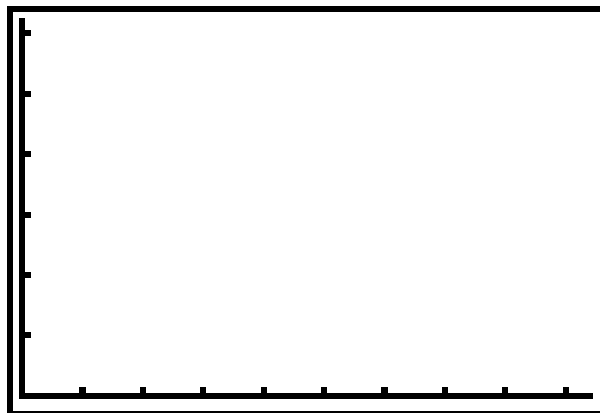
4. What is the difference between the mean BPM after each type of exercise and the person's resting rate?

Conclusion

If I exercise, my pulse rate _____ by an average of _____ BPM in the three activities compared to my resting rate.

Going Further

Compare the class data for mean heart rates for two of the exercises and at rest. Enter the mean heart rates for each class member into a separate TI-73 list for each exercise and at rest. Display the data from each list as a modified box plot. Set up all three box plots to display at one time on the TI-73. Sketch the plots below.



- ◆ On each plot, compare the median heart rates for class members. Which of these exercises raised pulse rates most?
- ◆ Which plot has a greater range of heart rate values?
- ◆ Where did most of the rates cluster for each exercise and at rest?
- ◆ Were there any outliers in the data?
- ◆ If a new student in your class were to do 50 jumping jacks, where would you expect his or her heart rate to fall on the plot?

Teacher Notes



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NSES Standards

- ◆ Life Science: Structure and function in living systems
- ◆ Science in Personal and Social Perspectives: Personal health

Preparation

- ◆ The ear clip monitor can produce inaccurate results when not properly used. It works by transmitting light between an LED and a light sensor. Students with earrings should remove them, since this can affect the collected BPM. Skin color and ear lobe thickness may also affect the accuracy of readings.
- ◆ You can also use the webbing between the thumb and index finger to collect data. If readings appear to be inaccurate, attach the ear clip monitor to this area.

Management

- ◆ Ask students to sketch the lab setup before starting the lab and label the sketch with key terms. Students learn vocabulary in context and seem less confused by the procedure.
- ◆ Assign these student jobs for this lab:
 - Materials/setup person (sets up samples, sensor)
 - Tech person (operates CBL 2™ and TI-73)
 - Data recorder (reads beats/minute readings from the CBL 2 at each collection interval)
 - Runner (brings CBL 2 and TI-73 to the computer to print out graphs with TI-GRAPH LINK™ or TI™ Connect and brings **Data Collection and Analysis** pages to the teacher)

- ◆ Students can record beats/minute readings as they are displayed on the TI-73 in their lab journals. This keeps them engaged throughout the data collection period and if they lose their data/graph later, they can still write up their lab report. Students can also access the data in the TI-73 lists after data collection. You can send the lists to all students' calculators using **APPS** **1:Link**.
 - a. Press **APPS**.
 - b. Press **ENTER** to select **1:Link**.
 - c. Select **4:List** and press **ENTER**.
 - d. Press **▾** to move the **▶** beside the list you wish to send. Press **ENTER**.
 - e. Repeat step **d** for each list you wish to send.
 - f. Set the receiving unit by pressing **APPS** **ENTER** **▶** to select **RECEIVE**. Press **ENTER**. **Waiting...** displays on the TI-73 screen.
 - g. On the sending unit, press **▶** to select **TRANSMIT** and press **ENTER**.

For more permanent storage of data, use TI-GRAPH LINK™ or TI™ Connect to save the lists in a computer folder.

- ◆ Suggested exercises:
 - Doing jumping jacks (50)
 - Running in place (2 minutes)
 - Jumping rope (2 minutes)
 - Climbing stairs (3 flights)

Selected Answers

Experimental Design

1. Independent variable: *activity (exercise time/type)*
2. Dependent variable: *heart rate (BPM)*
3. Number of trials: _____
4. Two Constants: *person, equipment (CBL 2™, heart rate monitor), time (the collection interval)*

Conclusion

If I exercise, my pulse rate *increases* by an average of _____ (average increase will vary) BPM in the three activities compared to my resting rate.

Application

Statistics will vary.

If the class does jumping jacks for one minute, their pulse rates will *increase*.

