Heart Rate and Calories

Most exercise machines tell you how many calories you have consumed after a period of exercise. Modern fitness trackers and software applications also perform calculations for how many calories you consume during exercise. Most of these calculations are based on the subject's age and weight, but all of these calculations use heart rate. Because humans rely primarily on aerobic metabolism, the amount of oxygen that you consume is related to how quickly your heart can pump blood to your lungs and then to the rest of your body. As a result, tracking heart rate is an excellent way to estimate calorie consumption.

The calories you see listed on food packaging are actually kilocalories (and are sometimes referred to as Calories). An average person should consume a minimum of about 2,000 Calories per day. Fitness trackers and exercise machines report the estimated number of Calories consumed during exercise.

OBJECTIVES

- Determine the effect of exercise on heart rates.
- Calculate the estimated calories burned as a function of heart rate, age, body weight, and sex.

MATERIALS

Chromebook, computer, **or** mobile device
Graphical Analysis 4 app
Go Wireless Hand-Grip Heart Rate **or** Go Wireless Exercise Heart Rate
saline solution in dropper bottle (only for use with Go Wireless Exercise Heart Rate)
stepping stool, 45 cm (18 inches) high

PROCEDURE

Each person in a lab group will take turns being the subject and the tester. **Important**: Do not attempt this experiment if physical exertion will aggravate a health problem. Inform your instructor of any possible health problems that might be affected if you participate in this exercise.

Part I Heart rate

1. Launch Graphical Analysis. Connect your Go Wireless Heart Rate or Go Wireless Exercise Heart Rate to your Chromebook, computer, or mobile device. **Note**: The sensor will only be seen by the application when the sensor is in contact with the subject's skin.

2. Have the subject sit in a chair with the sensor in the correct position (in the hands for Go Wireless Heart Rate or around the chest in contact with the skin for Go Wireless Exercise Heart Rate).

3. Click or tap Collect to start data collection.

4. After 2 minutes have passed, instruct the subject to stand upright and stay standing quietly for the next 2 minutes.

5. After 2 minutes have passed (approximately 4 minutes after data collection was started), instruct the subject to perform a step test using the following procedure:
   a. Place the right foot on the top step of the stool.
   b. Place the left foot completely on the top step of the stool next to the right foot.
   c. Place the right foot back on the floor.
   d. Place the left foot completely on the floor next to the right foot.
   e. This stepping cycle should take 3 seconds to complete.
   f. Repeat the step cycle 5 times.

6. When 5 step cycles have been completed, let data collection continue for 10 to 20 seconds and then click or tap Stop to stop data collection.

7. Determine the sitting heart rate, standing heart rate, and heart rate after the step test.
   a. Select the data during the second minute when the subject was sitting (the stable portion of data collected while sitting).
   b. Click or tap Graph Tools, , and choose View Statistics. Record the mean heart rate in the data table and dismiss the Statistics box.
   c. Select the data during the second minute when the subject was standing (the stable portion of data collected while standing).
   d. Click or tap Graph Tools, , and choose View Statistics. Record the mean heart rate in the data table and dismiss the Statistics box.
   e. Click or tap the point immediately following the step test and record the heart rate value in the data table.

Part II Calories burned

The formulas that are used to calculate calories consumed per unit time are gender specific and depend on several physiological factors, such as age, weight and VO_2 max. VO_2 max is hard to measure directly so a formula is provided that does not use VO_2 max. Weight needs to be in kilogram (kg). Use the appropriate formula for each entry in Table 1 and enter your approximate calories burned in Table 1 as the Calorie estimate for each activity.

For men, Cal/min can be estimated using the formula

$$(-55.0969 + (0.6309 \times HR) + (0.1988 \times weight) + (0.2017 \times age)) / 4.184$$

For women, Cal/min can be estimated using the formula

$$(-20.4022 + (0.4472 \times HR) - (0.1263 \times weight) + (0.074 \times age)) / 4.184$$

Note: These formulas were developed to estimate calories burned while exercising. It is possible to generate a negative value using a resting heart rate. If you generate a negative value, simply enter 0 Cal/min in the table for that data point. It is important to remember that these are only estimates.

DATA

Table 1		
Condition	Heart rate (bpm)	Calorie estimate (Cal/min)
Sitting		
Standing		
After 5 steps		

QUESTIONS

1. How did your heart rate change after moving from a sitting position to a standing position? Is this what you expected? How do you account for this?

2. Predict what your heart rate might be if you had exercised for twice the length of time that you actually did. Explain.

3. How did your estimates of Calories burned compare between sitting, standing, and after exercise?

4. How did estimates of Calories burned compare between members of your group? Is this what you expected? How do you account for this?

5. Some work places offer the option to stand while working at a desk. How might this impact the health of workers if they choose to stand while working?

EXTENSION

Design an experiment to determine Calories burned for different fitness activities.