Aim: Investigate the effect of a factor on Heart Rate

Introduction: People exercise on a daily basis for a variety of reasons. With exercise people often find themselves short of breath and must breathe deeply and more often in order to compensate. Due to the fact that exercise causes someone to breathe more rapidly, it would also seem that it also increases someone's heart rate. In order to gauge the effect of exercise on someone's heart rate, this lab will vary the periods of exercise that one undergoes and heart rate will be recorded afterwards. It would seem that the longer the duration of the exercise, the higher the heart rate will be.

Research Question: Does the duration of exercise have an increased effect on a person's heart rate?

Independent Variable: The duration of exercise

- Exercise will occur for periods of 0 seconds, 45 seconds and 90 seconds after each heart rate will be recorded

Dependent Variable: The heart rate of a person in beats per minute

- Immediately after exercise students will find their pulse on their neck and count the number of beats they feel in a sixty second time period

Control Variable:

-Pulse will be found at one's neck each time. This is done to avoid confusion when counting pulse and so that in case pulse recorded varies in other parts of the body such as the wrist such error can at least be consistent.

- The Type of exercise will be restricted to Jumping Jack. This is done because different exercises are more taxing than others, by at least each individual will be performing the same degree of activity.

- Each person will record their base-level heart rate by exercising for 0 seconds.

- The Temperature of the room will remain constant by allowing all individuals to exercise in the same room.

Materials:

-Clock

Procedure:

1. Gather at least 10 students for exercise and 1 other student to watch time
2. Assign a Time watcher
3. Record base-level Heart Rate
    a. Tell the 10 students to find their pulse.
        i. For purposes of consistentcy the pulse area will be the neck
        ii. Place two fingers on the center of your chin
        iii. Run your two fingers down until you feel your adams apple
        iv. Slightly move your two fingers to the right applying pressure
        v. Stop moving fingers once a thumping sensation is felt on fingers
    b. Explain to students that at the count of three they are to count the number of heart beats
    c. Have Time Watcher count aloud to three
    d. On three tell students to record their heart rate
    e. The Time Watcher should count 60 seconds by watching the clock
    f. After 60seconds the Time Watcher should shout "Stop"
    g. Record each students heart rate
4. Perform Jumping jacks
    a. Rest at least two minutes breathing normally allowing your heart rate to normalize.
    b. Tell the 10 students to spread out with enough space to perform jumping jacks
    c. Tell the students to begin performing Jumping Jacks.
    d. The Time Watcher should count 45 seconds using the clock.
    e. After 45 seconds the Time Watcher should shout "Stop"
5. Record Heart Rate for 60 seconds of exercise
    a. Tell the 10 students to find their pulse.
        i. For purposes of consistency the pulse area will be the neck
        ii. Place two fingers on the center of your chin
        iii. Run your two fingers down until you feel your Adams apple
        iv. Slightly move your two fingers to the right applying pressure
        v. Stop moving fingers once a thumping sensation is felt on fingers
    b. Explain to students that at the count of three they are to count the number of heart beats
    c. Have Time Watcher count aloud to three
    d. On three tell students to record their heart rate
    e. The Time Watcher should count 60 seconds by watching the clock
    f. After 60seconds the Time Watcher should shout "Stop"
    g. Record each students heart rate
6. Record Heart Rate for 90 seconds of exercise
    a. Repeat steps 4a-4e replacing 45 seconds with 90 seconds.

b. Repeat steps 5a-5g

Data Table:

		Jumping Jack Duration (seconds*)		
Subject	**Trial**	**Increment One 0 Seconds**	**Increment Two 45 Seconds**	**Increment Three 90 Seconds**
1	1	60	94	150
	2	74	120	126
2	1	76	136	156
	2	80	134	134
3	1	78	122	142
	2	82	124	146
4	1	78	134	156
	2	84	126	138
5	1	84	126	160
	2	58	108	108
6	1	70	150	170
	2	98	154	176
7	1	72	148	162
	2	96	134	162
8	1	74	154	186
	2	96	152	176
9	1	66	130	140
	2	74	126	144
10	1	90	170	170
	2	96	160	142
Qualitative Observations	- Students are exercising at different paces - Students had trouble finding their pulse immediately after exercise			

*** Because time wasn't directly involved in calculations it became unnecessary to record uncertainty**

Calculations:

Sample Calculation for Average Heart Rate in beats per minute

Average Heart Rate in beats per minute = (Subject 1 Trial 1 + Subject 1 Trial 2 + Subject 2 Trial 1 + Subject 2 Trial 2 + Subject 3 Trial 1 + Subject 3 Trial 2 + Subject 4 Trial 1+ Subject 4 Trial 2+ Subject 5 Trial 1 + Subject 5 Trial 2+ Subject 6 Trial 1 + Subject 6 Trial 2+ Subject 7 Trial 1 + Subject 7 Trial 2 + Subject 8 Trial 1 + Subject 8 Trial 2 + Subject 9 Trial 1 + Subject 9 Trial 2 + Subject 10 Trial 1 + Subject 10 Trial 2)

Increment One = 0 Seconds

Total Number of Trials= 20

Average Heart Rate in beats per minute =
(60+74+76+80+78+82+78+84+84+58+70+98+72+96+74+96+66+74+90+96) / (20)

Average Heart Rate in beats per minute "increment one of 0 seconds" = 79.30 seconds
Average Heart Rate in beats per minute "increment two of 45 seconds" =135.6 seconds
Average Heart Rate in beats per minute "increment three of 90 seconds" = 152.2 seconds
Round to 4 significant figures in all cases to keep consistent with the bigger heart rates.

Sample Calculation for Standard Deviation

Input column "**Increment One 0 Seconds**" **into** graphing calculator
Calc "1-Var Stats"
One Standard Deviation = 11.38902981 seconds
Round to 4 significant figures because smallest unit of data in the averages is 4 significant figures
One Standard Deviation = 11.40 seconds

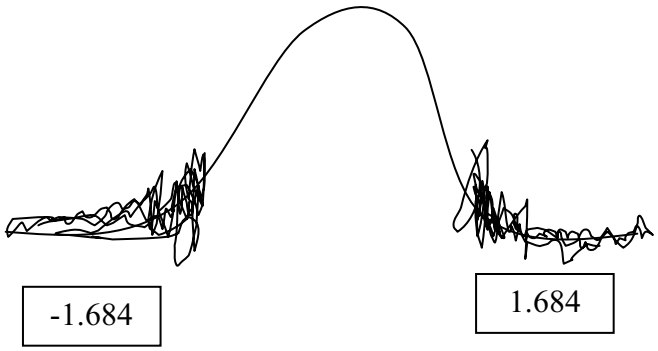
One Standard Deviation "Increment One 0 seconds" = 11.40 seconds
One Standard Deviation "Increment Two 45 seconds"= 19.03 seconds
One Standard Deviation "Increment Three 90 seconds" = 18.48 seconds

Sample Calculatoin for T-Test

1. Identify the Null hypothesis
   The Average Heart Rate between increment one and increment two are not significantly different
2. Identify the Significance Level (a)
   (a) = .05
3. Calculate Degrees of Freedom
   Degrees of freedom = Sum of sample sizes(n)-2

n= 20
n_2=20
n_3=20
Degrees of freedom = 20+20-2
38=40-2

4. Calculate Sample Size
   n= 20
   n_2=20
   n_3=20
5. Find Value of t from t table
   Value of t = 1.684
6. Find Rejection Region (RR)



7. Find t calculated and probability value (p)
   T calculated= -11.06
   P= $2.64 * 10^{-12}$
8. Decision
   T calculated is greater than t table value -1.684
   Reject null hypothesis
9. Conclusion
10. Since t- calculated is inside the rejection region at -11.06 the average Heart Rate for increment one 0 seconds is significantly different from the average Heart Rate for increment two 45 seconds.

Calculations Data Table:

	Average Time taken to change BTB color(seconds)	One Standard Deviation(seconds)
Increment One 0 Seconds	79.30	11.40
Increment Two 45 Seconds	135.6	19.03
Increment Three 90 Seconds	152.2	18.48

Conclusion:

The Duration of exercise that a person undergoes has a positive effect on their heart rate. In order to arrive at this conclusion 10 students preformed two trials each of three different time increments for exercise. As the duration of exercise increased, the average heart rate in beats per minute also increased. This is visible because the average heart rate for increment one of 0 seconds was 79.3 beats per minute while the average heart rate for increment two was even higher at 135.6 beats per minute. This positive effect held true through all three increments increasing average heart rate during increment three of 90 seconds at 152.2 beats per minute. To further verify these results standard deviation was calculated to clarify the distribution of data and also to see if any of it overlapped. The error bars appearing on the graph do not overlap between increments one and two but do overlap quite a bit between increments two and three. This shows us that while the duration of exercise does increase heart rate as shown in comparing increments one and two, its effect on heart rate begins to level off explaining the overlap between increments two and three.

Since the error bars between increment one and increment two did not overlap, a t-test was performed in order to identify whether the difference between the two increments was significantly different. Results showed that since t-calculated was -11.06 (well inside the rejection region) the average Heart Rate for increment one 0 seconds is significantly different than the average Heart Rate for increment two 45 seconds.

While these results agree with what was expected to happen, it seems strange that after doubling the duration of exercise, a lot of data ends up overlapping shown by the error bars between increments two and three. One possible explanation for these results is a failure to control the nature of the student's jumping jacks. It was noticed during data collection that while the students were jumping jacks the pace varied from student to student. What this means is that some were exercising at a more rigorous pace while others at a slower pace. While this was not significant enough to discard the duration of exercise as a factor affecting heart rate, it did inhibit the conclusion in terms of how effective duration of exercise is and continually affecting heart rate. Another Weakness is the way in which people recorded their pulse. While everyone recorded their pulse by using their neck some students reported issues with finding their pulse during the seconds following their exercise. This means that after long durations of exercising greater and greater amounts of beats were never recorded impacting the data to the point where increments two and three significantly overlapped in their error bars.

In order to improve the lab and reduce the overlap of the error bars exhibiting standard deviation the procedure should be modified with at least two changes. The first improvement would be assigning a lead student who would set the pace of jumping jacks which would ensure that everyone would be exercising at the same rate. Another improvement would be having each student pair up with another student. Half the students could do jumping jacks while half the students watch. Once done jumping jacks, the resting students could record their partner's jumping jacks for them. To do this they would learn how to find their partners pulse beforehand. This would effectively eliminate the beats lost to error in finding one's own heartbeat. Together these improvements would help reduced the overlap that occurs in the error bars of standard deviation by making results more consistent in two ways. The type of exercise is streamlined even more and the method for recording pulse is improved.