Incorporating Statistics into Physiology Experiments

Definitions

Reliability
Mean, median, mode
Correlation: scatter plot and regression line with correlation coefficients (*r values*)
Standard Deviation

PROCEDURE:

Part I: MEASURING LEG CIRCUMFERENCE:
This exercise is designed to determine the mean, median and mode of the circumference of each student's lower leg.

1. Divide the class into two groups by sex. Record the following data in **Table 1.**

2. Have one student sit on the edge of a table so that his/her legs hang freely.

3. Hold the string horizontally behind the student's knee. Move the string up and down along the calf to determine the maximum circumference. Wrap the string around the calf and mark the string where the two ends meet. The distance between one end of the string and the point marked is the circumference of the leg. The string, or measuring tape, should be in contact with the skin but it should NOT indent it. Record the measurement in **Table 1.**

4. Repeat step 3 two more times; each time have a different student obtain the measurement. Enter the values in **Table 1.**

5. Using the caliper, measure the skin-fold thickness on the medial side (internal) of the student's lower leg. Three measurements by different persons should also be taken and recorded in **Table 1.**

A. Were All Three Measurements The Same? Explain Why Or Why Not!

6. Find the **average** or **mean** for the leg and caliper measurements.

7. To find the **adjusted mean calf circumference.** Subtract the average caliper measurement from the average leg circumference measurement. The adjusted mean corrects for individual differences in body composition (muscle vs. fat).

Adjusted mean(calf circ.) = Ave. Leg Circ. **-** Ave. Caliper Measurement

8. Collect and record in **Table 2,** the adjusted mean values for all of the boys and all of the girls rounded off to the nearest whole number. Use these values to construct separate histograms for boys and girls.
Label them **Graph 1 (guys)** and **Graph 2 (girls).**

9. The highest bar on the histogram represents the most common measurement. This is known as the **mode.**
10. The histogram bar exactly in the middle represents the **median.**
Find the median for each graph and record it.

Part II: THE STANDING VERTICAL JUMP
This exercise is designed to determine the relationship between a student's calf size and his/her vertical jump by constructing a **scatter plot and regression line**.

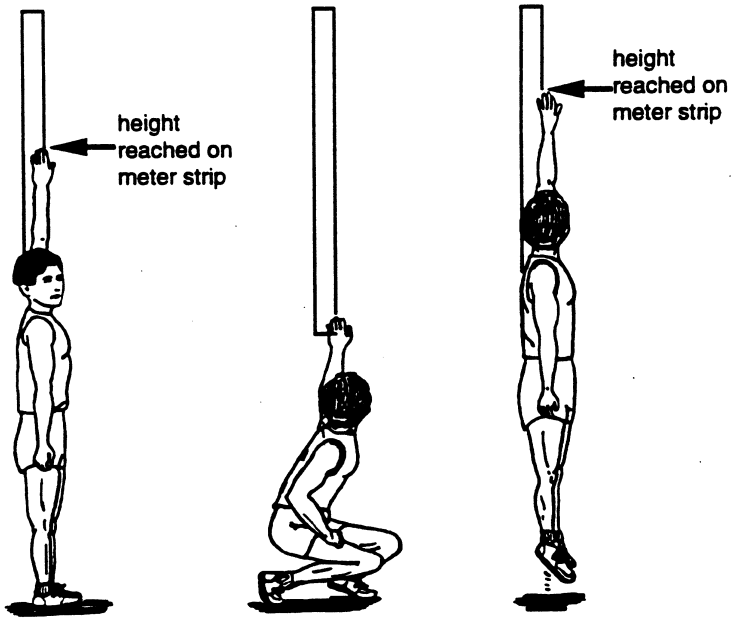
1. Use the meter sticks hanging around the room.

2. Stand with the favored arm closest to the wall.

3. With feet flat on the floor, the subject should reach as high as possible and touch the meter stick; this is the standing height. Record the height reached on the meter stick.

4.While keeping the trunk straight, bend at the knees and spring upward (jump) trying to touch the highest point on the stick as possible; this is the jumping height.

5. Record the height reached. Obtain an average of 3 vertical jumps.



6. The difference between the two values represents the vertical height jumped. Record the average vertical height jumped vs. adjusted mean calf circumference by everyone in **Table 3**. Round to the nearest whole number.
Keep the sexes separate on your data sheet.

7. On **Graphs 3 (guys) and 4 (girls),** plot the values obtained from the adjusted mean calf circumference and the vertical height jumped for each student.

8. The graphs you have made are known as **scatter plots,** diagrams with points representing two measurements; in this exercise the points represent the adjusted mean calf circumference of a student and his/her vertical jump. Estimate **the line of best fit or regression line**, and the **correlation coefficient (*r* value).**
You will use the regression line to make predictions in **Part IlI** of this exercise.

Part III: PREDICTING VALUES USING YOUR DATA

1. Ask a person in the class what their adjusted calf circumference is and predict the vertical height which that student can jump using your regression line. In order to do this, find the adjusted calf measurement using the regression line from Part II.

B. What Is The Predicted Vertical Height Jumped ?

C. What Is The Name Of The Above Subject?

2. Now ask the same person what their jumping height is. Compare the actual height jumped with the value predicted. (Note that you could also predict calf size from a measured jump.)

D. What Is The Actual Height Jumped?

3. A regression line can be used to predict many other relationships. For example, you could construct a regression line based upon the number of sit-ups and push-ups people can complete. Then, by having a person perform one of the activities, you can use the regression line to predict the other.

Part IV: STANDARD DEVIATION AND SIGNIFICANCE

1. Determine the **mean** for boys' and girls' jumping heights.

2. In order to analyze the data, several statistical operations are necessary. The first is to determine the standard deviation for the means of the boys' and the means of the girls' jumping heights. The standard deviation is a measure of the dispersion of individual points around the mean. The equation for standard deviation is:

$$s = \sqrt{\frac{N\left(\Sigma X^2\right) - \left(\Sigma X^2\right)}{N(N-1)}}$$

s = standard deviation

N= number of subjects **X= jumping height**

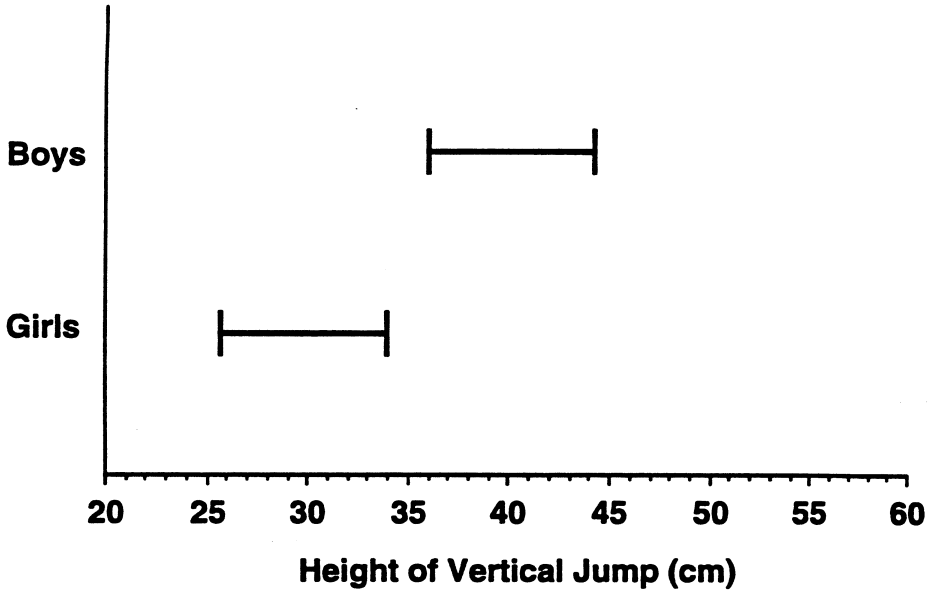
3. The **range** is found by adding one standard deviation to the mean and also subtracting one standard deviation from the mean. For example, if the mean = 30 cm and the standard deviation = 4.5, the upper limit of the range is 30 + 4.5, the lower limit is 30 - 4.5. Therefore, the range of jumping heights is 25.5 cm to 34.5 cm. Record standard deviation, and the range for the boys and for the girls and record it in **Table 4.**

4. On **GRAPH 5,** produce a line for each gender whose length is represented by the range. A range of 25.5 cm to 34.5 cm would result in a horizontal bar from

25.5 cm to 34.5 cm on the graph. If there is an overlap between the ranges of the two genders, then the difference is due to chance. If there is no overlap, then the difference is a significant finding. This means that there is an underlying reason for the difference; perhaps biological or genetic factors are responsible for the significant difference. Figure 5 (below) illustrates a sample range for girls (25 - 35 cm), and a sample range for boys (36 - 46 cm); each horizontal bar represents the range. There is no overlap between the two ranges; therefore the difference between the mean for the boys and the mean for the girls is a significant finding. Another way to describe the results is to say that there is some reason for the difference in vertical jumps between boys and girls.

E. If You Found No Overlap, Suggest A Possible Reason For The Difference

Figure 5. Sample range of vertical jumps for boys and girls.



Part V: BODY RATIO VERSUS JUMPING HEIGHT

1. It is possible that the scatter plot data is so random that the regression line is not easily drawn. It would be expected that there is a positive correlation between adjusted calf size and jumping ability, but this may not be true. To address this possibility, perform the following activity.

2. Determine your body weight in kilograms. ie. weight in pounds/2.2

3. Formulate the body weight to calf ratio by dividing the body weight in (kg) by the adjusted calf circumference (cm). Round to the nearest 0.1 of a decimal.

4. Record the body weight to adjusted calf ratio and vertical height jumped in **Table 5.**

5. Plot the body weight to calf ratio versus jumping height for each student on **Graph 6 (guys), and Graph 7 (girls).**

6. Generate a **scatter plot**, determine the **line of best fit or regression line**, and **correlation coefficient (*r* value)** as in Part II.

7. Notice that some people with different calf sizes are found to share the same ratios.

F. How Can The Difference In Height Jumped Be Explained If The Ratios Are The Same?