

Bones Tell Your Height

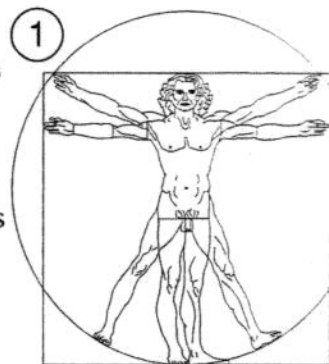


Topic

Calculation of height using long bones of arm or leg

Introduction

Scientists have long known that various measurements of the human body are in proportion to each other. For example, Leonardo Da Vinci's famous drawing (see diagram 1 opposite), "The Proportions of the Human Figure" (1492), shows that a person's height is equal to the span of his arms. Criminalists can estimate a person's height from a skeleton, but they also can do so if they have only one of the long bones such as the femur or humerus. In this experiment, you will measure the height, upper arm, and thigh of



Leonardo Da Vinci's drawing

members of a group of students. (Because your bones are hidden inside your bodies, the measurements will, of course, be an approximation of those made by forensic scientists, who work with the bones themselves.) You will then display measurements of height and upper arm, and height and thigh, on two graphs and discover the relationship between the height and the two lengths, observing how you can translate your findings into an equation. You will also learn how to estimate the height of a person whose upper arm or thigh length is known. Because male and female skeletons differ, you will need separate graphs and calculations for each sex.

Time required

1 hour

Materials

For group:
 metal tape measure, measuring up to
 2 meters
 book
 wall
 table
 straight-backed chair

For each student:
 2 sheets of graph paper ($8\frac{1}{2} \times 11$)
 pencil
 30 cm ruler
 calculator

Safety note

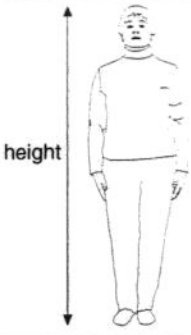
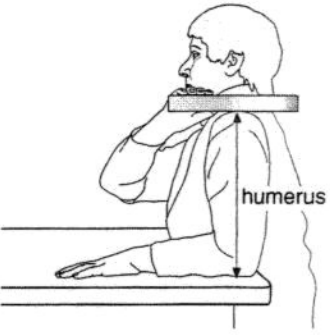
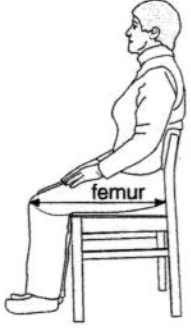


Please read the general safety precautions at the beginning of the book

Procedure

This experiment works best with students who have reached adult height and requires a group of ten students of the same sex. Each member of the group is measured in turn by one of the other group members. The person being measured is referred to as A and the measurer as B.

Table 1. *Measurement methods**

Height	Stand in bare feet flat on the ground against a wall.	Measure from the top of the head to the floor.	
Upper arm (humerus)	Place book on the top of the shoulder and the forearm flat on a table.	Measure the distance between the lower side of the book and the top surface of the table.	
Thigh (femur)	Sit on a straight-backed chair with the spine against the chair back.	Measure the distance between the chair back and the knee.	

*All measurements should be made in centimeters.

1. Measure the height of the first person using the method given in Table 1 above. Record this value in the first row of the data table on the next page.
2. Find the upper arm length of the first person using the method given in Table 1. Record this value in the data table.
3. Find the thigh length of the first person using the method given in Table 1. Record this value in the data table.
4. Repeat steps 1 to 3 for the other members of the group.
5. Give all members of the groups a copy of the results in the data table before proceeding with step 6.

- Work out a suitable scale and plot a graph of height against length of humerus for the group.
- Consider the graph carefully and draw a straight line that marks the best representation of the points (i.e., the line of best fit).
- Repeat steps 6 and 7, but this time plot a graph of height against length of femur for the group.

DATA TABLE

Is this a male or female group?

Person	Height in cm	Upper arm length (humerus) in cm	Thigh length (femur) in cm
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Analysis

- Where does the line cut the vertical axis on your graph of height against length of humerus? What is the gradient of the line of best fit?

To find the gradient of a line of best fit through the points on a scatter graph such as this, take two points on the line whose coordinates are given by x_1, y_1 and x_2, y_2 . The gradient (m) of the line is given by the formula:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

- Where does the line cut the vertical axis on your graph of height against length of femur? What is the gradient of the line of best fit?
- How would you expect your results to compare with those from a group of students of the opposite sex?
- How could you use your findings to estimate the height of a body from which you have either a humerus or a femur?

Want to know more?

See Section 10: Our Findings