

Hole-y Bones

Purpose

To compare the amount of calcium needed by the body at different developmental stages
To demonstrate the effect of calcium loss on bones

Background

Calcium is an important mineral that helps build and maintain strong bones and teeth. If calcium were removed from the body, it would resemble flour. The amount of calcium in your body will change throughout your life. Newborn babies have only about 30 grams of calcium. By age 10, the amount of calcium has increased to nearly 420 grams. As the bones continue to grow, the amount of calcium in the body continues to increase. By age 15, the amount of calcium will have doubled from that of a 10 year old to 840 grams. By the time children reach adulthood, the bones will contain 44 times as much calcium as they did when they were born, or nearly 1,320 grams. Physical activity also helps build strong bones. The good stress on the bones created from physical activity is particularly important during the bone growing years. After age 25, the bones stop growing and are as big as they will ever be. But the needs for calcium and physical activity do not stop. Bones lose about 1% of the total amount of calcium in the body each day. Because calcium is absorbed by the body in small quantities, it is important to take in additional amounts of calcium throughout the day. When the body does not get enough calcium, bones have a higher risk of fracture or breaking. Osteoporosis is a disease in which levels of calcium in the body drop so much that the bones begin to thin and weaken. Osteoporosis in adults cannot be detected until the bone loss is between 30 and 40%, making the bones very fragile. Astronauts who spend more than 180 days in space lose about 20% of their bone mass. Getting the recommended daily amount of calcium and being physically active will help keep bones healthy throughout life.

Procedure

Part 1

1. Using the scale, measure 30 g of flour.
2. Pour the flour into a zippered bag. Be sure to seal it completely.
3. Using the marker, label the bag "Newborn Child – 30g" and record in the Bone Data worksheet.
4. Measure 420 g of flour and put it into a bag.
5. Label the bag "Age 10 – 420 g" and record.
6. Measure 840 g of flour and put it into a bag.
7. Label the bag "Age 15 – 840 g" and record.
8. Measure 1,320 g of flour and put it into a bag.
9. Label the bag "Adult – 1,320 g" and record. See diagram 1.
10. To calculate the calcium of an adult suffering from osteoporosis
 - a. Multiply 1,320 times 40%
 - b. Subtract your answer from 1,320
 - c. Record the answer in the Bone Data Worksheet.
 - d. Round your answer to the nearest whole number and record.
11. Measure this amount of flour and put it into a zippered bag.
12. Label the bag "Adult with osteoporosis – ____ g."
13. To calculate how much calcium an astronaut loses after being in space for a long period of time
 - a. Astronauts lose about 20% of their bone mass while in space
 - b. Multiply 1,320 times 20%

Materials

2 bags of flour
(approximately 5 kilograms)
scale to measure grams
6 large, zippered plastic bags
marker
science journal
copy paper
scissors
pencil
single hole-punch
Bone Data Worksheet
(p. 46)
calculator (optional)

zipper bag

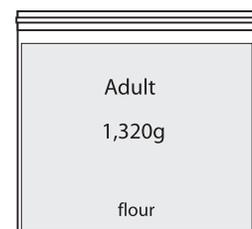
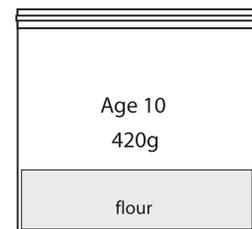
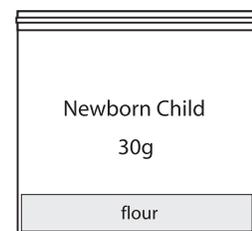


Diagram 1

Hole-y Bones

Segment 2

- c. Subtract the answer from 1,320.
- d. Record the answer in the Bone Data Worksheet
- e. Round your answer to the nearest whole number and record
14. Measure this amount of flour and put it into a zippered bag.
15. Label the bag, "Astronaut on long-duration space flight-- ____ g."
16. Look at the data in the Bone Data Worksheet. Compare the amount of flour in each bag. How do they compare?
17. To calculate how much calcium your body loses per year at each stage, take each measurement and multiply it by .01 (1%).
18. Record the answers in the Bone Data Worksheet.
19. Round the answers to the nearest whole number and record in the Bone Data Worksheet.

Part 2

20. Stack three sheets of paper together and fold them in half, lengthwise.
21. Keeping the papers folded, draw a tibia (lower leg bone) or femur bone (upper leg bone) on the top paper, filling the half sheet. See diagram 2.
22. Keeping the papers folded so that the bone you drew is on top, cut through all sheets to create six bones that are exactly the same.
23. Choose one bone to be the control bone and firmly grasp each end of the paper bone with both hands. See diagram 3.
24. Tug on both ends of the bone, creating stress in the center of the paper bone.
25. Count each tug and continue to tug until the paper bone breaks. If it doesn't break, stop after 40 tugs and record 40+ tugs.
26. Record the number of tugs in the Bone Data Worksheet.
27. Select a second paper bone to represent the bone of a 10 year old.
28. Looking at your bone loss chart, find the amount of calcium loss, rounded to the nearest whole number for a 10 year old.
29. Use a hole-punch to punch that number of holes in the center, long shaft of the bone. See diagram 4.
30. Tug on the bone, as before, being sure to count each tug.
31. Record how many tugs it took to break the bone on the Bone Data Worksheet.
32. Repeat for each of the remaining categories: 15-year old, adult, adult with osteoporosis, and astronaut. Make sure to punch the number of holes in the paper bone that corresponds to the grams of calcium lost.
33. Record your findings for each bone.

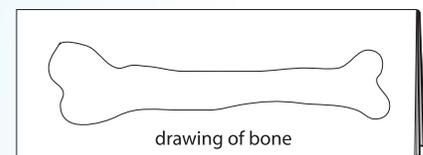


Diagram 2

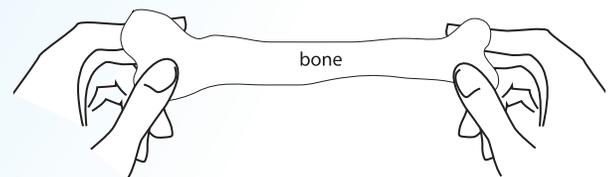


Diagram 3

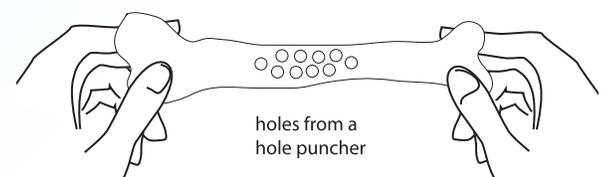


Diagram 4

Discussion

1. Why is calcium important to bones?
2. What happens to bone strength as bone mass is lost?
3. How much calcium is recommended for someone your age?
4. What can you do to prevent bone loss?

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Extension

1. A smoothie is a delicious, nutritious snack that is also a great source of calcium. A basic smoothie contains 118 mL (1/2 cup) to 177mL (3/4 cup) milk, 59 mL (1/4 cup) to 118 mL (1/2 cup) frozen yogurt or ice cream, and any combination of fruits, cinnamon, cocoa, chocolate syrup, oatmeal, vanilla extract, honey, peanut butter, and juice concentrates. With adult supervision, blend these ingredients or others you like to create your own smoothie.
2. Research to find the amount of calcium in your smoothie. Create a nutrition label for your smoothie. Produce an ad to promote it.
3. In class, have each group create a unique smoothie. Share a small amount with other classmates. Rate each group's smoothie for taste and calcium value.
4. Conduct research to learn what the recommended daily allowance is for calcium during each stage of development.
5. Research to find which foods are rich in calcium.
6. Keep a chart that shows how many foods you are eating that are good sources of calcium.

BONE DATA WORKSHEET

Age	Grams	Calcium loss (in grams)	Calcium loss (in grams rounded to nearest whole number)
Newborn			
10			
15			
Adult			
Adult with Osteoporosis			
Astronaut on long-duration flight			

Bone	Number of holes punched (each hole = 1 gram of calcium)	Number of tugs to break bone
1 – Healthy Bone (control)	- 0 -	
2 – 10 year old		
3 – 15 year old		
4 – adult		
5 – adult with osteoporosis		