



CALIFORNIA STATE SCIENCE FAIR 2017 PROJECT SUMMARY

Name(s) Ariel M. Fernandez	Project Number S1303
Project Title Break a Leg! A Study of the Correlation between Bone Mineral Density and Compressive Strength of Various Mammalian Bones	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals All animals within the Vertebrata subphylum develop a skeleton that is essential to life. Unfortunately, bones can fracture under heavy pressure or forceful hits. This project was designed in order to examine whether a higher body weight of a mammal correlates with stronger bones & higher bone mineral density (BMD). If mammalian bones are tested for compressive strength and bone mineral density, then mammals with higher body weights will have stronger and denser bones than mammals with lower body weights.</p> <p>Methods/Materials Six moose metacarpals, deer metacarpals, coyote tibiae, coyote fibulae, and coyote tibia/fibula articulated pairs were ordered from an online company in Idaho. The mass & anterior surface area of each bone was measured, and BMD was calculated by dividing the mass by the area. Horizontal & vertical compressive strength tests were then performed three times for each set. In the horizontal test, bones were placed flat on a plywood sheet, and weights were stacked & balanced on each bone. 595 lbs. of weight plates were provided for use throughout these tests. For the vertical test, a crusher was constructed to balance weights on the bone. Due to safety limitations, only 552 lbs. could be used in the vertical test. Weight placement ended when an open fracture was observed or the maximum weight was reached.</p> <p>Results The average BMD from greatest to least were moose metacarpals (3.66g/cm²), whitetail deer metacarpals (1.76g/cm²), coyote tibiae (1.10g/cm²), coyote tibia/fibula pairs (0.96g/cm²), & coyote fibulae (0.21g/cm²). The vertical tests matched this order exactly with the averages being 552 lbs., 552 lbs., 492 lbs., 473 lbs., & 6.7 lbs. respectively. In the horizontal tests, the averages were 595 lbs., 420 lbs., 565 lbs., 595 lbs. & 82 lbs. respectively. The average body weight of moose is 800-1,000 lbs. Whitetail deer weigh 155-203 lbs., and coyotes weigh 24-39 lbs.</p> <p>Conclusions/Discussion The data partially supported the hypothesis, as there were two horizontal discrepancies that occurred due to the anatomy of the bones. Thus, the anatomy of certain bones definitely has an effect on the strength of bones at different areas and angles of pressure. Ultimately, the correlation found between BMD and average body weight can be linked to multiple studies regarding osteoporosis, as a significantly low body weight may be a risk factor for osteoporosis in anatomically susceptible areas of bone.</p>	
Summary Statement Bone mineral densities and compressive strengths of various mammalian lower limb bones were found in order to determine a correlation between the two values and confirm that higher body weights are associated with denser & stronger bones.	
Help Received Home Depot Staff cut wood for the crusher; Edwards AFB Gym Staff provided 595 pounds of weight plates for use throughout the project; Mrs. Lewis, my Anatomy teacher, helped me brainstorm through the engineering process of the vertical testing; & my family assisted in stacking weights on the bones.	