Culture, Society, and Praxis

Volume 13
Number 1 *Embodying Change*

Article 4

May 2021

High Impact Sports Seen Through Bone Density in Human Remains

Emma Holmes
California State University, Monterey Bay

Follow this and additional works at: https://digitalcommons.csumb.edu/csp

 Part of the Social and Behavioral Sciences Commons

Recommended Citation

Holmes, Emma (2021) "High Impact Sports Seen Through Bone Density in Human Remains," *Culture, Society, and Praxis*: Vol. 13 : No. 1 , Article 4.
Available at: https://digitalcommons.csumb.edu/csp/vol13/iss1/4

This Main Theme / Tema Central is brought to you for free and open access by the Student Journals at Digital Commons @ CSUMB. It has been accepted for inclusion in Culture, Society, and Praxis by an authorized administrator of Digital Commons @ CSUMB. For more information, please contact digitalcommons@csumb.edu.

Culture, Society, and Praxis

High Impact Sports Seen Through Bone Density in Human Remains

Emma Holmes

High impact sports affect bone density in humans. Can anthropologists and archaeologists say a civilization played recreational sports based on their skeletal remains? In this paper, I will be discussing how exercise affects our bones. First, I will review the research on how sports affect bone density. Then, I will examine three main factors that influence bone density as it relates to exercise: magnitude, rate, and frequency of muscle strain because as the muscle moves, it pulls on the bone and as a response, the bone becomes stronger and denser. Lastly, I will examine what anthropologists can already tell from the bones of human remains.

HOW HIGH IMPACT SPORTS AFFECT BONE DENSITY

Wolff's Law states that bone is sensitive to mechanical stimuli, meaning it may adjust size and shape in response to external forces. Simulated bone adaptation in the human femur using topology optimization, which is a mathematical method that optimizes material layout within a given design space, supports Wolff's Law (Jang & Kim, 2008). Additionally, multiple studies demonstrate that removing the radius—one of the two bones in the lower arm—results in increased growth of the ulna, the other bone (Chamay and Tschantz, Lanyon). This means the radius responded to a part of the ulna being removed and compensated for the loss of bone. Bones adapt by retaining their minerals to build more of the inner bone, or medulla, which is going to make the bone denser.

This adaptation is pronounced in athletes since bones increase in density to accommodate the extra load being put on them during high-impact sports, (Guadalupe-Grau et al., 2009). In both adolescence and adulthood, people who exercise regularly have greater bone density. Adolescent male athletes show higher bone density in their lumbar spine, arms, and legs than nonathletic boys (Quiterio et al., 2011), and overall bone size is bigger in child athletes than nonathletic children (Markou et al., 2010). Gymnasts have a higher bone density than people who do not exercise regularly (Taaffe et al, 1995), while people who exercise for an hour or more a day have 3.4% more bone density overall and 8.5% more in just the hips than people who do not exercise (Ginty et al., 2005).

Bones also adapt due to muscle strain, or any activity that uses muscle. Our muscles are attached to bones by tendons. When someone moves a muscle, this movement tugs on the bone. The force the muscle puts on the bone causes a response in which the bone strengthens by getting denser. According to Wolff's Law, for the bone to stay strong when one is moving, their body will respond by sending more minerals to the bone to strengthen it. This will prevent the bone from breaking when a greater force is acted on it.

Emma Holmes is graduating from CSU Monterey Bay in Spring 2021 with a B.A. in Social and Behavioral Sciences.

Published by Digital Commons @ CSUMB, 2021

There are three categories of muscle strain that will affect bone density: magnitude, rate, and frequency of strain. The *magnitude* is how much force is placed on your muscles or bones during exercise. Exercise is typically broken into two categories: strength training and aerobic exercise. Strength training is a way to build muscle without getting your heart rate up. Strength training involves a great magnitude of strain that is put on your bones and muscles. A good example of this is rock climbing. To rock climb, one is putting all one's body weight on one's arms and legs.

The *rate* of muscle strain is how much force your muscle can exert. This type of strain would be anaerobic exercise. In an anaerobic state, your body is burning glucose without the use of oxygen. This happens during intense, brief exercises. The body uses lactate to break down glucose without the presence of oxygen. Lactate is only sustainable for a few seconds to a minute, so it is not able to use long term. An example of anaerobic exercise is plyometrics or jump training. Plyometrics is quick, dynamic movements that cause the muscles to exert their maximum force for a short interval of time.

The *frequency* of muscle strain is considered any longer periods of muscle strain, but with less force exerted or acting on them. This strain would be aerobic exercise. Aerobic exercise uses your aerobic metabolism. Aerobic metabolism is when your body breaks down glucose for energy using the oxygen that you breathed in. Endurance running is an example of aerobic exercise. It is low intensity but requires muscle strain for a long period.

WHAT WE CAN TELL FROM HUMAN REMAINS

While we don't yet have anthropological studies of skeletal remains that identify how past civilizations exercised, existing studies demonstrate that such research is possible. For example, the size and shape of the mandible between hunter-gatherer societies and agricultural societies are significant (Cramon-Taubadel, 2011). Hunter-gatherers ate more tough meat which would have used more jaw muscle than eating plants in an agricultural society. The muscle attachment sites to the bone would have more wear and tear on the bone from someone that is eating tough meat because the muscle pulls on the bone every time it is used and eventually it starts wearing down. Therefore, anthropologists and archaeologists can examine the jawbones of early humans to tell what type of food they ate, which helps us understand how they lived.

HOW THIS ALL TIES TOGETHER

High-impact sports have not been tied directly into forensic anthropology, but anthropologists can tell the lifestyle lived by our ancestors based on bone wear and tear, like in the hunter-gatherer example. The next step is to develop the technology and techniques that would allow anthropologists to see how the person whose remains are being studied exercised when they were alive. This research is a step toward being able to tell the story of the remains for them.

REFERENCES

Chamay, A., & Tschantz, P. "Mechanical influences in bone remodeling--experimental research in Wolff's law." Journal of Biomechanics, no. 5 (1972): 173-180.

Cramon-Taubadel, N. Von. "Global Human Mandibular Variation Reflects Differences in Agricultural and Hunter-Gatherer Subsistence Strategies." *Proceedings of the National*

Academy of Sciences 108, no. 49 (2011): 19546–51. https://doi.org/10.1073/pnas.1113050108.

Ginty, F., K.l. Rennie, L. Mills, S. Stear, S. Jones, and A. Prentice. "Positive, Site-Specific Associations between Bone Mineral Status, Fitness, and Time Spent at High-Impact Activities in 16- to 18-Year-Old Boys." *Bone* 36, no. 1 (2005): 101–10. https://doi.org/10.1016/j.bone.2004.10.001.

Greene, David A, and Geraldine A Naughton. "Adaptive Skeletal Responses to Mechanical Loading during Adolescence." *Sports Medicine* 36, no. 9 (2006): 723–32. https://doi.org/10.2165/00007256-200636090-00001.

Guadalupe-Grau, Amelia, Teresa Fuentes, Borja Guerra, and Jose A.l. Calbet. "Exercise and Bone Mass in Adults." *Sports Medicine* 39, no. 6 (2009): 439–68. https://doi.org/10.2165/00007256-200939060-00002.

Jang, In Gwun, & Kim, Il Yong. "Computational Study of Wolff's Law with Trabecular Architecture in the Human Proximal Femur Using Topology Optimization." *Journal of Biomechanics*, vol. 41, no. 11, 2008, pp. 2353–2361., https://doi.org/10.1016/j.jbiomech.2008.05.037.

Lanyon, L.e., A.e. Goodship, C.j. Pye, and J.h. Macfie. "Mechanically Adaptive Bone Remodelling." *Journal of Biomechanics* 15, no. 3 (1982): 141–54. https://doi.org/10.1016/0021-9290(82)90246-9.

Markou, Kostas B., Anastasia Theodoropoulou, Athanasios Tsekouras, Apostolos G. Vagenakis, and Neoklis A. Georgopoulos. "Bone Acquisition during Adolescence in Athletes." *Annals of the New York Academy of Sciences* 1205, no. 1 (2010): 12–16. https://doi.org/10.1111/j.1749-6632.2010.05675.x.

Quiterio, Ana L Dias, Elvis A Carnero, Fátima M Baptista, and Luís B Sardinha. "Skeletal Mass in Adolescent Male Athletes and Nonathletes: Relationships with High-Impact Sports." *Journal of Strength and Conditioning Research* 25, no. 12 (2011): 3439–47. https://doi.org/10.1519/jsc.0b013e318216003b.

Taaffe, Dennis R., Tracey L. Robinson, Christine M. Snow, and Robert Marcus. "High-Impact Exercise Promotes Bone Gain in Well-Trained Female Athletes." *Journal of Bone and Mineral Research* 12, no. 2 (January 1997): 255–60. https://doi.org/10.1359/jbmr.1997.12.2.255.