

Agriculture, declining mobility drove humans' shift to lighter bones

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Cross-sections of an Upper Paleolithic, left, and Early Medieval, right, thigh bone, showing the change in bone shape and reduction in strength in the later individual. Credit: Study authors

Modern lifestyles have famously made humans heavier, but, in one particular way, noticeably lighter weight than our hunter-gatherer ancestors: in the bones. Now a new study of the bones of hundreds of humans who lived during the past 33,000 years in Europe finds the rise of agriculture and a corresponding fall in mobility drove the change, rather than urbanization, nutrition or other factors.

The discovery is reported in the early edition of *Proceedings of the National Academy of Sciences* the week of May 18. It sheds light, researchers say, on a monumental change that has left modern humans susceptible to osteoporosis, a condition marked by brittle and thinning bones.

At the root of the finding, the researchers say, is the knowledge that putting bones under the "stress" of walking, lifting and running leads them to pack on more calcium and grow stronger.

"There was a lot of evidence that earlier humans had stronger bones and that weight-bearing exercise in [modern humans](#) prevents [bone](#) loss, but we didn't know whether the shift to weaker bones over the past 30,000 years or so was driven by the rise in agriculture, diet, urbanization,

domestication of the horse or other lifestyle changes," says Christopher Ruff, Ph.D. , a professor of functional anatomy and evolution at the Johns Hopkins University School of Medicine.

"By analyzing many arm and leg bone samples from throughout that time span, we found that European humans' bones grew weaker gradually as they developed and adopted agriculture and settled down to a more sedentary lifestyle, and that moving into cities and other factors had little impact."

The study was a collaborative effort of researchers from across Europe and the United States that began in 2008. The group focused on Europe because it has many well-studied archeological sites, Ruff says, and because the population has relatively little genetic variation, despite some population movements. That meant that any changes observed could be attributed more to lifestyle than to genetics.

For the study, the researchers took molds of bones from museums' collections and used a portable X-ray machine to scan them, focusing on two major bones from the legs and one from the arms. "By comparing the lower limbs with the upper limbs, which are little affected by how much walking or running a person does, we could determine whether the changes we saw were due to mobility or to something else, like nutrition," Ruff says.

When they analyzed the geometry of bones over time, the researchers found a decline in leg [bone strength](#) between the Mesolithic era, which began about 10,000 years ago, and the age of the Roman Empire, which began about 2,500 years ago. Arm bone strength, however, remained fairly steady. "The decline continued for thousands of years, suggesting that people had a very long transition from the start of agriculture to a completely settled lifestyle," Ruff says. "But by the medieval period, bones were about the same strength as they are

today."

Ruff notes that Paleolithic-style bones are still likely achievable, at least for younger humans, if they recreate to some extent the lifestyle of their ancestors, notably doing a lot more walking than their peers. He cites studies of professional athletes that have demonstrated how lifestyle is written in our bones. "The difference in bone strength between a professional tennis player's arms is about the same as that between us and Paleolithic humans," he says.

More information: Gradual decline in mobility with the adoption of food production in Europe, *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1502932112

Provided by Johns Hopkins University School of Medicine

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