

Human ancestor 'Lucy' was a tree climber, new evidence suggests

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The fossils that make up the Lucy skeleton. Credit: John Kappelman/University of Texas at Austin

Since the discovery of the fossil dubbed Lucy 42 years ago this month, paleontologists have debated whether the 3 million-year-old human ancestor spent all of her time walking on the ground or instead combined walking with frequent tree climbing. Now, analysis of special CT scans by scientists from The Johns Hopkins University and the University of Texas at Austin suggests the female hominin spent enough time in the trees that evidence of this behavior is preserved in the internal structure of her bones. A description of the research study appears November 30 in the journal *PLOS ONE*.

Analysis of the partial fossilized skeleton, the investigators say, shows that Lucy's upper limbs were heavily built, similar to champion tree-climbing chimpanzees, supporting the idea that she spent time climbing and used her arms to pull herself up. In addition, they say, the fact that her foot was better adapted for bipedal locomotion (upright walking) than grasping may mean that climbing placed additional emphasis on Lucy's ability to pull up with her arms and resulted in more heavily built upper [limb bones](#).

Exactly how much time Lucy spent in the trees is difficult to determine, the research team says, but another recent [study](#) suggests Lucy died from a fall out of a tall tree. This new study adds to evidence that she may have nested in trees at night to avoid predators, the authors say. An eight-hour slumber would mean she spent one-third of her time up in the trees, and if she also occasionally foraged there, the total percentage of time spent above ground would be even greater.

Lucy, housed in the National Museum of Ethiopia, is a 3.18 million-year-old specimen of *Australopithecus afarensis*—or southern ape of Afar—and is among the oldest, most complete fossil skeletons ever found of any adult, erect-walking human ancestor. She was discovered in the Afar region of Ethiopia in 1974 by Arizona State University anthropologist Donald Johanson and graduate student Tom Gray. The new study analyzed CT scan images of her bones for clues to how she used her body during her lifetime. Previous studies suggest she weighed less than 65 pounds and was under 4 feet tall.

"We were able to undertake this study thanks to the relative completeness of Lucy's skeleton," says Christopher Ruff, Ph.D., a professor of functional anatomy and evolution at the Johns Hopkins University School of Medicine. "Our analysis required well-preserved upper and lower limb bones from the same individual, something very rare in the fossil record."

The research team first had a look at Lucy's bone structure during her U.S. museum tour in 2008, when the fossil was detoured briefly to the High-Resolution X-Ray Computed Tomography Facility in the University of Texas at Austin Jackson School of Geosciences. For 11 days, John Kappelman, Ph.D., anthropology and geological sciences professor, and geological sciences professor Richard Ketcham, Ph.D., both of the University of Texas at Austin, carefully scanned all of her bones to create a digital archive of more than 35,000 CT slices. High-resolution CT scans were necessary because Lucy is so heavily mineralized that conventional CT is not powerful enough to image the internal structure of her bones.

"We all love Lucy," Ketcham says, "but we had to face the fact that she is a rock. The time for standard medical CT scanning was 3.18 million years ago. This project required a scanner more suited to her current state."

The new study uses CT slices from those 2008 scans to quantify the [internal structure](#) of Lucy's right and left humeri (upper arm bones) and left femur (thigh bone).

"Our study is grounded in mechanical engineering theory about how objects can facilitate or resist bending," says Ruff, "but our results are intuitive because they depend on the sorts of things that we experience about objects—including body parts—in everyday life. If, for example, a tube or drinking straw has a thin wall, it bends easily, whereas a thick wall prevents bending. Bones are built similarly."

"It is a well-established fact that the skeleton responds to loads during life, adding bone to resist high forces and subtracting bone when forces are reduced," explains Kappelman. "Tennis players are a nice example: Studies have shown that the cortical bone in the shaft of the racquet arm is more heavily built up than that in the nonracquet arm."

A major issue in the debate over Lucy's tree climbing has been how to interpret skeletal features that might be simply "leftovers" from a more primitive ancestor that had relatively long arms, for example. The advantage of the new study, Ruff says, is that it focused on characteristics that reflect actual behavior during life.

Lucy's scans were compared with CT scans from a large sample of modern humans, who spend the majority of their time walking on two legs on the ground, and with chimpanzees, a species that spends more of its time in the trees and, when on the ground, usually walks on all four limbs.

"Our results show that the upper limbs of chimpanzees are relatively more heavily built because they use their arms for climbing, with the reverse seen in humans, who spend more time walking and have more heavily built lower limbs," says Ruff. "The results for Lucy are

convincing and intuitive."

Other comparisons carried out in the study suggest that even when Lucy walked upright, she may have done so less efficiently than modern humans, limiting her ability to walk long distances on the ground, Ruff says. In addition, all of her limb bones were found to be very strong relative to her body size, indicating that she had exceptionally strong muscles, more like those of modern chimpanzees than modern humans. A reduction in muscle power later in human evolution may be linked to better technology that reduced the need for physical exertion and the increased metabolic demands of a larger brain, the researchers say.

"It may seem unique from our perspective that early hominins like Lucy combined walking on the ground on two legs with a significant amount of tree climbing," says Kappelman, "but Lucy didn't know she was "unique"—she moved on the ground and climbed in trees, nesting and foraging there, until her life was likely cut short by a fall—probably out of a tree."

More information: Ruff CB, Burgess ML, Ketcham RA, Kappelman J (2016) Limb Bone Structural Proportions and Locomotor Behavior in A.L. 288-1 ("Lucy"). *PLoS ONE* 11(11): e0166095. [DOI: 10.1371/journal.pone.0166095](https://doi.org/10.1371/journal.pone.0166095)

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