Does lifestyle change humeral bone structure?

- Researchers from the Minzu University of China have been finding out how humeral (upper arm bone) structure changes with lifestyle.
- Working with samples from archaeological sites containing modern human remains, the researchers used a novel method called morphometric mapping for limb structure visualisation. This determined differences in bone robustness in response to daily activities.
- Comparing agricultural and nomadic groups, we are learning more about past populations.

Dr Haijun Li, Professor for the Department of Archaeology and Museology at Minzu University of China, and Director of the Physical Anthropology Laboratory, has been finding out how modern humans' humeral (upper arm bone) structure changes depending on their lifestyle. The research team did this by comparing humerus samples from nomadic and agricultural groups.

Farmer or nomad?

Once humans learnt to farm, their lifestyles became much more sedentary but involved different forms of physical labour as farming technology developed. While nomadic groups depended upon different skillsets and resources, so their comparative bone structures adapted to these different conditions. Nomadic populations were often pastoralists, herding animals from place to place as opposed to keeping them in pens and growing crops like the agriculturalists. The types of work and level of activity involved in their lifestyle also depended on their gender. Women tended to carry out more sedentary, domestic tasks like caring for the children, cooking, and making clothes, while men were more active. With nomads herding, hunting, and fighting, and farming men dealing with the toil of tending to their crops.

The humeral structure

The humerus (plural 'humeri') is the upper arm bone that runs between a person's shoulder and elbow, and as such, is a region of the body that is vital to all hand-based, manual tasks. So, by examining changes in humeral structure, archaeologists can obtain a better picture of an individual's past. This analysis aids in discerning the specific physical activities that likely contributed to alterations in bone structure. When the surrounding archaeological evidence – or context – that the skeletal remains are found in is very clear, archaeologists therefore already know whether the individuals were nomadic or agricultural. They can also then check whether there are any noticeable patterns in the structural differences in the humeri from each group.

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Once enough samples have been studied and clear patterns of humeral structural differences emerge, then in the future, if remains are discovered without enough contextual evidence to provide the clues needed to work out who they were, researchers will be able to use measurements of their humeri as a proxy to predict what lifestyle that individual may have led. Ultimately, this would mean that if archaeologists found an unknown skeleton in the middle of nowhere, then by looking at their humeral structure alone, they could tell whether they were from a nomadic or agricultural population.

Morphometric mapping methods

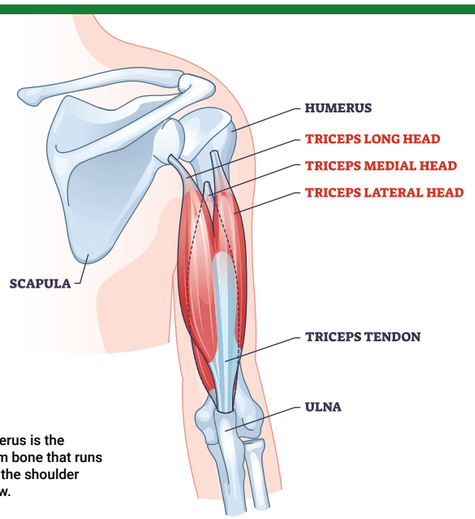
Li and his team examined 40 pairs of humeri from adult human remains collected from archaeological burial sites that contained either agricultural or nomadic populations from the Holocene period – the geological time period that we are living in. It began approximately 11,700 years ago when the last ice age ended, and so can include people from back then right up until the present day.

They included individuals from farming populations from three different eras in their research to enlarge the range of variation covered within the agricultural lifestyle samples. These included:

- *The Neolithic Age:* When people first settled on farms and established intensive agriculture, becoming fully sedentary.
- *The Qin-Hang Dynasty:* When iron tools started being used extensively for farming.
- *The Qing-Dynasty:* The last dynasty before industrial machinery came into use.

The researchers compared these agricultural populations with a Bronze Age nomadic population from the Xin-Jiang region in North-West China. A nomadic population from this period was chosen because after the Han Dynasty, there was much more cultural exchange between nomadic and agricultural populations so lifestyle differences would have become less distinct.

They used a novel method known as morphometric mapping to digitally visualise and measure the bone structure of the shaft of the humerus, otherwise known as the humeral diaphysis. This



The humerus is the upper arm bone that runs between the shoulder and elbow.

limb structure visualisation method allowed them to observe and compare how robust (resistant to bending) the arm bones were in different regions along its length.

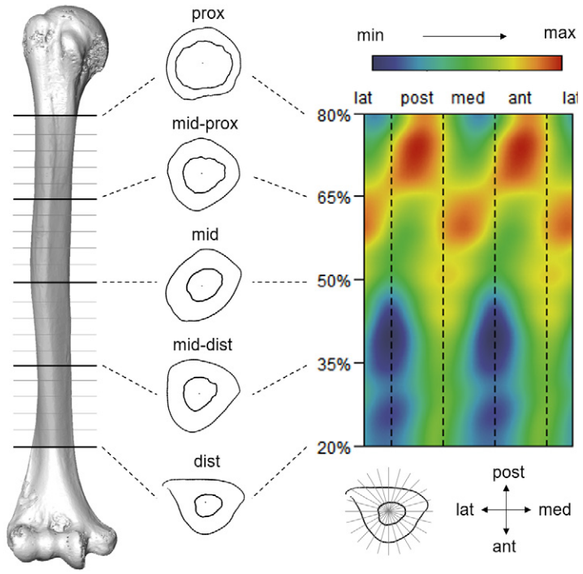
Robust results

Their results showed that the humeral diaphyseal structure in all individuals from both groups generally had similar robustness along the posteromedial-anterolateral direction of the bone near the shoulder, the direction which obeys the diagonal forwards and backwards motion that your arms naturally follow when you bring your hands together and apart. And the bones were also similarly robust along the mediolateral direction near the elbow, the direction that follows the motion of moving your lower arms from side to side, again as you press your hands together or pull them apart. The motions that occur the most when carrying out manual tasks.

They used a novel method called morphometric mapping to digitally visualise and measure the bone structure.

Their results found that within the farming group, the women's arm bones were very robust in the middle, while the men from the nomadic group had robust arm bones near the shoulder. Leaving the farming men and nomadic women, whose arm bone robustness was uniformly distributed throughout the top half of the humerus.

Overall, this study showed that an individual's lifestyle and gender influenced how robust different regions of their arm bones were. The regions that got the most reinforcement and were different between the groups and sexes were likely due to the specific ways that they used their arms in their daily activities.



Researchers from the Minzu University of China have been finding out how upper arm bone structure changes with lifestyle.

Personal response

What specific regions and populations are you most interested in learning more about?

Holocene hunter-gatherer populations have captured my particular interest. The Holocene epoch has witnessed a global transition from mobile hunting and gathering to sedentary agricultural practices, albeit with noteworthy persistence of diverse forms of hunter-gatherer societies. These Holocene hunter-gatherer populations are distinct not only from their agricultural and nomadic counterparts, but also from their Pleistocene hunter-gatherer forebears, particularly in the domains of hunting strategies, tools, and mobility.
It is also important to underscore the intricacy of the subsistence patterns adopted by certain hunter-gatherer populations. For instance, these societies may exhibit a multifaceted array of activities, engaging in agricultural production and livestock husbandry during specific seasons, while reverting to fishing and hunting during others. By scrutinising the skeletal remains, specifically the limb bones, of these Holocene hunter-gatherer populations, we have a valuable opportunity to enhance our comprehension of the extensive variation and diversity evident in human limb bone structures.

Are there any specific remains that have been found with little contextual evidence in their surroundings that you think your research could help reveal more about?

Within the scope of our research, the differentiation in humeral structures between agricultural and nomadic populations is discernible primarily at population level, with noticeable overlap observed within the variation range of specific individuals. However, the populations included in our study do not encompass the entirety of variation among Holocene modern humans. In the future, we aim to enhance the specificity of our research by incorporating more specialised populations. This may involve the inclusion of fully-sedentary and highly intensified agricultural populations residing in flatland regions, as well as highly mobile nomadic populations inhabiting mountainous terrains. The analysis of remains from individuals belonging to these distinct populations may offer a more unambiguous elucidation of their socio-cultural and ecological backgrounds, without relying on contextual evidence for such determinations.

Could your research be applied to determine who was who on a battleground?

Regrettably, establishing the precise identity of an individual solely through the examination of morphological or structural features of human limb bones remains an elusive goal. However, the implementation of molecular techniques, such as DNA determination, offers an effective avenue to achieve this goal. While the structural characteristics of human limb bones may not enable the direct identification of specific individuals in a battlefield, our research retains significant value in disclosing pivotal information about individuals, encompassing their age, physique, robustness, nutritional status, presence of pathologies, evidence of trauma, and various other relevant attributes.

How could this research pertain to present day humans and their lifestyles?

This research holds significant potential for monitoring and discerning physical condition changes in professional athletes, offering invaluable guidance for optimising their training regimens. Moreover, it can serve as a valuable tool in supporting the rehabilitation training of individuals who have sustained bone injuries.
Morphometric mapping, the method employed to visualise the diaphyseal structure of limb bones, can yield substantial benefits in the context of drug development programmes associated with these areas of study.
In the fields of palaeoanthropology and archaeology, extensive research has been carried out on the adaptive changes in the structural properties of human limb bones in response to various environmental pressures associated with different subsistence patterns. Nonetheless, it is crucial to acknowledge the inherent complexity of directing human evolution, primarily due to the multifaceted and unpredictable nature of future changes in environmental conditions and social structures. Consequently, our research is fundamentally retrospective in nature, focusing on the past phenomena rather than speculative considerations of the future.

Details

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Bio

Dr Haijun Li is Professor at the Department of Archaeology and Museology, Minzu University of China, and Director of Physical Anthropology Laboratory. His research interests include physical anthropology and human osteoarchaeology. Currently, Li's research focuses on the health conditions of humans in the Holocene, cultural traces associated with human bones, variations and environmental adaptations in human bone morphology.

Dr Yuhao Zhao serves as a research assistant at the Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences. His research focuses on the application of innovative morphometric methods to human skeletons within the realms of paleoanthropology and physical anthropology.

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Further reading

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