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Limb bone bilateral asymmetry: variability and commonality among modern humans

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Abstract

Humans demonstrate species-wide bilateral asymmetry in long bone dimensions. Previous studies have documented greater right-biases in upper limb bone dimensionsâ€”especially in length and diaphyseal breadthâ€”as well as more asymmetry in the upper limb when compared with the lower limb. Some studies have reported left-bias in lower limb bone dimensions, which, combined with the contralateral asymmetry in upper limbs, has been termed â€œcrossed symmetry.â€ The examination of sexual dimorphism and population variation in asymmetry has been limited.

This study re-examines these topics in a large, geographically and temporally diverse sample of 780 Holocene adult humans. Fourteen bilateral measures were taken, including maximum lengths, articular and peri-articular breadths, and diaphyseal breadths of the femur, tibia, humerus, and radius. Dimensions were converted into percentage directional (%DA) and absolute (%AA) asymmetries. Results reveal that average

directional (%DA) and absolute (%AA) asymmetries. Results reveal that average diaphyseal breadths in both the upper and lower limbs have the greatest absolute and directional asymmetry among all populations, with lower asymmetry evident in maximum lengths or articular dimensions. Upper limb bones demonstrate a systematic right-bias in all dimensions, while lower limb elements have biases closer to zero %DA, but with slight left-bias in diaphyseal breadths and femoral length. Crossed symmetry exists within individuals between similar dimensions of the upper and lower limbs. Females have more asymmetric and right-biased upper limb maximum lengths, while males have greater humeral diaphyseal and head breadth %DAs. The lower limb demonstrates little sexual dimorphism in asymmetry. Industrial groups exhibit relatively less asymmetry than pre-industrial humans and less dimorphism in asymmetry. A mixture of influences from both genetic and behavioral factors is implicated as the source of these patterns.

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Keywords

Postcranial variation; Laterality; Bone plasticity; Hominin; Crossed symmetry; Secular trends

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