Demographic Distribution of Finger Joint Space Width and Joint Space Width Change

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INTRODUCTION**:** Joint space width (JSW) is a commonly used metric to evaluate joint health [1]. The joint spacing of the finger joints can have complex demographic variability and can be affected differently by natural and pathological [2] considerations. Previous studies have established normative joint space values for the finger joints [3], but have not established how these normative values can naturally change over time and how this change can vary demographically. Understanding the demographic distribution of finger JSW and the natural history of finger JSW, with respect to essential demographics including age and gender, can aid in understanding joint structure complexity, as well as aid in the development of future epidemiological and biomechanical studies. The purpose of this study was to describe the natural history of JSW for healthy finger joints, using data from the Osteoarthritis Initiative. The hypothesis was that finger JSW would decline with increasing age for males and females and that the rate of finger JSW decline would be greater in females than in males.

METHODS**:** Healthy finger joints [distal interphalangeal (DIP 2-5), proximal interphalangeal (PIP 2-5), and metacarpal phalangeal (MCP 2-5)] were identified within participants from the Osteoarthritis Initiative who received a dominant hand radiograph at baseline and 48-months follow-up. Participants self-identified as either male or female. Healthy finger joints were defined as joints with a Kellgren-Lawrence grade of zero at baseline. One reader used semi-automated software to measure finger joint JSW from the hand radiographs at both time points. For each finger joint, participants were delineated by their percentile score for baseline JSW, JSWp. The percentile ranges were $\mathrm{JSWp} \leq 10, 10 < \mathrm{JSWp} \leq 25,\ 25 < \mathrm{JSWp} \leq 50,\ 50 < \mathrm{JSWp} \leq 75,$ and $75 < \mathrm{JSWp}$. For each percentile range for each joint, a linear mixed effects model with fixed effects for age and random intercepts for participants was fitted. A two-tailed t-test was used to compare differences in the slopes of the linear-mixed effects models for each joint between females and males ($\alpha = 0.05$).

RESULTS**:** The population sample consisted of 3,389 participants. There were 1,926 females and 1,463 males with at least one healthy timepoint observation, resulting in a total of 3,596 DIP2, 4,256 DIP3, 4,771 DIP4, 3,599 DIP5, 5,170 PIP2, 4,509 PIP3, 4,172 PIP4, 4,890 PIP5, 4,909 MCP2, 5,888 MCP3, 5,894 MCP4 and 6,661 MCP5 healthy joint assessments. Figures (1a), (2a), and (3a) give the linear mixed effect modeling for each percentile range of the DIP2, PIP2, and MCP2 joints for the male and female groups, respectively. Figures (1b), (2b), and (3b) give the mean slope (mm/year) of the linear mixed effects models for each joint for the male and female groups, respectively. The magnitude of the linear mixed effects model slopes for the female group were larger than the male group for the 2nd-5th DIP, the 2nd -4th PIP, and the 2nd-4th MCP. The differences between the slopes was not significant ($p < 0.05$).

DISCUSSION**:** The natural history of healthy finger JSW is gradual loss with age. Females had a greater rate of JSW loss per year than males, for ten of the twelve hand joints that were assessed. The larger rate of JSW loss amongst females identified a trend for which a significant difference may be detectable for future studies involving greater than 48 months follow-up. The magnitude of JSW decline per year was on the order of 0.001 mm/year for each represented joint, indicating the rate of decline in JSW among healthy joints is relatively minor. The gender-specific differences in the rate of JSW loss may be due to a variety of factors. Further study for the possible explanation of the gender and age-related effects on finger JSW is warranted to identify these potential factors. These findings aid our understanding of age and gender-related changes in JSW among healthy finger joints over time and highlight the importance of the inclusion of these demographic variables in the study of finger joint structure. These results can guide the design of future epidemiological and biomechanical studies.

SIGNIFICANCE/CLINICAL RELEVANCE: Demographic considerations, such as age and gender, are vital for clinical research, as it is known that certain phenomena can produce different observations for different gender and age groups. Understanding the variation of these phenomena with gender and age can aid in the design of future clinical studies and expand the relevancy of study results to a wider range of individuals.

REFERENCES: [1] Altman et al., Osteoarthritis Cartilage, 15, 2007. [2] Eaton et al., Arthritis and Rheumatology, 74, 2022. [3] Pfeil et al., Skeletal Radiol, 36, 2007.

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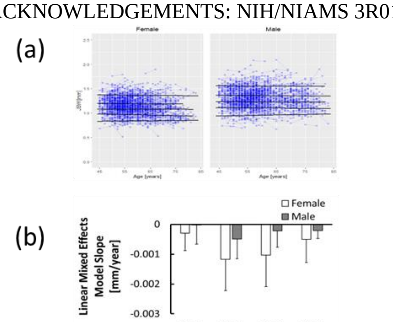

Figure 1: Linear mixed effects model results. (a) Linear mixed effects models for the male and female DIP2 joint. (b) Mean model slopes for the DIP (2-5) joints.

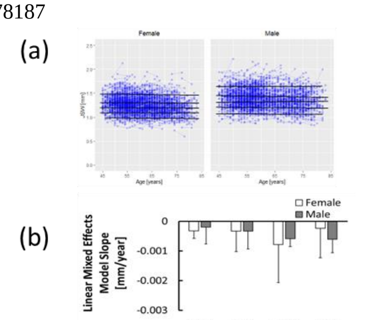

Figure 2: Linear mixed effects model results. (a) Linear mixed effects models for the male and female PIP2 joint. (b) Mean model slopes for the PIP (2-5) joints.

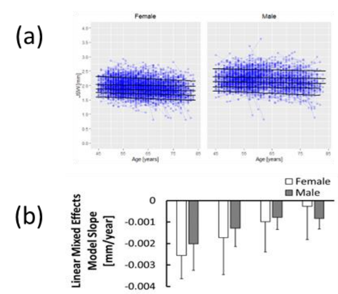

Figure 3: Linear mixed effects model results. (a) Linear mixed effects models for the male and female MCP2 joint. (b) Mean model slopes for the MCP (2-5) joints.