Development of an Automated Pipeline to Characterize Full Rib Cage Shape Variability

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INTRODUCTION

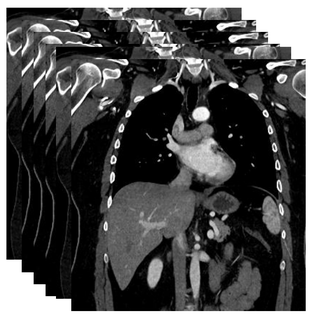
Thoracic injury remains a common injury outcome of motor vehicle crashes [1], but injury risk differs across populations [2, 3]. Such differences have been attributed to local and global geometric properties of the rib cage, which have been characterized via statistical shape models and morphological techniques [4-6]. However, past research primarily focuses on age-related changes, is limited in sample size when using the full rib cage and does not account for non-average geometries.

OBJECTIVES

1. Develop an automated pipeline to extract full rib cage measurements
2. Assess rib cage variability within the population

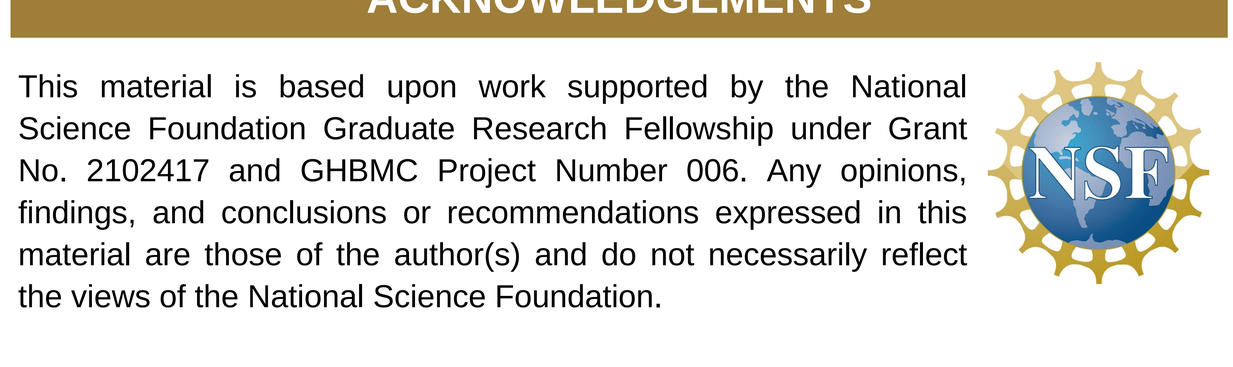
METHODS

1. Obtain CTs under #IRB00006511 from patients of AHWFB



2. Segment CTs using a ML-based segmentation tool [7]

3. Collect 10 rib cage measures using custom MATLAB code



4. Perform Statistical Analysis

Students t-test Comparing Measurements by Sex

Multivariate Multiple Regression

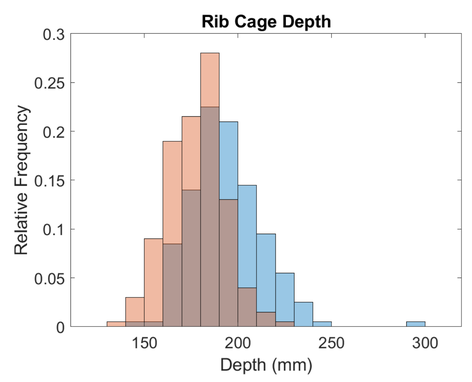
RESULTS

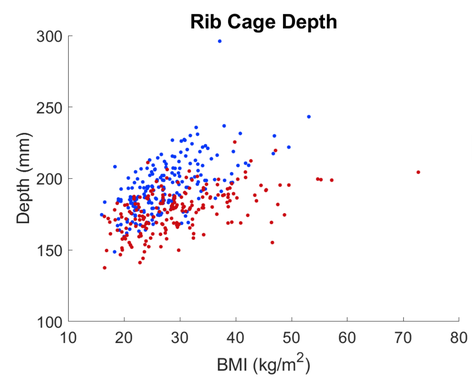
Study Population

Table 1. Subject Metadata

	Age (years)	Stature (m)	Weight (kg)	BMI (kg/m²)
Female (n = 200)	34.7 ± 6.2	1.64 ± 0.08	80.0 ± 24.0	29.7 ± 8.7
Male (n = 200)	34.1 ± 6.1	1.78 ± 0.08	88.0 ± 22.0	27.5 ± 6.2

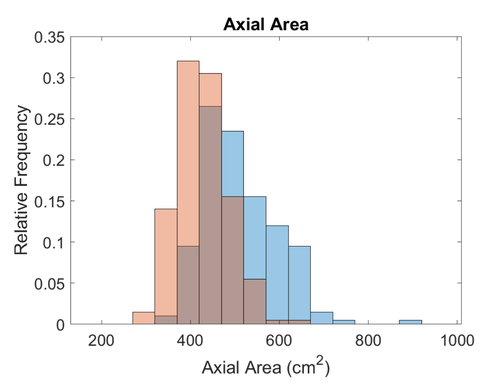
Measurement Distributions

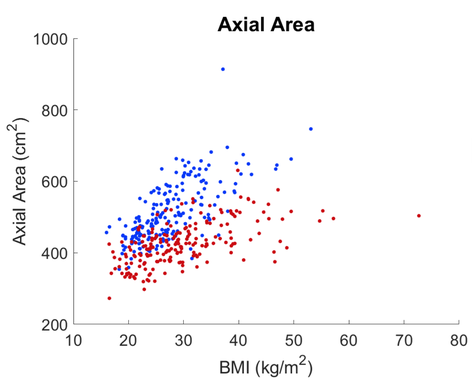




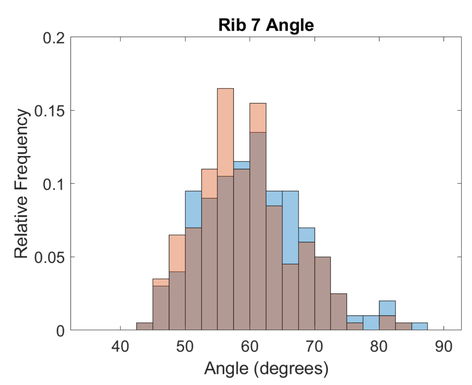
Adjusted-R^2

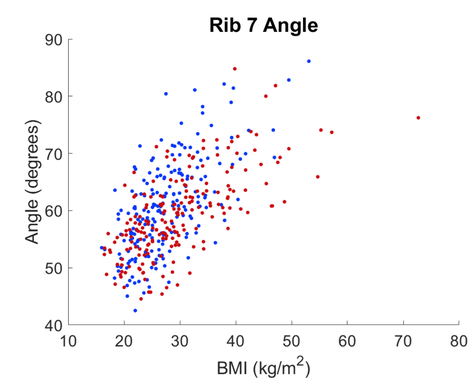
Female: 0.28
Male: 0.44





Female: 0.52
Male: 0.55





Female: 0.46
Male: 0.42

DISCUSSION & CONCLUSIONS

Males have statistically larger measurements than females except in angular measurements, although angles differ by less than 2 degrees. Demographics explain 27-55% of the variance in the measurements, variance explained increases with dimension. This dataset of real-world rib cages enables researchers to utilize diverse thoracic geometries in injury studies rather than relying on averages. In future work, this data will be used in computational models to predict injury risk for varying geometries.

ACKNOWLEDGEMENTS

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