A Statistical Human Head Geometry Model Considering Variations in Head Skin, Skull, and Brain among the Whole Population

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Introduction

Importance of Accurate Skull Modeling

- 7.3 million motor vehicle accidents occur annually in the U.S. Vehicle safety design is crucial to prevent such accidents
- Accurate skull modeling is vital for improving head injury assessments and enhancing safety features.

Limitations of Current Models

- Current models are based on three models: small female, midsize male, and large males, which fail to capture the variability in morphological dimensions across the broader adult population (Hu et al., 2021)

Objectives

Develop a Comprehensive Statistical Head Geometry Model

- Create a model that captures size and shape variations across the entire adult population to improve accuracy and inclusivity in safety and medical applications.
- Investigate correlations between skull and scalp parameters and key body metrics, such as age, height, BMI, and gender.
- Use the correlations to uncover patterns and relationships that enhance the predictive capabilities of the statistical model.

Application

- Utilize the improved model for advancements in vehicle safety design and personalized medical planning.

Discussion

Model Updates and Limitations

- Our updated model incorporates a larger sample size (n=181) spanning a broader age range and now includes the mandible in its statistical framework.
- This study is limited to examining morphological variations and does not address biomechanical or material variations in human tissues.

Moving forward

- Future efforts will aim to integrate this statistical model into baseline finite element (FE) models for risk and injury assessment applications.

Acknowledgements

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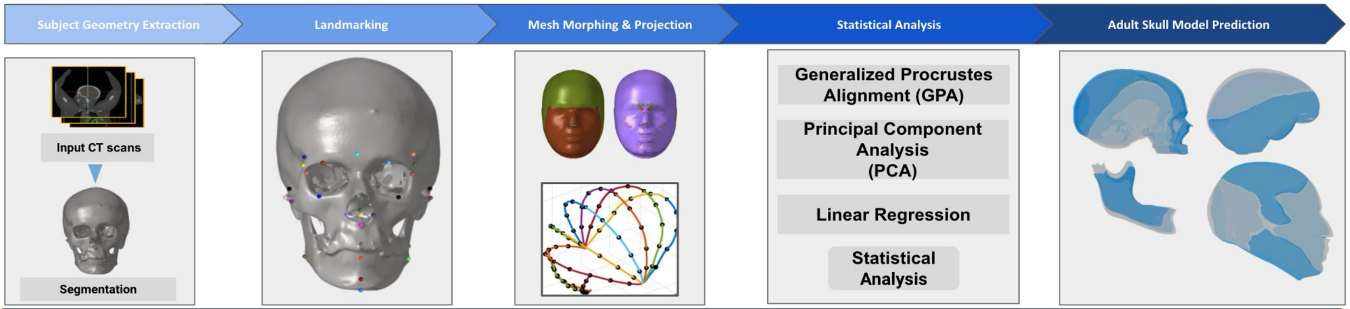
References

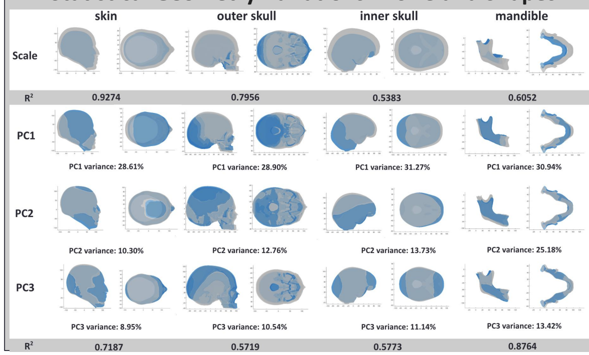
1. Bureau of Transportation Statistics. (2021). Motor Vehicle Safety Data.
2. Hu, J. & Jones, M. (2021). Adaptive Design for Human Mobility.

Methods



Results

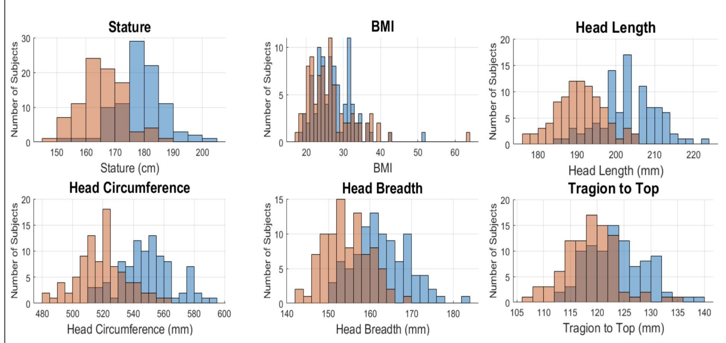
Statistical Geometry Variations In Size and Shapes



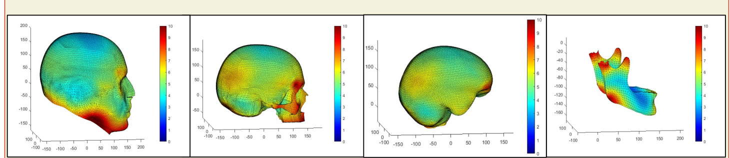
Correlations Among Covariate Predictors

	Age	Height	BMI	Gender	Head Circumference	Head Breadth	Head Length	Tragion To Top
Age	1	-0.1684	0.2088	0.02263	0.07935	0.1399	-0.07695	0.2473
Height	-0.1684	1	0.01212	0.6416	0.5456	0.5277	0.6143	0.3609
BMI	0.2088	0.01212	1	0.06368	0.2333	0.3223	0.133	0.2473
Gender	0.02263	0.6416	0.06368	1	0.6578	0.5669	0.6733	0.4427
Head Circumference	0.07935	0.5456	0.2333	0.6578	1	0.7422	0.8533	0.7844
Head Breadth	0.1399	0.5277	0.3223	0.5669	0.7422	1	0.5549	0.6502
Head Length	-0.07695	0.6143	0.133	0.6733	0.8533	0.5549	1	0.5785
Tragion To Top	0.2473	0.3609	0.2473	0.4427	0.7844	0.6502	0.5785	1

Subject Covariate Distribution



Prediction Errors



Residual Errors of Scaling Factor by Age