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SOPHIA K. TUSHAK, Ph.D.
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Dr. Sophia K. Tushak is a biomechanical engineer at Engineering Systems Inc. (ESi) in the Minnesota office. Dr. Tushak has expertise in injury causation analysis, experimental design and execution, imaging and video analysis, motion capture systems, injury detection and risk, computational modeling and simulation, analysis of vehicle crash databases, statistical analysis and data science. She has experience working with human surrogates, including biological tissue, anthropomorphic test devices, and computational models of the human body. At ESi, she is building her practice in a range of injury biomechanics investigative scenarios, such as motor vehicle crashes, product and premises liability claims, slips, trips, falls, and criminal matters.

Prior to joining ESi, Dr. Tushak earned her Ph.D. in Mechanical and Aerospace Engineering at the University of Virginia. Her doctoral research at the Center for Applied Biomechanics focused on quantifying traumatic lumbar spine fracture tolerance and developing statistical tools for predicting fracture risk in frontal vehicle crash scenarios. She also has researched pediatric biomechanics, multiple event crashes, reclined occupants, pelvis fractures, bone microstructure, and advanced statistical and computational modeling. She has presented her research at domestic and international conferences and is published in peer-reviewed scientific journals and conference proceedings, including the Journal of Biomechanics, Annals of Biomedical Engineering, Traffic Injury Prevention, Enhanced Safety of Vehicles, and International Research Council on Biomechanics of Injury.

Areas of Specialization

Human Injury Causation	Pediatric Injuries	Data Acquisition & Analysis
Injury Risk Analysis	Multiple Event Crashes	Diagnostic Imaging
Injury Tolerance & Mechanisms	Occupant Loading & Kinematics	Videography & Motion Analysis
Impact Biomechanics	Slips, Trips, Falls	Computational Modeling
Lumbar Spine Injury	Experimental Testing	Statistical Analysis

Education

Ph.D., Mechanical and Aerospace Engineering, University of Virginia, 2024

B.S., Biomedical and Health Sciences Engineering, NC State University, 2018

Professional Affiliations/Honors

International Research Council on Biomechanics of Injury

Best Presentation in Session, 2022, 2023, 2024

University of Virginia

Mechanical and Aerospace Engineering Outstanding Graduate Research Award, 2023

Copenhaver Charitable Trust Bicentennial Fellowship, 2022

Association for the Advancement of Automotive Medicine (AAAM)

H. Clay Gabler Scholars Award, 2022

Member, 2020 – Present

Institute of International Education Graduate International Research Experience Fellowship, 2020

National Science Foundation Graduate Research Fellowship, 2019 –2024

Biomedical Engineering Society (BMES), 2017 – 2019

NC State University

Abrams Scholar, 2016 – 2018

Biomedical Engineering Undergraduate Research Award, 2018

Women in Science and Engineering (WISE), 2016 – 2018

Children's Hospital of Philadelphia Student Research Day Best Presentation, 2018

Positions Held

Engineering Systems Inc., Plymouth, MN

Staff Consultant, 2025 – Present

University of Virginia, Department of Mechanical and Aerospace Engineering, Charlottesville, VA

Research Scientist, Center for Applied Biomechanics, 2024 – 2025

Graduate Research Assistant, Center for Applied Biomechanics, 2019 – 2025

Teaching Assistant, Strength of Materials & Continuum Mechanics, 2020 – 2021

Comillas Pontifical University, School of Engineering, Madrid, Spain

International Graduate Research Assistant, MoBios Laboratory, 2022

NC State University, Department of Biomedical Engineering, Raleigh, NC

Undergraduate Research Assistant, Orthopaedic Mechanobiology Laboratory, 2016 – 2018

Teaching Assistant, Orthopaedic Biomechanics, 2018

Children's Hospital of Philadelphia, Philadelphia, PA

Biomechanics Intern, Center for Injury Research and Prevention, 2018

Wake Forest University, Department of Biomedical Engineering, Winston-Salem, NC

Biomechanics Intern, Center for Injury Biomechanics, 2017 – 2018

Publications/Presentations

Journal Publications

1. **Tushak SK**, Chernyavskiy P, Gates B, George C, Gepner BD, Kerrigan JR. (2025). Does lumbar vertebra bone microstructure relate to combined loading fracture tolerance and inform fracture initiation site? Journal of Bone and Mineral Research, in review.
2. **Tushak SK**, Kerrigan JR. (2025). Characterization of the Lumbar Spine Dynamic Flexion Response Past its Physiological Range of Motion. Journal of Biomechanical Engineering, in review.
3. **Tushak SK**, Valdano M, Kerrigan JR, Lopez-Valdes FJ. (2025). The Effect of Varying Child Restraint System Seatback Angle on Spinal Loading of Toddler PIPER Human Body Models in Frontal Impacts. Traffic Injury Prevention, in review.
4. Kong JS, Chernyavskiy P, Hanggi C, **Tushak S**, Gepner B, Ostling M, Kerrigan J. (2025). Development of injury risk functions incorporating repeated measures in survival analysis with multiple samples from the same subject. Annals of Biomedical Engineering, in review.
5. Hanggi C, **Tushak S**, Garman E, Gepner B, Ostling M, Kerrigan J. (2025). Microstructure of the anterior iliac spine: identification of trends and relation to fracture tolerance. Journal of Mechanical Behavior of Biomedical Materials, in review.
6. **Tushak SK**, Gepner BD, Forman JL, Hallman JJ, Pipkorn B, Kerrigan JR. (2023). Human Lumbar Spine Injury Risk in Dynamic Combined Compression and Flexion Loading. Annals of Biomedical Engineering, 51:1216-1225.
7. **Tushak SK**, Donlon JP, Gepner BD, Chebbi A, Pipkorn B, Hallman JJ, Forman JL, Kerrigan JR. (2022). Failure Tolerance of the Human Lumbar Spine in Dynamic Combined Compression and Flexion Loading. Journal of Biomechanics, 135: 111051.
8. Tremoulet PD, Belwadi A, Corr B, Sarfare S, Seacrist T, **Tushak S**. (2021). How do novel seat positions impact usability of child restraints? TRIP, 10:100372.
9. **Tushak SK**, McMurry TL, Lee SH, Hong SH, Kerrigan JR. (2021). Comparison of injuries in multiple and single event crashes. Traffic Injury Prevention, 21: S90-S95.
10. **Tushak SK**, Tamburro MK, Fawcett EB, Merritt LE, Saul KR, Cole JH. (2020). Forelimb unloading impairs glenohumeral muscle development in growing rats. Journal of Orthopedic Research, preprint.
11. Belwadi A, Sarfare S, **Tushak S**, Maheshwari J, Menon S. (2019). Responses of the scaled pediatric human body model in the rear- and forward-facing child seats in simulated frontal motor vehicle crashes. Traffic Injury Prevention, 20(sup2):S143-S144.
12. Tremoulet PD, Seacrist T, McIntosh CW, Loeb H, DiPietro A, **Tushak S**. (2019). Transporting Children in Autonomous Vehicles: An Exploratory Study. *Human Factors,* 62(2): 278-287.

Conference Presentations with Proceedings

1. **Tushak SK**, Bollapragada V, O'Cain C, Shin J, Gepner BD, Pipkorn B, Kerrigan JR. (2024). The influence of subject-specific geometric morphing and soft tissue material scaling on lumbar spine biomechanical response. Proceedings of the International Research Council on the Biomechanics of Impact (IRCOBI).

2. **Tushak SK**, Gepner BD, Pipkorn B, Kerrigan JR. (2023). GHBMC-Specific Injury Risk Prediction for the Lumbar Spine Considering Two Different Metrics. Proceedings of the International Research Council on the Biomechanics of Impact (IRCOBI).
3. **Tushak SK**, Gepner BD, Pipkorn B, Kerrigan JR. (2022). Evaluation of the GHBMC Lumbar Spine in Subinjurious and Injurious Loading. Proceedings of the International Research Council on the Biomechanics of Impact (IRCOBI). September 14-16, Porto, Portugal.
4. **Tushak SK**, Richardson RE, Pipkorn B, Hallman JJ, Gepner BD, Forman JL, Kerrigan JK. (2020). A Method for Defining Failure Tolerance of the Lumbar Spine in Combined Loading. Proceedings of the International Research Council on the Biomechanics of Impact (IRCOBI). September 9-11, Munich, Germany.
5. **Tushak SK**, Maheshwari J, Belwadi A. (2019). Responses of the scaled infant human body model in simulated frontal motor vehicle crashes. *Proceedings of the 26th International Technical Conference on The Enhanced Safety of Vehicles (ESV)*. June 10-13, Eindhoven, Netherlands.
6. Decker W, Koya B, **Tushak S**, Shin J, Choi, HY, Pak W, Untaroiu, Gayzik FS. (2018). Use of Finite Element Human Body Models in a Standardized Evaluation Protocol for Pedestrian Safety Assessment. *Conference Proceedings of Human Modeling and Simulation.* October 18-19, Berlin, Germany.
7. **Tushak SK***, Tamburro MK*, Saul KR, Cole JH. *co-first authors. (2018). Development of a Rat Forelimb Unloading Model to Understand Mechanical Influences on Postnatal Shoulder Development. *Proceedings of the National Conference of Undergraduate Research.*

Additional Conference Presentations and Abstracts

1. **Tushak SK**, Kerrigan JR. (2023). Stiffness and biomechanical response of the human lumbar spine until injury: investigation of factors that may cause variation and creation of benchmarks for surrogate evaluation. 51st NHTSA Workshop on Human Subjects for Biomechanical Research, Ann Arbor, MI, October 30.
2. **Tushak SK**, Bollapragada V, O'Cain C, Shin J, Gepner BD, Pipkorn B, Kerrigan JR. (2023). The Influence of Subject-Specific Lumbar Spine Geometry and Bone Properties on Injury-Related Biomechanical Measurements. 67th Annual Scientific Conference of the Association for the Advancement of Automotive Medicine (AAAM), Indianapolis, IN, October 3-6. Keynote Speaker.
3. **Tushak SK**, Gepner BD, Kerrigan JR. (2022). Which anatomical parameters affect lumbar spine response in combined loading? 50th NHTSA Workshop on Human Subjects for Biomechanical Research, Denver, CO, November 6.
4. **Tushak SK**, Gepner BD, Forman JL, Hallman JJ, Pipkorn B, Kerrigan JK. (2021). Injury Risk Function for the Lumbar Spine in Combined Compression and Flexion. 65th Annual Scientific Conference of the Association for the Advancement of Automotive Medicine (AAAM), Virtual, October 19-22.
5. **Tushak SK**, McMurry TL, Lee SH, Hong SH, Kerrigan JR. (2020). Comparison of injuries in multiple and single event crashes. 64th Annual Scientific Conference of the Association for the Advancement of Automotive Medicine (AAAM), Virtual, October 13-16.
6. **Tushak SK***, Tamburro MK*, Fawcett EB, Dixit NN, Saul KR, Cole JH. *co-first authors. (2018). Glenohumeral Joint Development in Neonatal Rats Experiencing Forelimb Unloading. State of North Carolina Undergraduate Research and Creativity Symposium, Raleigh, NC.

7. **Tushak SK**, Maheshwari J, Belwadi A. (2018). The Development of PIPER 18MO Child Human Body Model and Its Response to Frontal Vehicle Impacts. Biomedical Engineering Society Annual Meeting, Atlanta, GA, October 17-20.
8. **Tushak SK**, Aira JR, Gayzik FS. (2017). Application of PIPER Software to Adjust Spinal Position of Human Body Models in Military Relevant Postures. Biomedical Engineering Society Annual Meeting, Phoenix, AZ, October 12-14.
9. **Tushak SK**, McCormick CM, Saul KR, Cole JH. (2017). Contributions of mechanical unloading to neonatal brachial plexus injury in rats. National Conference on Undergraduate Research, Memphis, TN, April 6-8.