



ZOE VILLAMAR, Ph.D.

PROFESSIONAL BIOGRAPHICAL OUTLINE

BACKGROUND

Dr. Villamar received a Bachelor of Science in Biomedical Engineering from Virginia Commonwealth University. She went on to obtain a Master of Science degree as well as a Ph.D. in Biomedical Engineering from Northwestern University. Dr. Villamar also completed certificate programs in Research Communication at The Graduate School at Northwestern University, and Management for Scientists and Engineers at Kellogg School of Management at Northwestern University, and a Machine Shop Certification at the Shirley Ryan Ability Lab. Dr. Villamar has been heavily involved in academic research for the past decade. She began investigating neurological and visual deficits in individuals with traumatic brain injuries at Virginia Commonwealth University. At Northwestern University, she utilized ultrasound imaging techniques to investigate lower extremity soft tissue structures in individuals following neurological stroke. As her Master's project, Dr. Villamar continued to investigate muscle neurological responses in addition to muscle structures. Specifically, she investigated reflex and other neurological responses in the upper extremity with varying levels of voluntary neuromuscular activation and control. As part of Dr. Villamar's Ph.D., she directed a series of research projects to understand the biomechanical deficits in individuals with recurring ankle sprains. This research involved designing and implementing testing protocols with robots and human volunteers, investigating the effect of mechanical loading on the human ankle, and using medical imaging in collaboration with medical doctors to understand the biomechanical contributions of pre-existing bony abnormalities. Dr. Villamar has published her work as the primary author in peer-reviewed articles in academic journals.

At ARCCA, Dr. Villamar continues to be involved with testing programs assessing human movement, responses to impacts, and tolerance thresholds for various scenarios (both automotive and non-automotive) using anthropomorphic test devices. Dr. Villamar has been engaged in various testing programs with anthropomorphic test devices, including falls from heights, drop testing, and head impacts. In addition to her background in biomechanics, Dr. Villamar has training in the field of accident reconstruction with experience that includes motor vehicle component testing, photogrammetric analyses, automotive crash testing, and crash data retrieval systems. Dr. Villamar has also conducted numerous inspections in residential and commercial environments in relation to applicable codes/standards and premise liability in addition to vehicle inspections in relation to motor vehicle collisions. With this hands-on experience, Dr. Villamar is able to conduct complete analyses for a breadth of incidents. Overall, Dr. Villamar's expertise includes, but is not limited to, severity analyses, human movement, injury mechanisms, reaction and perception, and human factors. With her background and unique skillset, Dr. Villamar is capable of understanding human responses to a variety of impact events, and assessing whether or not injury mechanisms were created by a subject event.

SUMMARY OF EXPERIENCE

- Designs and implements testing protocols, including with anthropomorphic test devices, to quantify the effect of external loading on the human body under various scenarios and the resulting internal loading experienced
- Utilizes peer-reviewed and generally-accepted engineering principles and methodologies to assess the severity of an event and its imposed forces and accelerations as part of injury causation analyses
- Evaluates occupant kinematics, kinetics, human tolerance, and human factors during automotive vehicle incidents and other scenarios
- Uses biomechanics and human factors to analyze slip, trip, and fall events
- Assesses peer-reviewed scientific literature to perform comprehensive analyses and support findings

AREAS OF SPECIALTY

- Anatomy and Physiology
- Kinematics and Kinetics
- Joint Biomechanics
- Injury Causation Biomechanics
- Human Injury Tolerance and Mechanisms
- Human Factors Analyses
- Vehicular Accident Reconstruction
- Visual Tracking
- Lower Extremity Musculoskeletal Mechanics

EDUCATION

- Ph.D. in Biomedical Engineering, Northwestern University (NU), Evanston, IL, 2023
 - Research Concentration: Rehabilitation
 - Dissertation Title: Load-dependent contributions to frontal-plane ankle stiffness and their relevance to Chronic Ankle Instability
- M.S. in Biomedical Engineering, Northwestern University, Evanston, IL, 2022
- B.S. in Biomedical Engineering, Virginia Commonwealth University, Richmond, VA 2018
 - Minor in Mathematics
 - University Honors
 - Latin Honors *Magna Cum Laude*

CERTIFICATIONS

- Management for Scientists and Engineers, Kellogg School of Management, Northwestern University, August 2022
- Research Communication Training Program, Northwestern University, August 2021
- Machine Shop Training, Shirley Ryan AbilityLab, July 2019 (recertification September 2022)

PROFESSIONAL EXPERIENCE

September 2023 – Present | ARCCA, LLC | Senior Biomechanist

- Utilizes peer-reviewed and generally accepted techniques to determine the presence or absence of biomechanical failures through investigation of an event's severity, an individual's response, and the direction and magnitude of the forces applied.
- Applies knowledge of anatomy, physics, and biomechanical principles to perform injury causation analysis based on an event's associated inertial and impact forces and an individual's unique biological attributes and responses.
- Uses biomedical engineering principles to analyze forensic evidence, e.g. via vehicular/site inspections, to reconstruct dynamic events, such as a motor vehicle collision, a sporting injury, or a slip, trip, fall event.
- Uses biomedical investigations involving human volunteers and anthropometric devices to analyze human response to an event, injury mechanisms, and human tolerance.
- Communicates findings of scientific analyses in the form of verbal and written reports.

- Investigates predictive models of athletic performance through the design, development, and implementation of machine learning algorithms

August 2018 – June 2023 | Northwestern University / Shirley Ryan AbilityLab | Research Assistant

- Performed thorough literature reviews to uncover significant gaps in knowledge in injury biomechanics.
- Designed and performed experiments on dozens of human participants with biomechanical equipment, including electromyography, motion capture, load cells, actuators, etc.
- Spearheaded new area of research in the lab involving chronic ankle injuries and novel use of imaging techniques alongside biomechanical measures.
- Authored scientific grant proposals for various agencies to secure \$2,000 in funds for a new area of research.

January 2021 – March 2021 | Dept. of Biomedical Engineering, Northwestern University | Teaching Assistant

- Assisted with teaching an undergraduate course focusing on quantitative physiological measurements and analyses, instrument characterization, design of experiments, and training in preparation and organization of laboratory notes and reports

June 2017 – August 2017 | Northwestern University / Shirley Ryan AbilityLab | Research Intern

- Investigated muscle structure and mechanics in individuals post-stroke using medical imaging techniques

June 2015 – May 2018 | Virginia Commonwealth University | Research Assistant

- Conducted research in a rehabilitation engineering laboratory involving eye movement tracking
- Contributed to data analysis of eye movements for research projects about mild traumatic brain injuries in military personnel; and individuals with neurodegenerative disorders, and individuals with addictive disorders.
- Designed and implemented eye movement stimuli and protocols for data collection of eye movements

SELECTED PUBLICATIONS

Journal Articles

Villamar Z, Ludvig D, Perreault EJ. Short-latency stretch reflexes depend on the balance of activity in agonist and antagonist muscles during ballistic elbow movements. *J Neurophysiol.* 2023 Jan 1;129(1):7-16.

Villamar Z, Perreault EJ, Ludvig D. Frontal plane ankle stiffness increases with axial load independent of muscle activity. *J Biomech.* 2022 Oct;143:111282.

Wetzel PA, Lindblad AS, Raizada H, James N, Mulatya C, Kannan MA, **Villamar Z**, Gitchel GT, Weaver LK. Eye Tracking Results in Postconcussive Syndrome Versus Normative Participants. *Invest Ophthalmol Vis Sci.* 2018 Aug 1;59(10):4011-4019.

Conference Proceedings

Lindblad AS, Wetzel PA, Li, Weaver LK, Mulatya C, Wilson SH, Kannan MA, **Villamar Z**; Eyetracker outcomes in a randomized trial of hyperbaric oxygen or sham in participants with persistent post-concussive symptoms. *Invest. Ophthalmol. Vis. Sci.* 2018;59(9):2318.

INVITED PRESENTATIONS

Villamar ZD, Perreault, EJ, Ludvig, D. Frontal plane ankle stiffness increases with load independent of muscle activation. *North American Congress on Biomechanics*, Ottawa, CA August 21-25, 2022

Villamar ZD, Ludvig, D., Perreault, EJ. Short latency stretch reflexes depend on the balance of activity in agonist and antagonist muscles during ballistic elbow movements. *International Society of Electrophysiology and Kinesiology World Congress*, Quebec City, CA June 22-25, 2022

Villamar ZD, Ludvig, D, Perreault, EJ. Stretch reflex modulation during ballistic movements are explained by the activity in agonist and antagonist muscles. *International Society of Electrophysiology and Kinesiology Virtual Congress XXIII*, July 12-14, 2020

Villamar Z, Rymer W, Son Jongsang, Saadat F. (2017) Changes in Muscles Architecture during Isometric Contractions in Stroke Survivors. Poster Presentation at the *Biomedical Engineering Society Annual Meeting*, Phoenix, AZ, October 11-14. 2017

Villamar ZD; Wetzel PA. Using Eye Movement Measurement and Analysis during a Reading Task to Assess the Effect of mTBI on the Saccadic System. Oral Presentation at the *Annual Biomedical Research Conference for Minority Students*. Tampa, FL, November 10-12, 2016.

Villamar ZD; Wetzel PA. Effect of Mild Traumatic Brain Injury on Eye Movements during Performance of a Memory-Guided Task. Poster Presentation at the *Annual Biomedical Research Conference for Minority Students*. Seattle, WA, November 12-14, 2015.

PROFESSIONAL AFFILIATIONS AND SERVICE

- Member, American Society of Biomechanics
- Member, Biomedical Engineering Society
- Member, International Society for Electrophysiology and Kinesiology
- Member, Society for Neuroscience
- Member, Tau Beta Pi, Engineering Honor Society
- Reviewer, Conference Proceedings of IEEE Engineering in Medicine and Biology Society

RESEARCH SUPPORT AWARDS

- Graduate Student Grant-in-Aid, American Society for Biomechanics, 2022
 - Awarded \$2000 to support research needs such as equipment, materials and supplies, animal or participant costs (including participant travel), and statistical consulting services or other research services.
- Pathophysiology and Rehabilitation of Neural Dysfunction NIH T32 Predoctoral Training Fellowship 2020 – 2022
 - Received 2 years of graduate school stipend, tuition, travel, and other training-related expenses at Northwestern University
- Initiative to Maximize Student Development NIH Training Program Undergraduate Scholar, 2015-2018
 - Received 3 years of funding as an undergraduate research assistant at Virginia Commonwealth University

HONORS AND AWARDS

- President's Choice Best Poster Award, American Society for Biomechanics Meeting, August 2023
- Travel Award, American Institute for Medical and Biological Engineering, September 2022
- Diversity Travel Award, International Society of Electrophysiology and Kinesiology, June 2022
- Neuroscience Scholars Program Associate, Society for Neuroscience, 2020
- Mark A. Sternheimer Senior Capstone Design Award Winner, Virginia Commonwealth University School of Engineering, 2017
- Best Oral Presentation in Engineering, Physics, Mathematics, Annual Biomedical Research Conference for Minority Students, Tampa, FL, 2016

LEADERSHIP EXPERIENCE & SERVICE

2022 – 2023: Co-President, Biomedical Engineering Graduate Student Organization (BMEGS), NU

2021 – 2022: Senior Social Chair, BMEGS, NU

2021 – 2022: Mentor, Graduate Student Engagement and Community, Cientifico Latino

2020 – 2022: Member, BMEGS Diversity Committee, NU

2020 – 2021: Mentor, Graduate Student Mentorship Initiative, Cientifico Latino

2020 – 2021: BMEGS Diversity Subcommittee Member – SMART Goals, NU

2020 – 2021: BMEGS Diversity Subcommittee Member – Undergraduate Involvement, NU

2019 – 2021: Social Chair, Biomedical Engineering Graduate Student Group (BMEGS), NU