

Sriram S. Muralidhar

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EDUCATION

University of Southern California

Jan 2025- present

Postdoctoral fellow, Division of Biokinesiology and Physical Therapy

Advisor: Dr. James Finley

The Ohio State University

Dec 2024

PhD, Mechanical Engineering

Advisor: Dr. Manoj Srinivasan

National Institute of Technology, Karnataka, India

May 2019

BTech, Mechanical Engineering

RESEARCH PROJECTS

1. Development of Novel Models of Human Energetics

I have made fundamental contributions to understanding how metabolic energy expenditure scales with muscle force production in humans. Through carefully designed human experiments measuring oxygen consumption during static force production tasks, I established that metabolic cost scales non-linearly with force following a power law relationship challenging previous linear or quadratic assumptions in biomechanics. I further characterized metabolic cost during time-varying forces, discovering that cost scales with force rate and that decreasing force is metabolically more expensive than increasing force—a finding not captured in existing models. These models provide essential tools for understanding energetic constraints on human movement and have applications in rehabilitation, assistive device design, and predictive biomechanical simulations.

2. Theoretical Foundations Linking Muscle-Level and Joint-Level Energetics

I established theoretical connections between metabolic cost at different scales of motor organization—from individual muscles to multi-joint coordination. Through mathematical formulation, I demonstrated that the power-law scaling of metabolic energy at the joint level implies specific muscle-level cost. This theoretical work provides a foundation for future multi-scale models connecting molecular mechanisms of muscle contraction to whole-body metabolic expenditure, offering a framework to validate and refine existing cross-bridge and Hill-type models against human-level experimental data.

3. Development of predictive models of Human force coordination during static tasks

I demonstrated that humans organize their force coordination to minimize metabolic cost in a manner consistent with the non-linear energy-force relationships I characterized. Through bilateral force-sharing experiments involving both upper and lower limbs, I showed that the non-linear metabolic cost model predicts how humans distribute forces between legs, hands, fingers significantly better than traditional linear, quadratic, or signal-dependent noise models. I provided theoretical evidence that this metabolic optimization principle may extend from the joint level to individual muscle coordination, suggesting a unifying framework for understanding multi-joint, multi-muscle motor control. This work bridges bioenergetics and motor control theory, offering insights into both healthy movement patterns and potential markers of movement disorders.

4. Computational Biomechanics of Yoga: Novel Dataset and Simulation Framework

I developed an innovative computational framework to predict joint torques and contact forces during static yoga poses using metabolic cost minimization. By analyzing 55 diverse yoga poses through 2D sagittal plane biomechanical modeling in MuJoCo, I generated the first comprehensive dataset of joint kinematics, kinetics, and contact forces. This dataset and simulation framework provide evidence-based foundations for developing yoga-based therapeutic interventions for movement disorders and injuries, and demonstrate the utility of metabolic cost models in whole-body predictive simulations.

5. Quantifying perceived risk and balance capacity while walking with external perturbations

Developed a treadmill perturbation paradigm that measures perceived fall risk and perceived balance capacity during walking. Faster walking and backward slips raised perceived risk and lowered perceived capacity. The effect of tying the arms varied by person, with no consistent group effect. This sets up a way to measure how aging, disease, and injury change people's sense of risk.

5. Relating perceived risk to biomechanical response

We are currently working on how biomechanical measures, such as COM kinematics and joint kinematics, relate to people's perceived risk in the treadmill perturbation paradigm. This helps us understand the link between mechanics and perception.

6. Influence of Fatigue on actual and perceived risk while walking with external perturbations

We are developing a new protocol to objectively induce fatigue and combining it with the treadmill perturbation paradigm to assess perceived and actual risk.

JOURNAL PUBLICATIONS AND PREPRINTS

S. S. Muralidhar, N. Marin, C. Melick, H. Ryu, A. Alwan, Z. Wang, R. Baldwin, K. Heitman, S. Walcott, and M. Srinivasan. Energy Cost for Force Changes Is Nonlinear and This Nonlinearity Predicts Human Forces in Legs, Arms, Fingers, and Muscles. [Pre-print available](#)

S. S. Muralidhar and Manoj Srinivasan. Biomechanical simulation of 55 yoga poses reveals that the yoga poses are more diverse kinematically than kinetically. [Pre-print available](#)

Bandyopadhyay, S., **Sriram, S.M.**, Parihar, V., Das Gupta, S., Mukherjee, R. and Chakraborty, S., 2019. Tunable adhesion and slip on a bio-mimetic sticky soft surface. *Soft Matter*, 15(44), pp.9031-9040.

CONFERENCE PRESENTATIONS

S. S. Muralidhar, A. Sirignano, N. Kamfwa and J. Finley. Impact of Walking Speed, Perturbation Direction, and Arm Constraints on Perceived Balance Capacity and Fall Risk. World Congress of Biomechanics, Vancouver, CA, 2026.

S. S. Muralidhar, N. Marin, C. Melick, H. Ryu, A. Alwan, Z. Wang, R. Baldwin, K. Heitman, S. Walcott, and M. Srinivasan. Energy Cost for Force Changes Is Nonlinear and This Nonlinearity Predicts Human Forces in Legs, Arms, Fingers, and Muscles. World Congress of Biomechanics, Vancouver, CA, 2026.

Petersen, D.J., **Muralidhar, S.**, Srinivasan, M. and Walcott, S., 2026. BPS2026-Energy cost scales supralinearly with muscle force, and the emergence of this nonlinearity from fiber recruitment. *Biophysical Journal*, 125(4), p.193a.

S. S. Muralidhar and M. Srinivasan. Biomechanical Simulation of 55 yoga poses reveals that the yoga poses are more diverse kinematically than kinetically. Annual Meeting of the American Society of Biomechanics, Knoxville, TN, 2025.

S. S. Muralidhar, K. Heitmann, R. Baldwin, S. Walcott, M. Srinivasan. Metabolic cost model for time-varying isometric force contractions: cost to reduce force more than increasing. Annual Meeting of the American Society of Biomechanics, Madison, WI, 2024.

S. S. Muralidhar, S. Walcott, M. Srinivasan. Human behavior is predicted well by minimizing effort but not signal-dependent noise. Conference on Dynamic Walking, Pensacola, FL, 2024.

S. S. Muralidhar, N. Marin, C. Melick, Z. Wang, A. Alwan, S. Walcott, M. Srinivasan. Metabolic Cost for Isometric Force Scales Nonlinearly with Force and Predicts Bilateral Limb Force Sharing. 5th Rocky Mountain Muscle Symposium, Canmore, 2023.

S. S. Muralidhar, N. Marin, Z. Wang, M. Srinivasan. Force sharing task with hands: An optimality framework from experiments. North American Congress on biomechanics, Ottawa, 2022.

S. S. Muralidhar, N. Marin, C. Melick, Z. Wang, A. Alwan, M. Srinivasan. Force Sharing: Cost Minimized by Humans is Correlated with Metabolic Cost of Force. Conference on Dynamic Walking, Madison, Wisconsin, 2022.

PROPOSAL WRITING EXPERIENCE

- Submitted a NSF style proposal to the USC Zumberge Interdisciplinary Research Award (summer 2026). Awaiting result.
- Submitted a proposal to the Ohio State Alumni Grants for Graduate Research and Scholarship for International Research (fall 2023). Not funded.
- Seminar course on NIH grant writing (fall 2023): Semester-long course on proposal writing, requiring all students to complete a full NIH R21 proposal by the end of the course. I wrote a proposal on the Mechanics of Yoga, combining experiments, machine learning, and physics-based biomechanical modeling.
- Future Academic Scholars Training II (fall 2022): Semester-long course on different aspects of being a faculty member and required all students to write a one-page NSF project summary.

AWARDS

- Winner of 3 min thesis competition organized by the Department of Mechanical and Aerospace Engineering for the year 2022.
- Winner of \$500 travel grant to attend Dynamic Walking 2024.
- Departmental ambassador award of \$1000 for professional development and conference travel 2022-2023.

TEACHING EXPERIENCE

- Teaching assistant for Capstone (fall 2025): Mentoring multiple teams on design projects.
- Future Academic Scholars Training I (fall 2022): Semester-long course on teaching best practices and delivered two mock lectures covering an undergraduate course assessed by multiple faculty members.
- Teaching assistant for System dynamics and Vibrations (fall 2021): Creating example problems, conducting recitation lectures, and helping students during office hours.
- Grader for Statics (fall 2019): Grading assignment and quizzes.

MENTORING

- Training
 - Integrated Movement Science Institute Excellence in Mentoring Certificate
- Mentees
 - Shad Bello, Neuroscience Undergraduate, Summer intern 2025
 - Nkumbu Kamfwa, Biology Undergraduate, Summer intern 2025
 - Ava Sirignano, M.S. in Biokinesiology, 2025-2026
 - Avanthi Obadage, Mechanical Engineering Undergraduate, Summer intern 2026
 - Aaron Matthews, Psychology Undergraduate, Summer intern 2026

SERVICE

Reviewer

- Journals
 - Gait and Posture (2026-Present)
 - Journal of Experimental Biology (2026-Present)
 - IEEE Transactions of Biomedical Engineering (2025-Present)
- Conference
 - American society of Biomechanics Annual meeting 2025
 - World Congress of Biomechanics Annual Meeting 2026

Graduate Ambassador, Mechanical and Aerospace Engineering

Columbus, OH
August 2022- 2023

- Participated in incoming graduate student orientations, panel discussions, and mentoring events.
- Collaborated with department staff in organizing research seminars, poster presentations, and lab tours for incoming and potential students.
- Publicized the department at university-wide recruitment events.

Co-founder and convenor, Biomechanics interest group, The Ohio State University

Columbus, OH
August 2022- 2023

- Organized monthly meetings of biomechanics graduate students across all the departments at Ohio State. The meetings include lab tours, individual research presentations, professional development sessions, or faculty presentations.

Biomechanics Outreach, The Ohio State University

Columbus, OH

- Organized lab tours and seminar presentations on biomechanics for middle and high school students
- Organized school outreach during National Biomechanics Day by making videos on select topics in biomechanics, virtual panel discussions, and in-person lab tours.

TECHNICAL AND SOFTWARE SKILLS

Technical: Biomechanics data collection and analysis (motion capture systems, force plates, EMG, IMU, indirect calorimetry, real-time feedback, and data acquisition systems), data-based modeling, optimization, inverse optimization and model parameter estimation, musculoskeletal modeling and simulation, hardware-in-the-loop optimization, machine learning, some computer vision and fabrication (3D printing).

Software: MATLAB (optimization, simulation, machine learning, etc.), Python (optimization, machine learning, simulation, etc.), Vicon Nexus (marker-based motion capture), OpenSim (biomechanical simulation), Arduino (microcontroller robot control), MuJoCo (multibody simulation), OpenCV (computer vision)

RELEVANT COURSEWORK

Advanced dynamics, Introduction to Musculoskeletal Biomechanics, Experimental methods in biomechanics, Advanced human and animal movement, Real-time robotics, Autonomy in vehicles, Reinforcement learning, Machine learning, Seminar on NIH Grant Writing, Future academic scholars training 1 and 2.